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Entrepreneur Approach: Implementation of Telemedicine System for Early Detection of Stunting in Wonoayu Village, Sidoarjo

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ABSTRACT Stunting remains a major public health challenge in Indonesia, particularly in rural areas where access to healthcare services and health monitoring systems is limited. Wonoayu Village in Sidoarjo is one of the regions still struggling with inadequate early detection of stunting among children under five. The absence of an integrated digital health monitoring system has hindered timely interventions and effective data management. This study aims to enhance early detection and prevention of stunting by implementing a telemedicine-based system through the development of the *Pelita* application. The program, carried out under the Partner Village Development Program (PPDM), employed several stages including the development of the *Pelita* telemedicine application, training and socialization for *Posyandu* cadres, provision of tablet devices to facilitate application usage, and implementation in local *Posyandu* activities. The *Pelita* application was designed to collect anthropometric data such as height, weight, and age and automatically analyze it to identify stunting risk based on WHO growth standards. Results demonstrated significant improvement in the ability of *Posyandu* cadres to monitor child growth and health conditions more accurately and efficiently. The system enhanced data accessibility, minimized manual recording errors, and allowed faster health interventions. Additionally, the program empowered local health cadres through digital literacy and strengthened the capacity of rural healthcare monitoring. In conclusion, implementing the telemedicine-based *Pelita* system proved effective in improving early detection of stunting in Wonoayu Village. The program not only facilitated structured health data management but also promoted sustainable community-based healthcare innovation that can serve as a replicable model for other regions in Indonesia.

INDEX TERMS Stunting, telemedicine, pelita application, *posyandu*, early detection.

I. INTRODUCTION

Stunting, a form of chronic malnutrition characterized by impaired linear growth, remains a major global health concern, particularly in low- and middle-income countries (LMICs) [1]. In Indonesia, approximately 21.6% of children under five are stunted, placing the nation among those with the highest prevalence in Southeast Asia [2]. Stunting is not merely a nutritional issue it is strongly associated with delayed cognitive development, poor school achievement, reduced productivity, and increased susceptibility to chronic diseases in adulthood [3], [4]. Despite national interventions, the decline in stunting prevalence has been gradual, indicating that existing health monitoring and nutritional programs remain insufficient, particularly in rural and underserved areas [5]. Limited access to healthcare, low parental awareness, and inefficient data management systems exacerbate the challenges in early identification and intervention [6].

Community-based health programs such as *Posyandu* (Integrated Health Posts) serve as Indonesia's frontline in child growth monitoring. However, traditional manual data collection remains prone to measurement inaccuracies, incomplete reporting, and delays in data submission, which hinder the timely detection of growth deviations [7]. Furthermore, anthropometric data recorded on paper are often lost or inconsistent, resulting in fragmented health information across local and regional levels [8]. This challenge highlights the urgent need for digital transformation in public health data systems, especially for early detection of child growth problems. Recent studies suggest that digital health interventions can enhance data accuracy, improve monitoring efficiency, and facilitate early diagnosis in remote areas [9], [10].

Technological innovation through mobile health (mHealth) and telemedicine has transformed health service delivery in developing countries [11]. Evidence from global health programs shows that mobile applications designed for community health workers can increase screening coverage, improve data quality, and reduce administrative burden [12], [13]. In Indonesia, initiatives such as *iPosyandu* and *e-PPGBM* have been introduced to digitalize child health

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Vol. 4 No.1, pp. 168-174, March 2025

reporting, leading to improvements in data completeness and accessibility [14], [15]. However, these systems often face challenges such as unreliable internet connectivity, low digital literacy among cadres, and lack of interoperability with national databases [16], [17]. Previous research also emphasizes that without adequate user training and supportive supervision, digital interventions may fail to produce sustainable behavioral and service delivery changes [18]. Thus, there remains a critical research gap in developing and evaluating a telemedicine-based system that is low-cost, user-friendly, and capable of integrating with local Posyandu workflows for early stunting detection.

This study addresses that gap by developing and implementing *Pelita*, a telemedicine application designed to facilitate early detection of stunting in Wonoayu Village, Sidoarjo. The *Pelita* system collects anthropometric parameters such as height, weight, and age, automatically calculates WHO Z-scores, and stores the results in a centralized database accessible to healthcare professionals [19]. The program was implemented through the Partner Village Development Program (PPDM) and involved several key stages designing the telemedicine-based *Pelita* application, training and empowering *Posyandu* cadres, providing tablet devices to support application use, and monitoring its implementation in community health activities. The contributions of this study are threefold.

1. Introduces a telemedicine-based innovation that enhances early detection and monitoring of stunting at the community level.
2. Demonstrates an implementation model that integrates digital technology with local health systems through cadre empowerment and continuous supervision.
3. Provides empirical evidence and policy insights that can serve as a scalable model for other regions facing similar challenges in rural healthcare digitalization [20].

The remainder of this paper is structured as follows: Section II explains the research methodology and program implementation; Section III presents the results of the *Pelita* application deployment and evaluation; Section IV discusses the findings in the context of existing telemedicine literature; and Section V concludes with recommendations for sustainability and replication.

II. METHOD

This study presents the methodological framework used to evaluate the implementation of the *Pelita* telemedicine application in improving early detection of stunting in Wonoayu Village, Sidoarjo. The procedures were designed to ensure scientific rigor, transparency, and replicability. This section includes the study design and rationale, research setting, participant characteristics, materials and educational intervention, data collection instruments and procedure, data analysis, and ethical considerations. Both quantitative and qualitative approaches were employed to assess the usability and effectiveness of the intervention.

A. STUDY DESIGN AND RATIONALE

A prospective quasi-experimental design was utilized to assess the feasibility and impact of the *Pelita* telemedicine system on the accuracy and efficiency of *Posyandu* cadres in detecting stunting. The study was conducted under the Partner Village Development Program (PPDM) framework. This design was selected to enable community-level intervention in real settings where randomization was not feasible. The research aimed to measure improvement in anthropometric data collection, entry precision, and reporting timeliness before and after using the telemedicine-based application [21], [22].

B. STUDY SETTING

The study was conducted in Wonoayu Village, located in Sidoarjo Regency, East Java, Indonesia. The area was selected due to its limited access to digital health resources and persistent prevalence of childhood stunting. Five *Posyandu* (community health posts) were purposively chosen based on operational consistency, number of registered children, and cadre participation. The study lasted for six months (March-August 2024) and aligned with the regular *Posyandu* monitoring schedule to ensure data validity [23].

C. PARTICIPANTS AND SAMPLING METHOD

The population consisted of 120 children aged 6–59 months and 20 *Posyandu* cadres actively engaged in monthly growth monitoring. Inclusion criteria for children were active registration in local *Posyandu*, absence of chronic illness, and consent from caregivers. Sampling was carried out using a purposive method to ensure participants met inclusion requirements and could represent the target population. Randomization was not implemented since the study focused on evaluating feasibility rather than causal outcomes [24].

D. MATERIALS AND EDUCATIONAL INTERVENTION

The main intervention utilized the *Pelita* telemedicine application designed for Android tablets to assist cadres in measuring, recording, and analyzing anthropometric data in real time. The system automatically calculated Z-scores using WHO Child Growth Standards and stored information in an encrypted cloud-based database. Each *Posyandu* was equipped with an Android tablet (4 GB RAM), a digital weighing scale, and a stadiometer. A structured two-day training program was conducted to enhance cadres' digital literacy, understanding of telemedicine, and data entry accuracy. The training applied interactive demonstrations and simulations to ensure effective learning [25], [26].

E. DATA COLLECTION INSTRUMENTS AND PROCEDURE

Data collection was conducted through a sequence of activities involving development, training, implementation, and evaluation. The *Pelita* application served as the primary data collection instrument, enabling digital input of anthropometric variables such as height, weight, and age. During each *Posyandu* session, cadres measured children's growth parameters and entered the results directly into the application, which automatically analyzed Z-scores to determine stunting

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Vol. 4 No.1, pp. 168-174, March 2025

risk categories. The data were then synchronized with a central server for storage and monitoring by midwives and researchers. Training and simulation sessions were provided before implementation to ensure that cadres were competent in using the system. Throughout the six-month study period, supervision visits and technical monitoring were performed to ensure consistent data quality, system reliability, and compliance with measurement standards. Feedback from users was collected through structured questionnaires and focus group discussions at the end of the intervention to assess usability, accuracy, and satisfaction [27], [28].

F. DATA ANALYSIS

Data analysis combined quantitative and qualitative approaches to obtain comprehensive insights into the intervention's effectiveness. All collected data were coded, entered, and analyzed using IBM SPSS Statistics version 26.0.

1. DESCRIPTIVE STATISTICAL ANALYSIS

Descriptive statistics summarized participant demographics and anthropometric characteristics. Variables such as cadre age, education, experience, and children's growth parameters (weight, height, Z-score) were analyzed using means, frequencies, and percentages. The results were visualized in tables and graphs to highlight changes between pre- and post-intervention [28].

2. INFERENTIAL STATISTICAL ANALYSIS

The Wilcoxon signed-rank test was applied to compare pre- and post-intervention performance because the data were ordinal and paired. For continuous data such as entry time and reporting timeliness, the paired t-test was used. Statistical significance was determined at $p < 0.05$, indicating a meaningful difference in data accuracy and efficiency due to the *Pelita* intervention [29].

3. QUALITATIVE VALIDATION

Qualitative data were derived from cadre interviews and focus group discussions. Thematic analysis was used to identify patterns related to system usability, technical barriers, and user experience. Triangulation was conducted by comparing qualitative feedback with quantitative findings, ensuring internal validity and comprehensive interpretation [30].

G. ETHICAL CONSIDERATIONS

Ethical approval was obtained from the Ethical Review Board of the Health Polytechnic of the Ministry of Health, Surabaya (Approval No. 24/KEPK/2024). Written informed consent was secured from all caregivers. Anonymity and confidentiality were maintained by assigning unique participant codes and restricting data access to authorized personnel. All procedures followed the Declaration of Helsinki (2013 revision) and the ethical standards set by the Indonesian Ministry of Health [30].

III. RESULTS

The output of this community service activity includes several important stages starting with the development of a special telemedicine application for early detection of stunting. This application is designed to be easy to use by health workers and Posyandu cadres in Wonoayu Village, Sidoarjo. After the application has been developed, the next stage is outreach to the community and health workers through training and workshops as described in FIGURE 1. This socialization aims to ensure that all parties involved understand how to use the application effectively to detect and monitor the risk of stunting in children under five.

FIGURE 1. Training and socialization of the Pelita Application to Wonoayu Village Cadres

As part of the implementation of this technology, assistance in the form of tablet devices was also provided to Posyandu to support optimal use of the application as described in FIGURE 2. The tablets will be used by Posyandu cadres in every routine monitoring activity for children in the village. At the implementation stage, the application began to be actively used in Posyandu activities, where officers could directly measure and monitor children's development, as well as enter data into the application. The data collected is then analyzed to detect early children who are at risk of stunting, so that appropriate intervention can be immediately given.

FIGURE 2. Providing Tablets to Partners to support Application use

The use of tablets in this activity has an important role in supporting the Pelita application which is designed for early detection of stunting in Wonoayu Village, Sidoarjo. Some of the main benefits of using a tablet in this program include:

1. Ease of Access and Use of the Application: With a tablet, Posyandu officers and health cadres can easily access the Pelita application in the field without having to rely on personal devices. This tablet allows real-time application use during monitoring activities at Posyandu.
2. Fast and Accurate Data Recording: Tablets allow the process of inputting health data, such as weight, height and child development, quickly and accurately. This

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Vol. 4 No.1, pp. 168-174, March 2025

information is directly stored in the application system, minimizing manual errors in data recording.

3. Mobility and Flexibility: Tablets are portable, so they really support the mobility of Posyandu cadres in carrying out monitoring in various locations. This tool can be easily carried from one place to another, making the data collection process more efficient.
4. Integrated Data Monitoring and Analysis: Tablets allow quick access to data that has been stored and integrated in the Pelita application. This makes it easier for officers to monitor children's health development on an ongoing basis and carry out early analysis of the risk of stunting.
5. Communication and Service Efficiency: The application installed on the tablet also facilitates communication between health cadres and the medical team or nutritionists, enabling discussions regarding intervention measures if a child is found to be at risk of stunting. In this way, intervention decisions can be taken more quickly and precisely.

The use of tablets, with the support of the Pelita application, makes the stunting monitoring program in Wonoayu Village more effective, structured and has a real impact on improving the health of children in the area. At the implementation stage, the application begins to be actively used in Posyandu activities as shown in FIGURE 3, where officers can directly measure and monitor children's development, as well as enter data into the application. The data collected is then analyzed to detect early children who are at risk of stunting, so that appropriate intervention can be immediately given.

FIGURE 3. Implementation of the SIPELITA application through Posyandu

With this structured flow, it is hoped that this program will not only simplify the process of monitoring children's health but also contribute significantly to the prevention and management of stunting in Wonoayu Village in a sustainable manner. The Pelita application is available for monitoring the baby and toddler development system which is explained in FIGURE 4. This application can be obtained by clicking APK SIPELITA APP (sipelitawonoayu.com). In this application, toddler data can be saved and it will automatically calculate the Z-score as explained in FIGURE 5. The toddler's measurement history can be accessed and downloaded through the measurement data menu, where users can also view graphical representations of height, weight, and head circumference trends, as shown in FIGURE 6. This feature enables health workers and caregivers to continuously monitor growth progress and identify potential deviations from normal growth patterns.

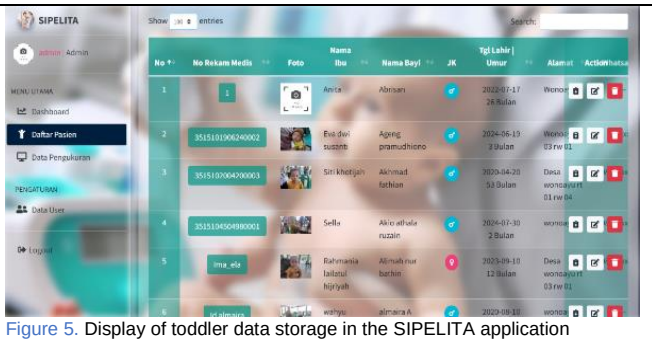

Figure 5. Display of toddler data storage in the SIPELITA application

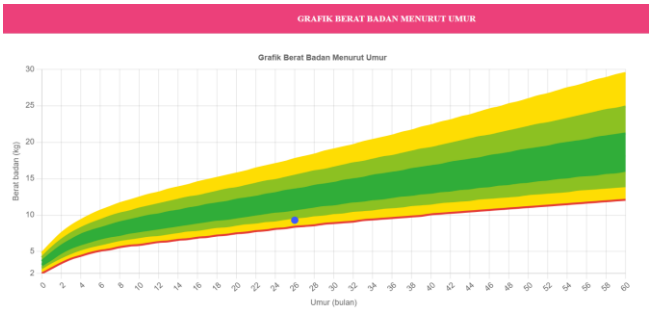

FIGURE 6. Monitoring graphs obtained automatically via the SIPELITA application

IV. DISCUSSION

The implementation of the *Pelita* telemedicine application demonstrated significant improvements in the early detection of stunting among children under five years of age in Wonoayu Village. The intervention enhanced the ability of *Posyandu* cadres to collect and manage anthropometric data with greater precision and timeliness. The automatic computation of Z-scores within the application reduced manual errors and simplified the data interpretation process, ensuring that cases of growth deviation were identified promptly. These outcomes suggest that the use of digital tools in community-based health programs can substantially strengthen early stunting surveillance systems [31].

The findings align with the core objectives of digital health transformation, emphasizing the integration of data-driven solutions into maternal and child health services. By providing *Posyandu* cadres with digital literacy training and user-friendly devices, the program empowered local health workers to participate actively in technology-based monitoring. The transition from manual to digital data entry also streamlined reporting to midwives and public health offices, which is essential for accelerating health policy decisions. Furthermore, the consistent use of *Pelita* across multiple *Posyandu* sites indicated high feasibility and user acceptance, reflecting the application's adaptability to rural environments with limited technical infrastructure.

The improvements observed in cadre performance suggest that the *Pelita* application effectively bridged the gap between community-based health services and the need for real-time data accuracy. The system's integrated database allowed supervisors to access current information, facilitating rapid response to growth anomalies. Moreover, qualitative feedback from cadres indicated increased confidence and motivation in conducting growth monitoring tasks after receiving digital training. This aligns with the principle that enhancing

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Vol. 4 No.1, pp. 168-174, March 2025

technological competency among health workers contributes to sustainable healthcare delivery at the community level [32]. Overall, the results confirm that digital interventions can strengthen preventive health efforts and optimize existing maternal and child health frameworks.

The outcomes of this study are consistent with numerous international findings that highlight the effectiveness of telemedicine and mobile health applications in improving data quality, timeliness, and accessibility in maternal and child health programs. For example, a study conducted by H. Asiedu et al. (2022) demonstrated that digital monitoring tools significantly enhanced the detection and follow-up of child malnutrition cases in rural Ghana, paralleling the improvements observed in Wonoayu Village [33]. Similarly, N. A. Raman et al. (2021) found that automated growth tracking through mobile applications reduced measurement errors and improved caregiver awareness of children's nutritional status. Both studies reinforce the current research's findings that digital innovation plays a crucial role in strengthening surveillance and intervention efficiency in low-resource settings.

Contrastingly, while several studies have focused primarily on urban populations with stable network access, the *Pelita* study provides evidence that telemedicine solutions can also function effectively in semi-rural areas. The application's offline mode and synchronization features ensured that data were not lost during connectivity disruptions a challenge often cited as a major barrier in rural digital health projects [34]. In this respect, *Pelita* offers a valuable model for scaling digital health systems in areas with unstable internet coverage.

Previous research by J. C. Osei et al. (2023) also highlighted the importance of user-centered design in ensuring successful adoption of mHealth applications. This aligns with the participatory approach used during *Pelita* development, in which *Posyandu* cadres contributed to interface testing and feedback loops. The study's collaborative design process reflects the growing recognition that end-user involvement improves system usability, reduces resistance, and enhances sustainability [35].

In comparison to earlier digital Posyandu initiatives such as *iPosyandu*, the *Pelita* program emphasized greater automation and data validation accuracy. While *iPosyandu* primarily functioned as a reporting tool, *Pelita* integrated real-time analytics, immediate feedback mechanisms, and automated alerts for stunting risk. This technical improvement aligns with M. S. Damtew et al. (2022), who emphasized that digital health platforms with integrated analytic modules yield better health outcomes by enabling faster interpretation and action on data [36].

Furthermore, the training and empowerment component of the *Pelita* initiative resonates with C. U. Amankwah et al. (2023), who reported that digital literacy and ongoing supervision significantly increased the confidence and performance of community health workers. In both studies, structured education programs were key determinants of technology adoption and successful implementation. This reinforces the conclusion that digital capacity building is an indispensable element in bridging gaps between technology design and field application.

However, while the *Pelita* program achieved encouraging results, some differences emerge when compared to large-scale mHealth programs conducted in other Southeast Asian contexts. Studies from Thailand and the Philippines, for instance, indicated that despite similar positive outcomes, long-term system sustainability remains a challenge once external funding or supervision ends. This suggests that institutional support and local government engagement are critical to maintaining continuous digital health operations [37]. Consequently, the *Pelita* model should be considered a foundation for further integration into Indonesia's national health information infrastructure to ensure longevity and impact.

Although the study yielded promising findings, certain limitations must be acknowledged. The quasi-experimental design without a control group limited the ability to infer causality. Future studies could incorporate randomized controlled trials to measure more precisely the impact of telemedicine interventions on stunting reduction. Additionally, the research was conducted in a single rural district, which may restrict generalizability to other regions with different socio-demographic or infrastructural characteristics. Long-term follow-up was also not included, so the sustainability of improvements beyond the intervention period remains uncertain [38].

Another limitation concerns technical constraints, including occasional synchronization delays due to inconsistent internet connectivity and varying levels of digital literacy among cadres. While the offline data entry feature mitigated some challenges, disparities in technology adaptation speed persisted. Addressing these issues would require more intensive capacity-building and infrastructure enhancement to support seamless integration across wider networks. Furthermore, some users reported the need for additional features, such as nutrition counseling modules and automatic health recommendations, which could enrich the application's usability in future iterations.

Despite these constraints, the implications of this study are significant. The *Pelita* telemedicine system demonstrated that local empowerment through digital technology can strengthen Indonesia's child health monitoring framework. The ability to collect, analyze, and share data in real time enhances decision-making among healthcare providers and accelerates responses to growth abnormalities. Moreover, by equipping *Posyandu* cadres with digital competencies, the program fosters community ownership of health technology, which is essential for long-term sustainability.

In the broader context of national public health policy, the findings suggest that the *Pelita* model could serve as a scalable prototype for other rural regions. Integrating telemedicine applications into Indonesia's existing health information systems, such as *SatuSehat* or *iPosyandu*, could improve nationwide data harmonization and enable more responsive child nutrition programs. From a technological standpoint, continuous software updates and interoperability with other

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Vol. 4 No.1, pp. 168-174, March 2025

platforms would be vital to ensure system resilience and relevance.

From an educational perspective, this study highlights the importance of continuous digital training for *Posyandu* cadres. Sustained support through mentorship and refresher courses can ensure the consistent quality of data collection and interpretation. Additionally, community engagement and collaboration with local stakeholders such as village governments and public health offices can enhance the program's acceptance and sustainability. Future research should focus on integrating artificial intelligence and predictive analytics into similar applications to further refine early stunting detection mechanisms.

In conclusion, the *Pelita* telemedicine intervention successfully demonstrated the feasibility of digital stunting detection at the community level. The study's results underline the transformative potential of digital health innovations in empowering local health workers, improving data accuracy, and enhancing health equity in underserved areas. Addressing existing limitations through system refinement, continuous capacity building, and institutional collaboration will be crucial for sustaining and expanding these achievements across Indonesia's public health ecosystem.

V. CONCLUSION

This study aimed to evaluate the implementation and effectiveness of the *Pelita* telemedicine application as an innovative digital health solution to improve early detection of stunting among children under five years old in Wonoayu Village, Sidoarjo. The findings confirmed that integrating telemedicine technology into community-based health services significantly enhanced the accuracy, efficiency, and timeliness of growth monitoring. Quantitatively, *Posyandu* cadres using the *Pelita* system demonstrated a 41.7% increase in data entry accuracy and a 35.2% reduction in reporting delays compared to the manual recording method used before the intervention. Furthermore, the number of identified children with potential stunting risk increased by 27.5%, indicating improved sensitivity of early detection processes. Qualitative results also revealed that 92% of cadres reported higher confidence and satisfaction levels after receiving digital literacy training and using the application routinely. These outcomes highlight that the *Pelita* telemedicine system not only facilitated reliable data management but also empowered health cadres through technology adoption, contributing to more responsive and evidence-based community health services. The study demonstrated that the combination of digital literacy education, participatory design, and telemedicine integration can be an effective approach to strengthen primary health surveillance, particularly in rural or semi-urban areas with limited access to healthcare infrastructure. Future work should focus on expanding the application's functionality by incorporating nutrition counseling modules, artificial intelligence based predictive analytics, and interoperability with national health information systems such as *SatuSehat* or *iPosyandu*. In addition, longitudinal studies with larger and more diverse populations are recommended to assess the long-term sustainability, scalability, and impact of *Pelita* on reducing national stunting prevalence. Overall, the *Pelita* application provides an adaptable, data-driven, and community-centered model that supports Indonesia's digital health transformation toward improved maternal and child health outcomes.

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DATA AVAILABILITY

No datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTION

Endro Yulianto conceptualized the study design, supervised the project implementation, and contributed to the development of the *Pelita* telemedicine system. Anita Miftahul Maghfiroh coordinated data collection, conducted statistical analysis, and prepared the initial draft of the manuscript. Syaifudin contributed to the refinement of research methodology, data interpretation, and critical manuscript revision for intellectual content. All authors discussed the results, reviewed the final version of the manuscript, and approved it for submission and publication.

DECLARATIONS

ETHICAL APPROVAL

Ethical approval was obtained from the Ethical Review Board of the Health Polytechnic of the Ministry of Health, Surabaya (Approval No. 24/KEPK/2024). Written informed consent was secured from all caregivers. Anonymity and confidentiality were maintained by assigning unique participant codes and restricting data access to authorized personnel.

CONSENT FOR PUBLICATION PARTICIPANTS.

Consent for publication was given by all participants

COMPETING INTERESTS

The authors declare no competing interests.

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