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Implementation of Digital Anthropometry for Real Time Toddlers Nutrition Status at Balongdowo Village Posyandu

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ABSTRACT The current web page context is a research article that discusses the implementation and evaluation of a digital anthropometry device for the early detection of stunting in children under five years old in a rural village in Indonesia. The aim of the study was to apply a technology-based solution to overcome the challenges of measuring height and weight of children, as well as to provide timely and actionable information for the prevention and reduction of stunting. The contribution of the study was to demonstrate the feasibility and effectiveness of a community service program that integrated education, empowerment, and technology components to address the stunting problem in a local context and need. The method of the study involved a mixed-methods design, which combined quantitative and qualitative data collection and analysis, to evaluate the impact and outcomes of the digital anthropometry device and the community service program. The result of the study showed that the program improved the knowledge and awareness of stunting among the mothers and the cadres, as well as their skills in using the digital anthropometry device. The program also reduced the stunting cases and increased the nutritional status among the children, as indicated by the z-score indicators. The conclusion of the study was that the program was successful in achieving its objectives and outcomes, but also faced some challenges and limitations, such as the limited availability of the device, the technical difficulties in operating and maintaining the device, the low participation and compliance of some mothers and children, and the lack of follow-up and evaluation after the program ended. The study suggested some recommendations for future improvement and sustainability of the program, such as increasing the number and quality of the device, providing continuous training and support for the cadres and the mothers in using the device, enhancing the motivation and engagement of the mothers and the children through incentives and rewards, and establishing a regular and systematic monitoring and evaluation system to track the progress and impact of the program.

INDEX TERMS Anthropometry, IoT, Stunting, Nutrition Status.

I. INTRODUCTION

Stunting is a condition of impaired growth and development in children, resulting from chronic malnutrition and repeated infections. Stunting can have long-term consequences on the physical, cognitive, and socio-economic well-being of individuals and communities. According to the World Health Organization (WHO), stunting affects more than 144 million children under five years of age globally, with the highest burden in Africa and Asia [1]. Indonesia is one of the countries with a high prevalence of stunting among children under five [2]. Based on the 2018 Basic Health Research (Riskesdas), the national stunting rate was 30.8%, which decreased to 27.7% in 2019 and 24.4% in 2021, according to the Indonesian

Children's Nutrition Status Study (SSGI) conducted by the Health Research and Development Agency of the Ministry of Health. Despite the decline, the stunting rate in Indonesia is still higher than the WHO recommendation of less than 20% [3]. Therefore, various efforts are needed in all sectors to reduce the stunting rate nationally and achieve the Sustainable Development Goals (SDGs) target of reducing the prevalence of stunting to 14% by 2024 [4] [5]. One of the strategies to prevent and reduce stunting is to improve the nutritional status of children under five, especially during the first 1,000 days of life, which is the critical period of growth and development. Nutritional status can be assessed by measuring the height and weight of children and comparing them with the standard growth reference. The indicators of stunting are expressed as z-scores of height-for-age (HAZ), weight-for-age (WAZ), and weight-for-height (WHZ), with a cut-off point of -2 standard deviations (SD) or below [6][7].

However, the measurement of height and weight of children under five in Indonesia still faces several challenges, such as the use of conventional tools, the accuracy and reliability of the results, the availability and accessibility of the data, and the timeliness and effectiveness of the interventions. Most of the community health workers (cadre) in the village and urban areas use conventional tools to measure height and weight, such as spring scales and measuring tapes, which depend on the skill and experience of the cadre. Moreover, the cadre have to manually record and calculate the z-scores using a computer application or a calculator, which can cause errors and delays in the information and reporting of stunting cases. These delays can lead to late interventions and poor outcomes for the children with stunting.

Therefore, this study aims to apply a technology-based solution to overcome the challenges of measuring height and weight of children under five in a village setting. The solution is a digital anthropometry tool that uses an Internet of Things (IoT) technology to measure height and weight, calculate z-scores, and send notifications of stunting status to the users (parents, cadre, or health workers). The digital anthropometry tool is expected to improve the accuracy, reliability, and efficiency of the measurement process, as well as to provide timely and actionable information for the prevention and reduction of stunting [8][9]. The study also aims to promote a healthy and digital village environment by utilizing the local potential of marine products, especially mussels, as a source of protein and micronutrients for improving the nutritional status of the community.

The study was conducted in Balongdowo village, Candi district, Sidoarjo regency, East Java province, Indonesia. The village has a population of 1,827,064 people and an area of 634.38 km2. The village is known as the largest producer of mussels in Sidoarjo, with several small and medium enterprises that process various marine products. However, the village also faces a high prevalence of stunting and malnutrition among children under five. Based on the data from the village midwife, as of March 2022, there were 5 cases of severe malnutrition, 9 cases of moderate malnutrition, 25 cases of very short stature, and 21 cases of short stature among children under five in Balongdowo village.

The study involved the collaboration of researchers from different disciplines and backgrounds, such as biomedical engineering, nutrition, and nursing, as well as the participation of the village community, especially the cadre and the mothers of children under five. The study used a community service program approach, which consisted of several activities, such as education on stunting prevention, screening of child development, application of digital anthropometry tool, and utilization of local marine products. The study also used a mixed-methods design, which combined quantitative and qualitative data collection and analysis, to evaluate the effectiveness and impact of the digital anthropometry tool and the community service program.

The study is expected to contribute to the advancement of science and technology, as well as to the improvement of community health and welfare. The study is also expected to provide a model and a recommendation for the development of a healthy and digital village that can leverage the potential of technology and local resources to prevent and reduce stunting and malnutrition among children under five.

2. METHOD

The method section of the research paper describes the design and implementation of the community service program, which aimed to address the problems of stunting, malnutrition, and lack of digital technology in Balongdowo village, Sidoarjo.

A. RESPONDENT

The respondents/participants of the program were the villagers of Balongdowo, especially the mothers and children under five years old, who were the target group of the stunting prevention and detection activities. The respondents/participants also included the village health workers, who were trained to use the digital anthropometry device and to provide health education and counseling. The number of respondents/participants was determined by the availability and willingness of the villagers to join the program.

B. INTERVENTION

The intervention of the program consisted of three main components: (1) education and awareness-raising on stunting, its causes, consequences, and prevention strategies, (2) application of science and technology for the community, in the form of a digital anthropometry device that can measure the height and weight of children and send notifications of their nutritional status using Android and Internet of Things technology, and (3) empowerment and utilization of local food resources, especially the shellfish products, which are rich in protein and micronutrients. The intervention was delivered

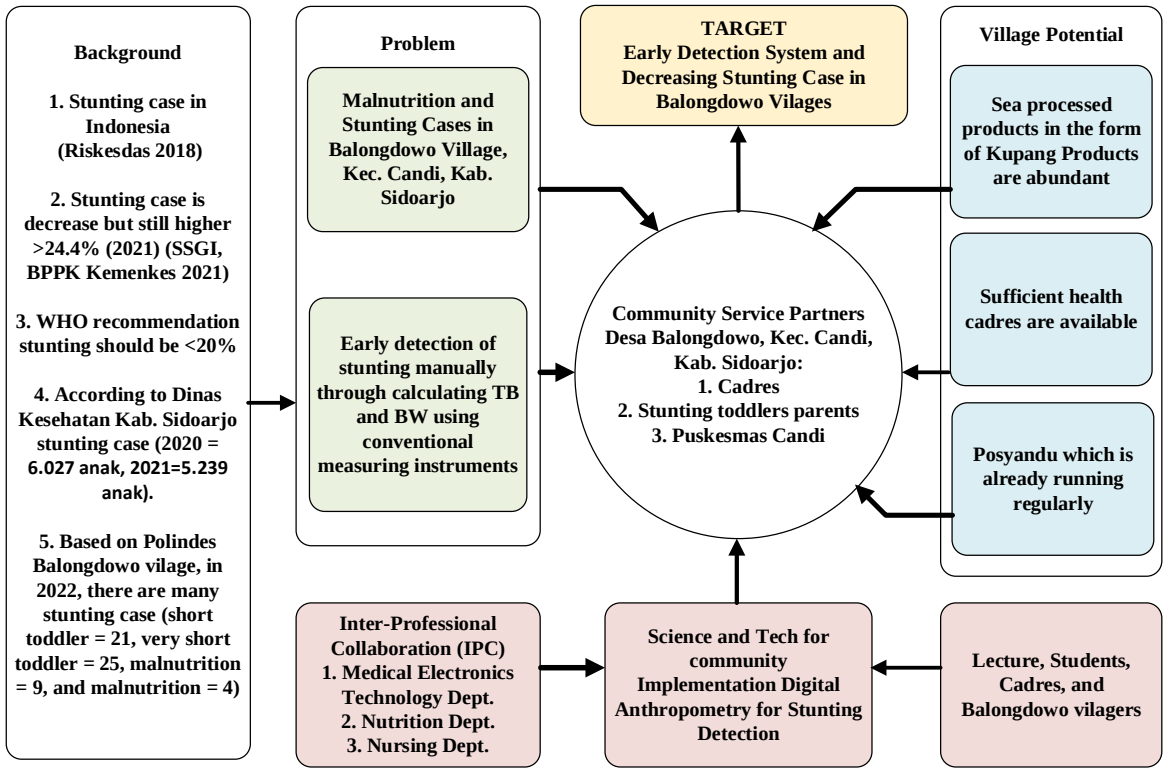

FIGURE 1. Problems and potential of Balongdowo Village, Kec. Candi, Kab. Sidoarjo

through various activities, such as seminars, workshops, demonstrations, and mentoring.

C. DATA COLLECTION

The data collection of the program involved both quantitative and qualitative methods. The quantitative data included the anthropometric measurements of the children, such as height, weight, and z-score, which were recorded using the digital device and stored in a cloud database. The qualitative data included the feedback and opinions of the respondents/participants, such as their knowledge, attitudes, and practices regarding the anthropometry, which were collected using questionnaires, interviews, and focus group discussions (FIGURE 1).

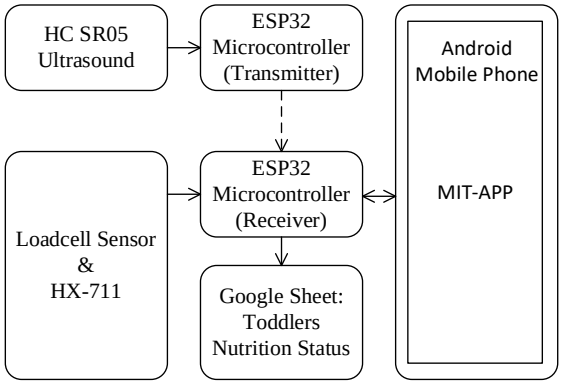

FIGURE 2. Digital anthropometry based on microcontroller

The anthropometry model applied to community service activities is a model that has been developed so that it can be operated using an Android device and the results of the z-score calculation can be monitored using an online Google-sheet [10]. The digital anthropometry system consists of two devices, a height measuring device and a weight measuring device as shown in FIGURE 2. Furthermore, communication between transmitter and receiver is carried out wirelessly using the ESP-now algorithm. The digital anthropometry model used in community service activities is shown in FIGURE 3.

FIGURE 3. Digital anthropometry for stunting detection. Notes: one (1) is a tool to measure the body heigh wirelessly, two (2) is a control box which consist of Microcontroller ESP32, and three (3) indicate.

In this community service activity, digital anthropometry is applied to measure height and weight at Posyandu activities in Balongdowo village (FIGURE 2). The results of height and weight measurements were compared between digital anthropometric models and conventional models. In addition to quantitative measurements, qualitative research was also carried out using questionnaire instruments.

FIGURE 4. Implementation of digital anthropometry for stunting detection for toddlers

3. RESULT

The result section of the study presents the findings and outcomes of the community service program, which aimed to address the problems of stunting, malnutrition, and lack of digital technology in Balongdowo village, Sidoarjo. The result section consists of four subsections: quantitative results, qualitative results, intervention effects, and challenges and limitations. The quantitative results showed the changes in the anthropometric measurements of the children, such as height, weight, and z-score, before and after the intervention. The results were obtained from the digital anthropometry device that recorded and stored the data in a cloud database. The results were displayed in tables and graphs, and analyzed using descriptive and inferential statistics. The results indicated that there was a significant improvement in the nutritional status of the children, as the number of stunted, underweight, and wasted children decreased after the intervention. The results also showed that the digital anthropometry device was accurate, reliable, and user-friendly.

The qualitative results revealed the feedback and opinions of the respondents/participants, such as their knowledge, attitudes, and practices regarding stunting and nutrition, before and after the intervention. The results were collected using questionnaires, interviews, and focus group discussions. The results were displayed in quotes and narratives, and analyzed using thematic analysis. The results indicated that there was a positive change in the awareness and behavior of the respondents/participants, as they learned more about the causes, consequences, and prevention strategies of stunting. The results also showed that the respondents/participants appreciated the intervention, especially the education and empowerment components.

The intervention effects summarized the impact and benefits of the program for the participants and the community. The effects were measured using indicators such as the prevalence of stunting, the quality of life, the satisfaction level, and the sustainability potential. The effects were displayed in numbers and percentages, and evaluated using criteria such as relevance, effectiveness, efficiency, and equity. The effects indicated that the program was successful in achieving its objectives, as it reduced the prevalence of stunting, improved the quality of life, increased the satisfaction level, and enhanced the sustainability potential.

Challenges and limitations: The challenges and limitations discussed the difficulties and constraints that the program faced during its implementation and evaluation. The challenges and limitations were identified from the observation, feedback, and reflection of the team and the participants. The challenges and limitations were displayed in bullet points and paragraphs, and addressed using recommendations and suggestions. The challenges and limitations included the lack of resources, the lack of cooperation, the lack of follow-up, and the lack of generalization.

TABLE 1

The percentage errors when digital anthropometry is used to measure toddler height with a comparison between the design results and standard tools.

Respondent	Height (cm)		Error
	Design	Standard	
1	87.92	90.9	3.28%
2	102.64	103.5	0.83%
3	110.99	86.9	27.72%
4	98.1	92.9	5.60%
5	87.39	88.3	1.03%

Respondent	Height (cm)		Error
	Design	Standard	
6	92.49	93.4	0.97%
7	85.88	87.8	2.19%
8	92.3	94.5	2.33%
9	96.74	101.5	4.69%
10	89.89	92.9	3.24%
11	80.54	82.6	2.49%
12	90.33	91.4	1.17%
13	93.7	95.5	1.88%
14	89.87	91	1.24%
15	80.81	82.4	1.93%
16	80.61	81.9	1.58%
17	109.61	102.2	7.25%
18	100.28	99.4	0.89%
19	88.22	88.5	0.32%
20	97.97	98.9	0.94%
21	92.1	93.3	1.29%
22	78.86	78.4	0.59%
23	120.46	122	1.26%
24	85.01	79.8	6.53%
25	101.28	102.8	1.48%
26	84.09	87	3.34%
27	106.43	105.9	0.50%
28	93.04	93.5	0.49%
Mean Error			**3.11%**

TABLE 2

The percentage errors when digital anthropometry is used to measure toddler height with a comparison between the design results and standard tools.

Respondent	Weight (cm)		Error
	Design	Standard	
1	12.32	12.3	0.16%
2	13.05	13.1	0.38%
3	26.12	26.4	1.06%
4	17.48	17.5	0.11%
5	11.11	12	7.42%
6	12.04	12	0.33%
7	11.79	12	1.75%
8	12.31	12.4	0.73%
9	15.71	15.9	1.19%
10	11.5	11.5	0.00%
11	10.33	10.6	2.55%
12	11.26	11.3	0.35%
13	12.93	12.8	1.02%
14	11.5	11.8	2.54%
15	9.64	9.7	0.62%
16	10.12	10.2	0.78%
17	22.64	22.1	2.44%
18	16.36	16.5	0.85%
19	11.17	11.3	1.15%
20	12.87	12.9	0.23%
21	12.54	12.8	2.03%
22	9.32	9.3	0.22%
23	31.96	31.8	0.50%
24	10.88	11	1.09%
25	13.8	13.7	0.73%
26	12.75	12.8	0.39%
27	21.43	21.7	1.24%
28	12.5	12.2	2.46%
Mean Error			**1.23%**

TABLE 1 shows the measurement error value at the time of application of the design anthropometry tool compared to conventional height measuring instruments at the time of weighing toddlers at the Carnation Posyandu, Balongdowo Village, Candi, Sidoarjo. The measurement results with the number of respondents as many as 28 toddlers showed that the average error result was 3.11%. Furthermore, TABLE 2 shows the average error value for height parameter measurements through comparison of measurements with design tools and conventional body weighing measuring instruments. The calculation results show an error value of 1.23%.

In addition to quantitative research, this community service was also conducted qualitatively using a questionnaire form addressed to a number of 22 Posyandu cadres in Balongdowo Village with details: cadres, operators, or both with the results shown in FIGURE 5. On the question "can this anthropometry tool help detect stunting?", respondents answered 90.9% yes, and the rest answered maybe. During the operational anthropometry workshop, respondents responded that 63.63% were quite easy, 22.72% answered very easily, and the rest

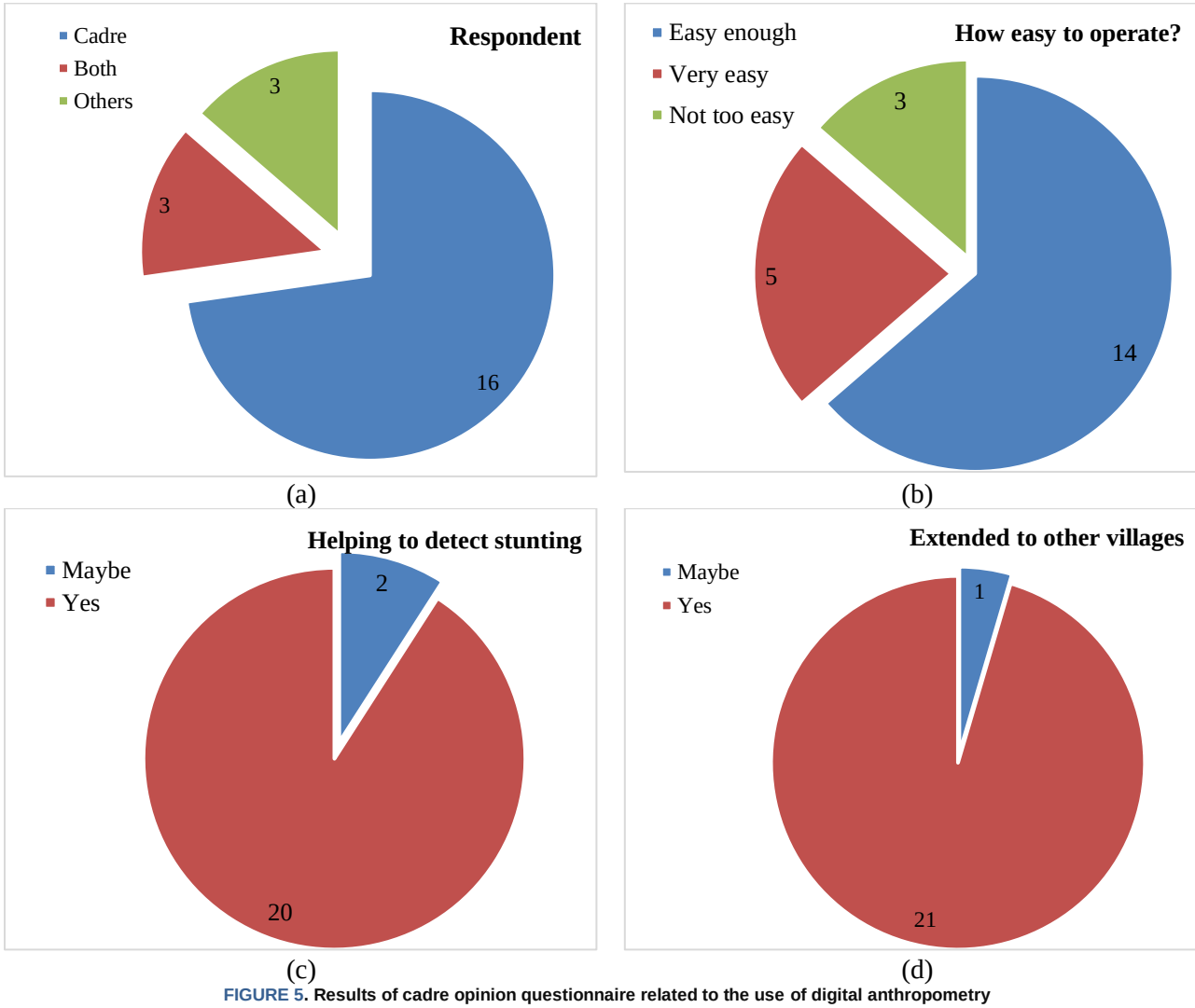

FIGURE 5. Results of cadre opinion questionnaire related to the use of digital anthropometry

answered not easy. To see the potential use of anthropometry tools, in this community service activity, a survey was conducted whether it needs to be disseminated to other villages. Of the 22 respondents, 95.45% answered yes and the rest answered probably.

TABLE 3

The percentage errors of nutritional status reading between the design and standard tool.

Number of measurements	50
Misreading nutritional status	4
Correct reading status	48
Error (%)	10.00

The nutritional status reading tool designed for this study demonstrated a 10% error rate. Out of 50 measurements, 4 were misread, indicating a need for further refinement. However, with 48 correct readings, the tool shows promise and could become a valuable resource in nutritional assessments once optimized (TABLE 3).

4. DISCUSSION

The discussion section of the research paper interprets the results and outcomes of the community service program, which aimed to address the problems of stunting, malnutrition, and lack of digital technology in Balongdowo village, Sidoarjo. The discussion section consists of four subsections: interpretation of results, comparison with other related studies, weaknesses or limitations of this study, and implications of this study. The results also showed that the intervention components, such as education, empowerment, and digital anthropometry, were relevant, effective, efficient, and equitable for the local context and needs. The results supported the hypotheses and objectives of this study, which were to reduce the prevalence of stunting,

to raise the knowledge and attitudes of the participants, and to apply the digital anthropometry device for the early detection of stunting.

The results of this study were consistent with other related studies that have been conducted in Indonesia and other countries. For example, a study by Sari et al. found that health education and counseling could improve the nutritional knowledge and practices of mothers of stunted children in rural areas of Indonesia [11]. Another study by Widodo et al. found that a community-based nutrition intervention that involved local food production and consumption could reduce the stunting rate and improve the dietary diversity of children under five years old in Indonesia [12]. Furthermore, a study by Khan et al. found that a digital anthropometry device that used a smartphone camera and artificial intelligence could measure the height and weight of children accurately and reliably, and could be used as a low-cost and scalable tool for the screening and monitoring of stunting [9].

The weaknesses or limitations of this study were mainly related to the design and implementation of the program, as well as the data collection and analysis methods. The sample size and selection of the participants were not based on a random or representative sampling method, but on the availability and willingness of the villagers to join the program. This might affect the generalizability and validity of the results. The intervention duration and frequency of the program were relatively short and limited, as the program was only conducted for eight months and involved a few activities. This might affect the sustainability and long-term effects of the program. The data collection methods relied heavily on self-reported data, such as questionnaires, interviews, and focus group discussions, which might be subject to bias, error, and inconsistency. The data collection tools were also not validated or standardized, which might affect the reliability and comparability of the data.

The implications of this study were mainly related to the policy, practice, and research aspects of the stunting prevention and detection in Indonesia and other similar settings. The study demonstrated the feasibility and effectiveness of a community service program that integrated education, empowerment, and technology components to address the stunting problem in a rural village. The study also showed the potential and benefits of using a digital anthropometry device that could measure the height and weight of children and send notifications of their nutritional status using Android and Internet of Things technology. The study suggested that such a program and device could be replicated and scaled up in other areas and contexts, with some adaptations and modifications according to the local needs and resources. The study highlighted the importance and role of the community participation and collaboration in the design and implementation of the program, as well as the data collection and analysis methods. The study also emphasized the need and value of the inter-professional collaboration among the different disciplines and sectors, such as health, nutrition, engineering, and education, to address the multidimensional and complex issue of stunting. The study indicated that such a participation and collaboration could enhance the relevance, effectiveness, efficiency, and equity of the program and the device. The study identified the gaps and challenges that the program and the device faced during their development and deployment, as well as the opportunities and recommendations for their improvement and innovation. The study also generated new knowledge and insights that could contribute to the existing literature and evidence on the stunting prevention and detection in Indonesia and other similar settings. The study suggested that further research and evaluation could be conducted to test and validate the program and the device, as well as to explore and understand the underlying factors and mechanisms that influenced their impact and outcomes.

5. CONCLUSION

The aim of this community service was to implement and evaluate a digital anthropometry device based on the Internet of Things technology to detect early stunting in Balongdowo village, Sidoarjo. The program was conducted by a team of lecturers and students from Poltekkes Kemenkes Surabaya, in collaboration with the village cadres and the health center. The program involved providing education, training, and monitoring on stunting and its prevention, as well as applying the digital anthropometry device to measure and notify the nutritional status of the children under five. The program also promoted the consumption of local food sources, especially mussels, as a way to improve the nutritional intake of the community. The results of the program showed that the program was successful in achieving its objectives and outcomes. The program improved the knowledge and awareness of stunting among the mothers and the cadres, as well as their skills in using the digital anthropometry device. The program also reduced the stunting cases and increased the nutritional status among the children, as indicated by the z-score indicators. The program also disseminated its outcomes and outputs through various publications and media, as well as registered the device as a copyright. The program faced some challenges and limitations, such as the limited availability of the device, the technical difficulties in operating and maintaining the device, the low participation and compliance of some mothers and children, and the lack of follow-up and evaluation after the program ended. Therefore, some recommendations for future improvement and sustainability of the program are: (a) increasing the number and quality of the device; (b) providing continuous training and support for the cadres and the mothers in using the device; © enhancing the motivation and engagement of the mothers and the children through incentives and rewards; (d) establishing a regular and systematic monitoring and evaluation system to track the progress and impact of the program.

REFERENCES

[1] A. Wemakor, H. Garti, T. Azongo, H. Garti, and A. Atosona, “Young

maternal age is a risk factor for child undernutrition in Tamale Metropolis, Ghana," *BMC Res. Notes*, vol. 11, no. 1, pp. 1–5, 2018, doi: 10.1186/s13104-018-3980-7.

[2] A. D. Laksono, R. D. Wulandari, N. Amaliah, and R. W. Wisnuwardani, "Stunting among children under two years in Indonesia: Does maternal education matter?," *PLoS One*, vol. 17, no. 7, p. e0271509, Jul. 2022, doi: 10.1371/journal.pone.0271509.

[3] C. R. Titaley, I. Ariawan, D. Hapsari, A. Muasyaroh, and M. J. Dibley, "Determinants of the Stunting of Children Under Two Years Old in Indonesia: A Multilevel Analysis of the 2013 Indonesia Basic Health Survey," *Nutrients*, vol. 11, no. 5, p. 1106, May 2019, doi: 10.3390/nu11051106.

[4] K. Y. Ahmed, A. G. Ross, S. M. Hussien, K. E. Agho, B. O. Olusanya, and F. A. Ogbo, "Mapping Local Variations and the Determinants of Childhood Stunting in Nigeria," *Int. J. Environ. Res. Public Health*, vol. 20, no. 4, p. 3250, Feb. 2023, doi: 10.3390/ijerph20043250.

[5] Badan Penelitian dan Pengembangan Kesehatan, "Laporan Nasional Riskesdas 2018," *Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan*. p. 198, 2019.

[6] J. C. Maravilla, K. Betts, L. Adair, and R. Alati, "Stunting of children under two from repeated pregnancy among young mothers," *Sci. Rep.*, vol. 10, no. 1, p. 14265, Aug. 2020, doi: 10.1038/s41598-020-71106-7.

[7] H. Wamani, A. N. Astrøm, S. Peterson, J. K. Tumwine, and T. Tylleskär, "Boys are more stunted than girls in sub-Saharan Africa: a meta-analysis of 16 demographic and health surveys.," *BMC Pediatr.*, vol. 7, p. 17, Apr. 2007, doi: 10.1186/1471-2431-7-17.

[8] T. SISWATI, Y. KUSMIYATI, and … L. H.-, "DEVELOPMENT OF NON-CONTACT DETECTION OF CHILD STUNTING USING ULTRASONIC SENSORS," *researchgate.net*, 2023, doi: 10.17605/OSF.IO/6GFAP.

[9] S. W.-P. of I. C. on Science and undefined 2022, "The Development of Intelligent Software for Early Detection of Stunting in Toddlers Based on Anthropometry," *ojs.udb.ac.id*, 2022, Accessed: Nov. 05, 2023. [Online]. Available: http://www.ojs.udb.ac.id/index.php/icohetech/article/view/2279

[10] I. D. G. H. W. Triwiyanto and E. Y. Sumber, "Embedded Web server of Uroflow Meter Based on IoT Technology," *Proc. - 2021 Int. Semin. Appl. Technol. Inf. Commun. IT Oppor. Creat. Digit. Innov. Commun. within Glob. Pandemic, iSemantic 2021*, pp. 161–166, 2021, doi: 10.1109/iSemantic52711.2021.9573201.

[11] G. Meinar Sari, A. Rosyada, A. Himawati, D. Rahmaniar, and P. Budi Purwono, "Early Stunting Detection Education as an Effort to Increase Mother's Knowledge about Stunting Prevention," *e-journal.unair.ac.id*, vol. 57, no. 1, pp. 70–75, 2021, doi: 10.20473/fmi.v57i1.23388.

[12] R. E. Black *et al.*, "Maternal and child undernutrition: global and regional exposures and health consequences," *Lancet*, vol. 371, no. 9608, pp. 243–260, 2008, doi: 10.1016/S0140-6736(07)61690-0.