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Original Research

Effect of mHealth based intervention on Maternal Knowledge and Practices of Child Care: A quasi-experimental study

Tri Siswati[1,2*], Almira Sitasari[1,2], Bunga Astria Paramashanti[3,4], Tjaronosari Tjaronosari[1], Nurhidayat Nurhidayat[1], Agus Wijanarka[1,2], Lukman Waris[5]

[1] *Poltekkes Kemenkes Yogyakarta, Jalan Tata Bumi No. 3 Banyuraden, Gamping, Sleman, Daerah Istimewa Yogyakarta, 55293, Indonesia*
[2] *Center of Excellence for Applied Technology Inovation in The Field of Public Health (PUI_Novakesmas), Poltekkes Kemenkes Yogyakarta, Jalan Tata Bumi No. 3 Banyuraden, Gamping, Sleman, Daerah Istimewa Yogyakarta, 55293, Indonesia*
[3] *Department of Nutrition, Faculty of Health Sciences, Universitas Alma Ata, Jalan Brawijaya No. 99, Kasihan, Bantul, Daerah Istimewa Yogyakarta 55183, Indonesia*
[4] *Sydney School of Public Health, Faculty of Medicine and Health, The University of Sydney, New South Wales, Australia*
[5] *Department of Public Health, Universitas Faletehan, Jalan Raya Cilegon KM 6, Serang, Banten 42162, Indonesia*

Corresponding author:
Dr. Tri Siswati.,M.Kes
Department of Nutrition, Poltekkes Kemenkes Yogyakarta Jl Tata Bumi no 3, Banyuraden, Gamping, Sleman, Yogyakarta 55293, Indonesia Email: tri.siswati@poltekkesjogja.ac.id

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Abstract

Background: Child malnutrition contributes to elevated rates of mortality and morbidity, profoundly affecting child welfare. Maternal childcare knowledge and practices play a pivotal role in addressing this issue.
Objective: This study aims to evaluate the impact of the mHealth App on maternal knowledge and practices in child care.
Method: A randomized controlled trial was conducted in Yogyakarta, Indonesia, from May to August 2022. Mother-child pairs were assigned to either the intervention (n=100) or control (n=100) groups. Data on maternal knowledge and practices were collected at baseline, follow-up 1, and follow-up 2. Maternal knowledge was assessed using a structured questionnaire covering child growth and development, while feeding practices were evaluated using a yes-no checklist. The analysis of maternal knowledge and practices involved mean difference, t-test, and general estimating equations in STATA-15.
Result: The results revealed a consistent increase in knowledge and practice scores between follow-ups 1 and 2. The mHealth application significantly enhanced maternal knowledge about child growth, development, and feeding at follow-up 2 compared to baseline, with improvements of 1.42 (CI 95% 1.34-1.89), 1.32 (CI 95% 1.22-1.72), and 1.45 (CI 95% 1.34-2.42), respectively. Additionally, growth and development monitoring practices increased by 0.80 (CI 95% 0.08-0.99) and 0.98 (CI 95% 0.21-0.99).
Conclusion: The mHealth application significantly enhances maternal knowledge and practices related to child growth, development, and feeding.

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Key words: mHealth; maternal; knowledge; practices; children

Background

Child malnutrition is a public health issue that contributes to high child mortality and morbidity (Ahmed, Hossain, & Sanin, 2013). Globally, 45% of under-five deaths were associated with malnutrition (World Health Organization, 2021). In 2021, as many as 149.2 million children (22%) suffered from stunting, 45.4 million (6.7%) experienced wasting, and 38.9 million (5.7%) were underweight (World Health Organization, 2018). In the same year, the prevalence of malnutrition in Indonesia was much higher than the global prevalence. As many as 24.4% of children were stunted, 7.1% wasted, and 17% underweight (Kementerian Kesehatan Republik Indonesia, 2021)

Adequate nutrition is indispensable to support children's growth and development (World Health Organization, 2021). Evidence suggests that child malnutrition can result in cognitive impairment and behavioral deviations throughout the life cycle (Prado & Dewey, 2014; Wiggins, Fuller, & Enna, 1984). Chronic child malnutrition is associated with low resource capacity throughout all periods of life (World Health Organization, 2021), an increased risk of morbidity and mortality (Alam et al., 2020), metabolic syndrome (Soliman et al., 2021), low adult productivity (De Sanctis V, Soliman A, Alaaraj N, Ahmed S, Alyafei F, 2021), non-communicable diseases (De Lucia Rolfe et al., 2018), DALYs (Rahmawaty & Meyer, 2020), and hampered the nation's economy (McGovern, Krishna, Aguayo, & Subramanian, 2017). Evidence showed that decreased productivity related to stunting resulted in the loss of 3.057–13.758 billion rupiahs (0.04-0.16%) of Indonesia's total gross domestic product (Renyoet & Nai, 2019).

Low maternal knowledge is one of the causes of child malnutrition (United Nations International Children's Emergency Fund, 1998). Previous research has shown the association of maternal knowledge and stimulation of child growth and development (Siswati, Iskandar, et al., 2022) with breastfeeding and complementary feeding practices (Dukuzumuremyi, Acheampong, Abesig, & Luo, 2020; Rakotomanana et al., 2020; Siswati, Nurhidayat, Widyawati, & Rialihanto, 2022), child nutritional status and well-being(M. M. Black & Surkan, 2015), anemia (M. M. Black & Surkan, 2015; MacCormack, Castro, Halberstadt, & Rogers, 2020), and social and emotional skill (MacCormack et al., 2020). Various strategies have been carried out to improve knowledge and practices of early parenting, including Communication, Information, and Education (Alemayehu, 2018; Saleem, Mahmud, Baig-Ansari, & Zaidi, 2014), behavior change communication (Fahmida et al., 2020; Lin et al., 2018; Workicho et al., 2021), counselling (Babughirana et al., 2021), social support (Babughirana et al., 2021), peer groups and maternal classes (Ruchala & James, 1997), home visits (Siswati, Iskandar, et al., 2022), and campaigns (Ruchala & James, 1997) with various media. However, child under- and overnutrition remain an issue (R. E. Black et al., 2013).

Currently, the mHealth application has been widely used as an educational tool to improve the health and well-being of children, health monitoring, lifestyle, and health promotion (Ruchala & James, 1997). Several previous studies have shown the effectiveness of applications for early detection of hearing loss in children (Yousuf Hussein, Swanepoel, Mahomed, & Biagio de Jager, 2018), education to families with Down Syndrome children (Skelton, Knafl, Van Riper, Fleming, & Swallow, 2021), maternal and child health (Rajak & Shaw, 2019), and tracking the dietary intake (Rajak & Shaw, 2019). The use of monitoring applications to monitor health has been recommended by the World Health Organization (World Health Organization, 2018). The COVID-19 pandemic has revealed the importance of using a mHealth application to monitor community health, including children (Helmyati et al., 2022). Moreover, the use of the mHealth application has several advantages, including facilitating access to health, providing nutrition counseling, reducing the burden on health workers, enabling an education media for the community, increasing their understanding and awareness of nutrition and health, supporting health surveillance programs, and saving resources and manpower (Ruchala & James, 1997). Several barriers were found in the use of mobile health technology to assist healthcare in rural areas, such as low internet access and poor user skills related to knowledge, awareness, education, income, and motivation (Anderson-Lewis, Darville, Mercado, Howell, & Di Maggio, 2018).

In the previous research stage, we successfully developed a child growth and development monitoring application (Siswati, Iskandar, et al., 2022). Then, in this study, we evaluate the impact of maternal knowledge and practices on child care with a mHealth app.

Methods

Study Design and Setting

This study was a quasi-experimental study with a pre-posttest with a control group design. This study was conducted in Sedayu Subdistrict, Bantul Regency, Yogyakarta Special Region. Based on the 2021 Indonesia Nutritional Status Survey (SSGI), Bantul had the second highest stunting prevalence after Gunung Kidul Regency (19.1%), the highest wasting prevalence in the region (6.5%), and the prevalence of underweight which was higher than the national average (13.5%). We then particularly selected the Sedayu Subdistrict since it had multiple nutrition problems and was regarded as a suburban area. We then randomly selected Argorejo village as the intervention group, while Argodadi village was the control group.

Participants

Participants in this study were pairs of mothers and toddlers with a total of 100 people each calculated based on the Lemeshow formula (Lemeshow, 1990), with an α of 95%, power of 80% and an average difference before and after the intervention of integrated nutrition package(Siswati, Nurhidayat, et al., 2022). Thus, the minimum sample was 94 toddlers for each group. We then randomly selected 94 children for each group who met the following criteria: aged 0-59 months, those whose mothers used Android phones for the intervention group and those who used Maternal and Child Health (MCH) Book for the control group, and those who we willing to participate in this study.

Intervention

We provided a mHealth application to the intervention group for eight weeks. Participants in the intervention group were able to access the educational messages as well as to input the children's data on growth, development, and feeding practices. During the intervention phase, the WhatsApp group allowed participants to discuss the application's use with researchers and peers. Meanwhile, the control group used MCH Book as a regular community-based program. The MCH Book contained information about health and nutrition advice for both mothers and children and a growth chart. For both intervention and control groups, we assessed maternal knowledge and practices regarding the children's growth, development and feeding at baseline, week 4, and week 8. Figure 1 shows the flow of the study.

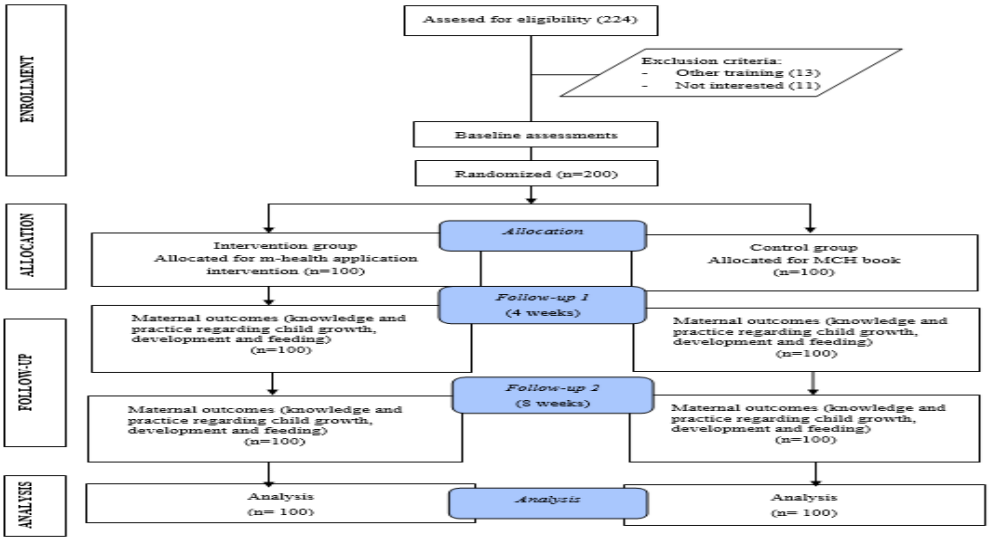

Figure 1 CONSORT flow diagram

Data Collection and Instrument

Four trained surveyors collected the data from May to August 2022. A structured questionnaire was used to collect data on maternal and child characteristics and knowledge of child growth, development, and feeding. These surveyors consisted of nutrition graduate diploma and last year's nutrition student diploma. The first author led field supervising. There were 10 items for each aspect of knowledge, and then we scored 1 for favorable answers and 0 for unfavorable ones. Practices regarding growth, development and feeding were obtained through observations using a checklist form. Likewise, we scored 1 for appropriate answers and 0 for inappropriate ones. This questionnaire was tested for its validity using Pearson correlation and Cronbach's Alpha (r = 0.36) and reliability (score: 0.99), indicating that the instrument was valid and reliable.

Statistical Analysis
Data were analyzed using a t-test to compare knowledge and practice scores before and after the intervention. We also performed generalized estimating equations (GEE) analysis to determine the impact of interventions on follow-ups 1 and 2 (difference in difference) using STATA -15.

Ethical Consideration
Ethical approval has been obtained for this research from the Ethic Committee Poltekkes Kemenkes Yogyakarta number e-KEPK/POLKESYO/0375/IV/2022, date April 05, 2022.

Results

Table 1 presents child and maternal characteristics. Mothers in both intervention and control groups were dominated by those who were aged 20-30 years, completed senior high school, and were housewives. The majority of children had normal birth weight and length.

Table 1 Characteristics of study participants

Characteristics	Intervention (n=100) (%)	Control (n=100) (%)	p
Mother's age			
<20 years	3	4	0.78
20-30 years	67	64	
>31 years	30	32	
Mother's education			
Completed junior high school	3	3	0.87
Completed senior high school	89	91	
Completed high education	8	6	
Father's education			
Completed junior high school	1	2	0.49
Completed senior high school	80	89	
Completed high education	19	9	
Mother's employment			
Farmers	21	27	0.35
Private sectors	20	18	
Housewives	59	55	
Father's employment			
Farmers	30	25	0.73
Private Sectors	56	55	
Civil servants	14	20	
Child's age			
≤24 months	55	45	0.89
>24 months	46	56	
Sex			
Male	49	51	0.58
Female	51	49	
Birth weight			
Low birth weight (<2500 g)	18	21	0.34
Normal (≥2500 g)	82	79	
Birth length			
Short (<48 cm)	21	24	0.56
Normal (≥48 cm)	89	76	

Maternal knowledge and practice scores on child growth, development and feeding at baseline or early intervention did not differ significantly as presented in **Table 2**.

Table 2 Baseline maternal knowledge and practices related to child growth, development and feeding

Variables	Intervention	Control	p
Knowledge			
Growth	7.13±1.2	6.70±0.30	0.59
Development	7.73±0.8	6.81±0.72	0.61
Feeding	7.60±0.6	6.81±1.19	0.52
Mean±SD	7.49±0.9	6.77±1.40	0.76
Practices			
Growth	7.47±1.1	7.37±0.98	0.68
Development	7.87±1.9	7.67±0.87	0.67
Feeding	8.03±1.2	7.89±0.65	0.59
Mean±SD	7.79±1.4	7.64±0.83	0.40

The Impact of the mHealth Intervention on Maternal Knowledge and Practices

There was a difference in the mean maternal knowledge score between the intervention and control groups in follow-ups 1 and 2 as shown in **Table 3**.

Table 3 The impact of the mHealth intervention on maternal knowledge and practices between intervention and control groups

Variables	Intervention	Control	Mean difference (95%CI)
Baseline			
Knowledge			
Growth	7.13±1.2	6.70±0.30	0.4 (0.32-1.34)
Development	7.73±0.8	6.81±0.72	0.9 (0.56-1.54)
Feeding	7.60±0.6	6.81±1.19	0.8 (0.39-1.24)
Mean±SD	7.49±0.9	6.77±1.40	0.7(0.44-1.57)
Practices			
Growth	7.47±1.1	7.37±0.98	0.1 (0.1-1.84)
Development	7.87±1.9	7.67±0.87	0.2 (0.12-1.14)
Feeding	8.03±1.2	7.89±0.65	0.14 (0.10-2.94)
Mean±SD	7.79±1.4	7.64±0.83	0.15 (0.10-1.98)
Follow-up 1			
Knowledge			
Growth	8.10±0.75	7.13±1.56	0.97 (0.12-0.99)*
Development	8.33±0.83	7.28±1.75	1.05 (1.00-1.32)*
Feeding	8.42±0.92	7.22±1.87	1.02 (1.00-1.74)*
Mean±SD	8.28±0.77	7.21±0.91	1.07 (1.00-0.56)*
Practices			
Growth	7.57±0.67	7.47±0.76	0.1 (0.10-1.34)*
Development	8.45±0.76	7.77±0.45	0.68 (0.32-0.89)*
Feeding	8.56±0.55	7.91±0.33	0.65 (0.22-0.99)*
Mean±SD	8.19±0.45	7.72±0.21	0.47 (0.32-10.89)*
Follow-up 2			
Knowledge			
Growth	8.55±0.31	7.55±0.17	1.0 (1.00-1.84)*
Development	9.05±0.38	7.80±0.93	1.25 (1.01-1.37)*
Feeding	9.05±0.54	7.73±0.63	1.32 (1.12-1.74)*
Mean±SD	8.88±0.67	7.69±0.65	1.19 (1.13-1.94)*
Practices			
Growth	8.00±0.34	7.51±0.66	0.49 (0.32-0.99)*
Development	8.99±0.56	7.89±0.98	1.0 (1.00-1.94)*
Feeding	8.78±0.78	8.03±0.76	0.75 (0.32-1.09)
Mean±SD	8.59±0.87	7.81±0.54	0.78 (0.65-1.44)

Figures 2 to 5 present maternal knowledge scores on child growth, development and feeding aspects. **Figures 6 to 9** show maternal practice scores on child growth, development and feeding aspects.

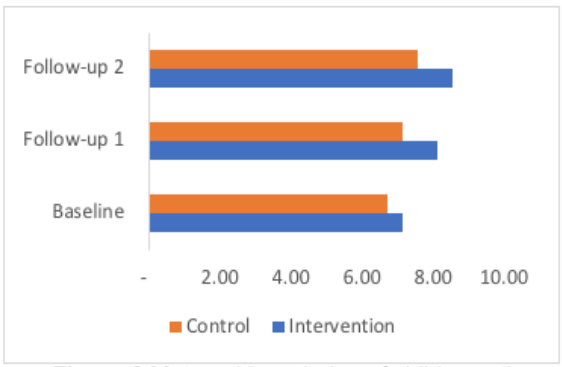

Figure 2 Maternal knowledge of child growth

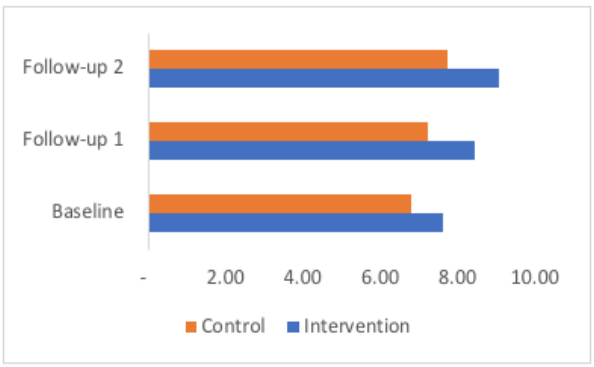

Figure 3 Maternal knowledge of child development

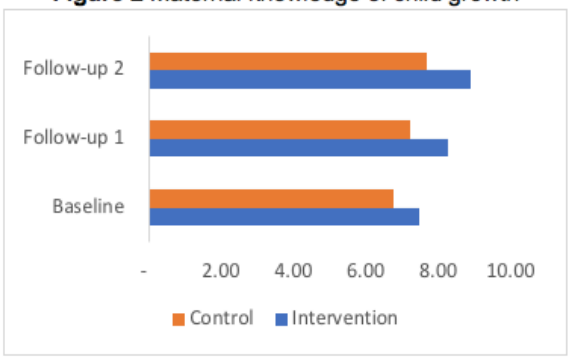

Figure 4 Maternal knowledge of child feeding

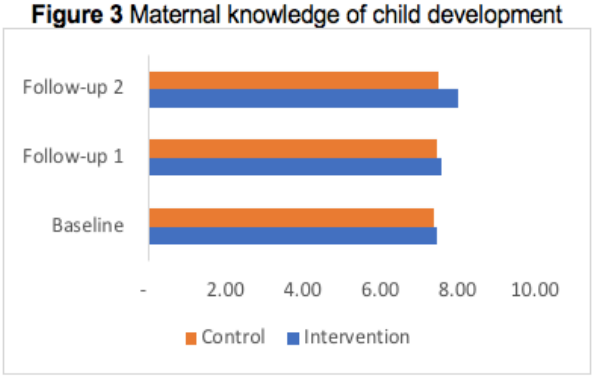

Figure 5 Mean scores of maternal knowledge

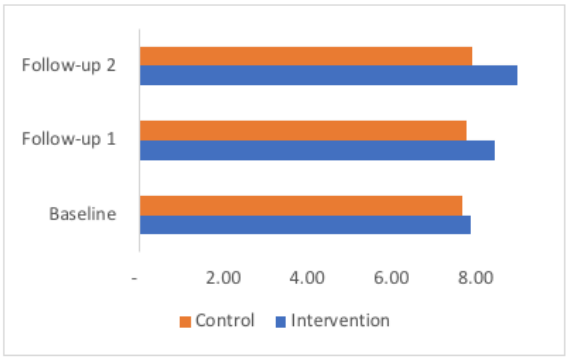

Figure 6 Maternal practices on child growth

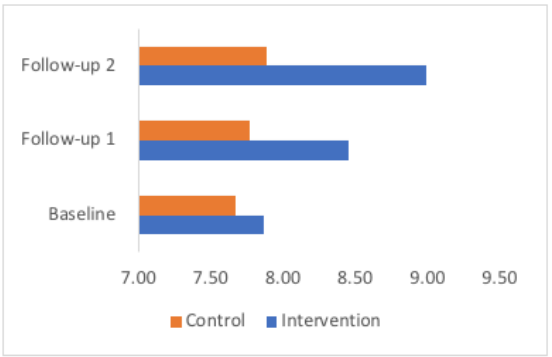

Figure 7 Maternal practices on child development

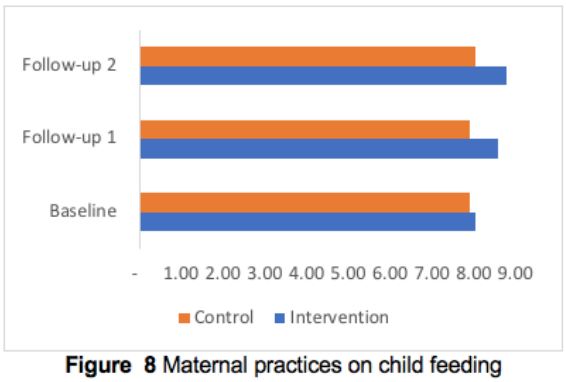

Figure 8 Maternal practices on child feeding

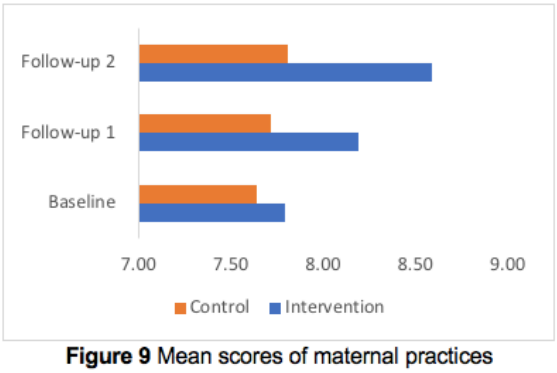

Figure 9 Mean scores of maternal practices

The Impact of the mHealth Intervention on Maternal Knowledge and Practices between Groups and Phases

There were significant differences in the effect of the mHealth application on maternal knowledge about growth, development and feeding in the intervention group during follow-ups 1 and 2 (**see Table 4**).

Table 4 The impact of the mHealth intervention on maternal knowledge and practices across groups and phases

Variables	Pretest	Post-test 1	Post-test 2	Post-test 1 vs pretest (95% CI)	Post-test 2 vs pretest (95% CI)
Knowledge					
Intervention group					
Growth	7.13±1.21	8.10±0.75	8.55±0.31	0.97 (0.78-0.99)*	1.42 (1.12-1.89)*
Development	7.73±0.82	8.33±0.83	9.05±0.38	0.60 (0.16-0.89)*	1.32 (1.21-1.72)*
Feeding	7.60±0.61	8.42±0.92	9.05±0.54	0.80(0.67-0.97)*	1.45(1.22-2.42)*
Mean±SD	7.49±0.52	8.28±0.64	8.88±0.48	0.79 (0.45-0.98)*	1.39 (1.20-2.98)*
Control group					
Growth	6.70±1.30	7.13±1.56	7.55±0.17	0.43 (-0.32-0.99)*	0.80(0.08-0.99)*
Development	6.80±1.72	7.28±1.75	7.80±0.93	0.48 (0.17-0.97)*	1.00 (0-89-2.21)
Feeding	6.80±1.19	7.22±1.87	7.73±0.63	0.42 (0.27-1.60)	0.93 (0.35-1.62)
Mean±SD	6.77±1.13	7.21±1.52	7.69±0.98	0.44 (0.34-1.24)	0.92 (0.89-1.98)
Practices					
Intervention group					
Growth	7.47±0.87	7.57±1.34	8.00±0.67	0.10 (0.04-0.89)*	0.53 (0.34-0.89)*
Development	7.87±0.96	8.45±1.43	8.99±0.52	0.58 (0.34-0.99)*	1.12 (1.01-1.94)*
Feeding	8.03±1.45	8.56±1.56	8.78±0.52	0.50 (0.34-0.88)*	0.75 (0.34-0.98)*
Mean±SD	7.79±1.56	8.19±0.98	8.59±0.32	0.4 (0.34-0.96)*	0.80 (0.34-0.99)*
Control group					
Growth	7.37±0.67	7.47±0.63	7.51±0.76	0.10(0.07-1.24)*	0.1(0.03-1.24)*
Development	7.67±0.56	7.77±0.43	7.89±0.56	0.1(0.01-1.84)	0.2(0.04-1.94)
Feeding	7.89±0.23	7.91±0.65	8.03±0.98	0.2(0.03-1.54)	0.14(0.03-2.214)
Mean±SD	7.64±0.43	7.72±0.87	7.81±0.56	0.08(0.34-1.94)	0.17(0.09-1.94)

**p <0.05*

The Impact of the mHealth Intervention on Maternal Knowledge and Practices between Groups and Phases, Adjusting Other Variables

After adjustments, the results showed that there was an interaction between the intervention and the follow-up phase for all outcomes. The mHealth intervention consistently improved the knowledge and practice scores of mothers regarding growth, development and feeding, as detailed presented in **Table 5**.

Table 5 The impact of the mHealth intervention on maternal knowledge and practices across groups and phases, adjusting other variables

Variables	Intervention vscontrol[a]	
	Follow-up 2 vs Baseline	Follow-up 1 vs Baseline
Knowledge		
Growth	1.42 (1.34-1.89)*	0.97 (0.78-0.99)*
Development	1.32 (1.22-1.72)*	0.60 (0.16-0.89)*
Feeding practices	1.45(1.34-2.42)*	0.80 (0.67-1.87)
Mean knowledge scores	1.39(1.02-1.50)*	0.79 (0.56-1.34)
Practices		
Growth	0.80(0.08-0.99)*	0.43 (0.32-0.99)*
Development	0.98 (0.21-0.99)*	0.48 (0.17-0.97)*
Feeding practices	0.93 (0.35-1.62)	0.42 (0.37-1.60)
Mean practice scores	0.92 (0.78-1.34)	0.44 (0.34-1.56)

[a]Adjusted difference in differences (DID) coefficients using GEE

Adjusted by the mother's age, mother's educational level, mother's occupation, father's educational level, and father's occupation.

Discussion

This study showed significant improvements in the mHealth intervention group on child growth, development and feeding aspects compared to the control group with a regular program using MCH Book. The effect of the mHealth application on improving maternal knowledge and practices on child growth, development and feeding consistently increased in follow-ups 1 and 2. After adjustments, the mHealth intervention group showed a higher improvement in all aspects than the control group.

The first explanation could be that the user-centred design which enables users to use the mHealth application comfortably (Couture et al., 2018; Graham et al., 2019; Korpershoek, Hermsen, Schoonhoven, Schuurmans, & Trappenburg, 2020; LeRouge, Durneva, Sangameswaran, & Gloster, 2019). Users are more likely to use an mHealth application that meets their needs and preferences, thus leading to effective outcomes (Korpershoek et al., 2020). Second, the mHealth application was previously tested on public health experts, nutritionists, midwives, psychologists, mothers, cadres, and other community members. Therefore, involving both users and experts throughout the mHealth design and development is key to favorable outcomes.

Lastly, the mHealth application that accommodates child health services is likely to be used (Free et al., 2013). The design of the mHealth application in our study was adapted from child health programs in the communities (e.g., growth and development monitoring), leading to the usability and effectiveness of this application. Our results follow previous research suggesting that interventions that come from real-world settings may improve effectiveness (Graham et al., 2019). Thus, identifying the community problems as well as adapting the mHealth application based on the community needs and settings are important initial steps to develop successful mHealth-based interventions.

Overall, our findings follow previous research on Android-based mHealth applications to support public health, including the use of mHealth applications for cadres to encourage the utilization of maternal, infant and child health services in rural areas of India (Song et al., 2021), dental health monitoring (Song et al., 2021), food consumption record (Pendergast, Ridgers, Worsley, & McNaughton, 2017), health monitoring of stroke patients (Burns et al., 2021), improving maternal, newborn and infant health (Lee et al., 2016), and promoting healthy eating behavior (Slazus, Ebrahim, & Koen, 2022).

This research has several strengths as follows: 1) Android phone has become a need in the community, indicated by the wide use of this phone, including among mothers, 2) the installation process of the mHealth application was easy and user-friendly, 3) the mHealth application was multi-function, 4) the mHealth application had multi-users, including mothers, cadres, early childhood educators, and public health programmers. Beureu Statistics of Indonesia reported an increase in smartphone usage by 89% of the Indonesian population in 2021. The ease of the installation process and its multi functions encourages the users to utilize it (Rajak & Shaw, 2019). The application has multi-functional tools so that users get more advantages from it. In addition, these multi-functional benefits motivate the users to implement the educational messages in real life (Kim & Chang, 2007; Slazus et al., 2022). However, there were also limitations of this study, such as 1) the follow-up period was only carried out in the 8th week, while the following time was the crucial evaluation time, 2) the continuity of the intervention depended on mothers' willingness to use all functions in the application, 3) child feeding was highly dependent on other factors, such as household food security and purchasing power, and 4) the generalization of the results may differ when comparing to a different society.

Conclusion

The mHealth application effectively improved maternal knowledge and practices in child growth, development, and feeding. This application can support the children's health and nutrition program, thus the achievement of the 2nd and 3rd Sustainable Development Goals, as well as Indonesia's transformation of health in the first pillar, namely transformation in primary healthcare including preventive and promotive efforts. Global implementation of an mHealth application for monitoring children's growth, development and feeding requires socialization at all levels, advocacy to stakeholders, and policy support.

Declaration Conflicting Interest

The authors have no conflicts of interest to declare.

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Sincere appreciation to everyone who has participated in this study.

Author Contribution
The author confirm contribution to the paper as follows: study conception and design, Author, data collection, analysis and interpretation of results, draft manuscript preparation, reviewed the results of the manuscript.

Author Biography
Tri Siswati is a Lecturer at Poltekkes Kemenkes Yogyakarta, Jalan Tata Bumi No. 3 Banyuraden, Gamping, Sleman, Daerah Istimewa Yogyakarta, 55293, Indonesia
Almira Sitasari is a Lecturer at Poltekkes Kemenkes Yogyakarta, Jalan Tata Bumi No. 3 Banyuraden, Gamping, Sleman, Daerah Istimewa Yogyakarta, 55293, Indonesia
Bunga Astria Paramashanti is a Lecturer at Department of Nutrition, Faculty of Health Sciences, Universitas Alma Ata, Jalan Brawijaya No. 99, Kasihan, Bantul, Daerah Istimewa Yogyakarta 55183, Indonesia
Tjaronosari Tjaronosari is a Lecturer at Poltekkes Kemenkes Yogyakarta, Jalan Tata Bumi No. 3 Banyuraden, Gamping, Sleman, Daerah Istimewa Yogyakarta, 55293, Indonesia
Nurhidayat Nurhidayat is a Lecturer at Poltekkes Kemenkes Yogyakarta, Jalan Tata Bumi No. 3 Banyuraden, Gamping, Sleman, Daerah Istimewa Yogyakarta, 55293, Indonesia
Agus Wijanarka is a Lecturer at Poltekkes Kemenkes Yogyakarta, Jalan Tata Bumi No. 3 Banyuraden, Gamping, Sleman, Daerah Istimewa Yogyakarta, 55293, Indonesia
Lukman Waris is a Lecturer at Department of Public Health, Universitas Faletehan, Jalan Raya Cilegon KM 6, Serang, Banten 42162, Indonesia

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