The Effectiveness of the SOBUMIL mHealth App in Enhancing Early Detection of Pregnancy Complications in Bogor Regency, Indonesia

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Abstract: *Background*: Global and national efforts are underway to reduce maternal mortality. Empowering pregnant women enables health decision-making and early detection of pregnancy complications. Developing applications related to pregnancy potentially improves women's behavior in preventing pregnancy complications.

Objective: This study aimed to explore the influence of SOBUMIL (Sobat Ibu Hamil), an android-based application on pregnant women's empowerment for early detection of complications.

Methods: A quasi-experimental study was conducted in the Bogor Regency, Indonesia. Study participants were pregnant women residing in two primary health care in their second and third trimesters. Pregnant women were excluded if they were disabled or unable to read and write. A total sample of 350 was calculated using the Lemeshow sample formula, which included an intervention and control group.

Results: Overall, we found a statistically significant positive effect of SOBUMIL application in all pregnant women's empowerment parameters to detect pregnancy complications early in Bogor Regency (p<0.001).

Conclusion: This study confirms the positive influence of the SOBUMIL application in empowering pregnant women for early detection of pregnancy complications. This underscores the potential of mobile health interventions to enhance knowledge, attitudes, and abilities, enabling independent monitoring and addressing of pregnancy-related risks, ultimately improving maternal healthcare outcomes.

Keywords: mHealth, Pregnant women, Pregnancy, Pregnancy complications, Telemedicine.

1. INTRODUCTION

Maternal health is a global concern, including in Indonesia. Maternal mortality is a crucial indicator of health status, requiring earnest attention as a public health priority [1,2]. Maternal mortality is defined as the death of a mother during pregnancy, childbirth, or within 42 days of pregnancy termination, excluding accidental or incidental causes, per 100,000 live births [3]. Approximately 810 women lose their lives daily due to preventable causes during pregnancy and childbirth, resulting in maternal mortality. Developing countries bear 94% of these deaths, with a global total of 303,000 [2]. In the ASEAN region, maternal mortality is reported as 235 per 100,000 live births [4] . Maternal mortality in Indonesia remains high, recording over 7,000 cases in 2021, equating to a rate of 228 per 100,000 live births [3].

Global and national efforts are underway to reduce maternal mortality. The World Health Organization (WHO) collaborates with partners worldwide to comprehensively address the causes of maternal death [5-7]. Health facility systems should implement

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measures to reduce maternal mortality through early detection in antenatal care (ANC) services, such as preeclampsia, as recommended by several existing studies [7–11]. Additionally, decreasing maternal mortality rates requires the empowerment of women and families [12]. The decline in maternal mortality is influenced by the ability to detect various diseases and pregnancy complications early, enabling informed decision-making based on personal preferences and empowerment [13].

Prior to this study, a preliminary assessment was conducted in one region of Bogor Regency and found that out of 20 pregnant women interviewed, 17 had a poor understanding of how to care for, maintain and improve their pregnancy health. In addition, they were unaware of the signs and symptoms of potential pregnancy complications and lacked knowledge of how to identify and prevent them. This led to a comprehensive study to understand how pregnant women and those around them perceive maternal health care, and we developed a model to empower pregnant women in the early detection of pregnancy complications through a communication and education application.

The intervention application to be implemented is called *Sobat Ibu Hamil* (SOBUMIL), and it aims to empower pregnant women for the early detection of complications. SOBUMIL is an android-based health promotion application developed to facilitate the early detection of pregnancy complications in pregnant women, with the goal of enhancing their knowledge, attitudes, and behaviors to prevent pregnancy complications. The model provides health education to pregnant women about risk factors that may pose a threat during pregnancy and childbirth. This study aims to evaluate the effectiveness of the SOBUMIL application in empowering pregnant women to detect pregnancy complications early in Bogor Regency.

2. METHODS

2.1. Study Design and Participants

This quasi-experimental study was conducted in the Bogor Regency at the Babakan Madang Public Health Center (PHC) and Cijeruk PHC. Study participants were pregnant women in their second and third trimesters, residing in the primary care catchment area. Pregnant women who were disabled or unable to read and write were excluded. A total sample size of 350 was calculated using the Lemeshow sample formula for this study, which 175 participants for each intervention

and control group. The control group consisted of pregnant women receiving standard prenatal care without using the SOBUMIL application. Participants in both the intervention and control groups were matched based on key characteristics such as age, gestational period, and socioeconomic status to minimize selection bias. Additionally, statistical adjustments were applied to control for potential confounding factors that could influence pregnancy outcomes.

2.2. Instrument

Empowered pregnant women refers to the ability of pregnant women to meet their own needs and self-reliance, recognize pregnancy complications, and make decisions (13,14). The parameter of empowered pregnant women is measured using a Likert scale questionnaire with 39 questions, where the response options are strongly agreed (4) to strongly disagree (1). The variables of empowered pregnant women include self-efficacy (7 items), future image (7 items), self-esteem (6 items), support and assurance from others (4 items), mobilization of pregnant women (4 items), and decision-making (11 items).

2.3. SOBUMIL Application

The SOBUMIL application was designed and developed using Flutter for Android and a MySQL database. This Android-based application adopts the concept of telemedicine as a service for pregnant women, enabling them to obtain information about pregnancy complications and other relevant pregnancy-related information. The purpose of the SOBUMIL application is to empower pregnant women to prevent pregnancy complications. This model is educational, providing health education to pregnant women about the risk factors that can pose a threat during pregnancy and childbirth, as well as various efforts to maintain health during pregnancy. The SOBUMIL mHealth application is designed primarily for Indonesian-speaking users, ensuring accessibility for pregnant women in Indonesia. The application is currently available for download on the Google Play Store, enabling wider access to its features. Future plans include the development of an English version to expand its usability. The interface and workflow of the SOBUMIL application are shown in Figure **1**.

2.4. Statistical Analysis

The data were analyzed using SPSS version 26 through independent sample t-tests. Bivariate analysis was conducted using the SPSS software to test
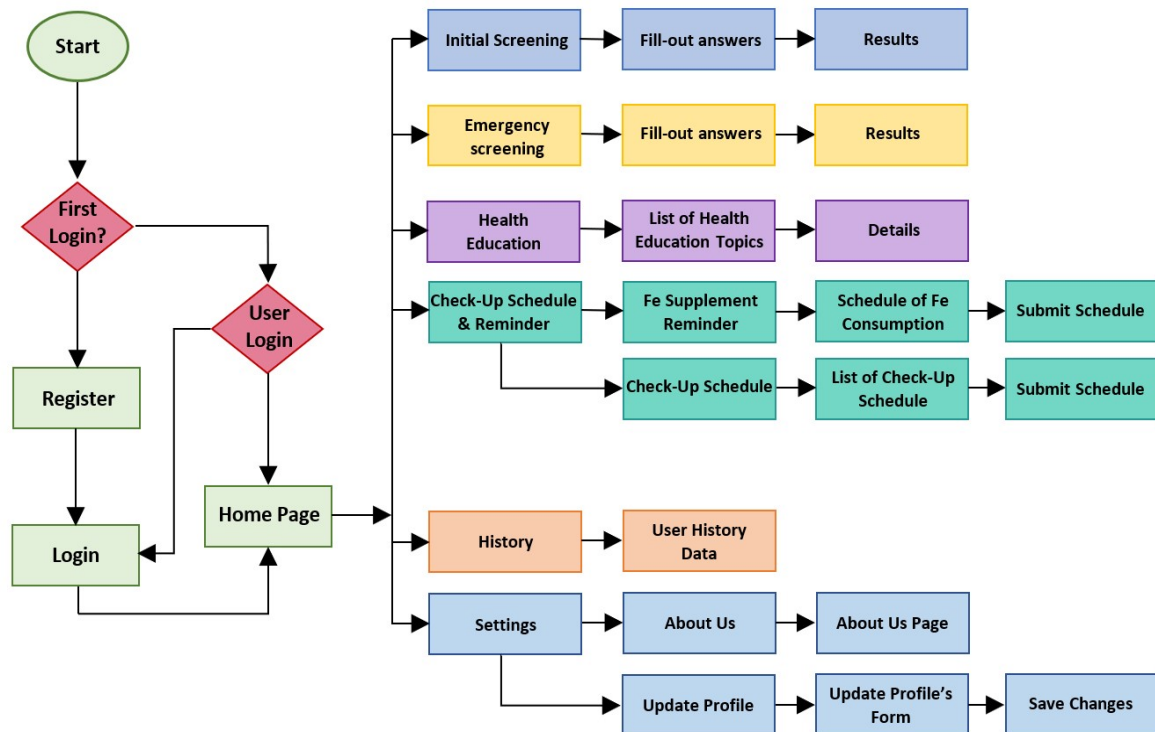
Figure 1: Interface and flowchart of the SOBUMIL application on Android devices.

hypotheses by determining the relationship between independent and dependent variables.

2.5. Ethical Aspects and Patient Data Protection

The study adhered to ethical research guidelines concerning patient data protection. All study participants provided written informed consent before enrollment. They were informed about the study objectives, potential risks, and benefits. Ethical approval for this study was obtained from the Institutional Review Board (IRB) of the Faculty of Public Health, Hasanuddin University (1215/UN4.6.4.5.31/PP36/2019), ensuring compliance with international ethical standards, including the Declaration of Helsinki. To ensure data security and participant confidentiality, the SOBUMIL application employs encryption measures to protect sensitive information. All personal identifiers are anonymized before analysis, and data transmission is secured using industry-standard encryption protocols.

3. RESULTS

The characteristics of 350 pregnant women are presented in Table **1**. The majority of pregnant women are aged 25-35 years (53.7%). Most pregnant women had a primary school education (43.4%), and their income was below the regional minimum wage (RMW)

(80.3%). In terms of parity, the majority of pregnant women have three or more children (45.7%). There are no substantial differences in the characteristics of pregnant women in the intervention and control groups.

Based on the results presented in Table **2**, self-efficacy increased from pretest to posttest in both the intervention group (pretest: 19.25±2.40; posttest: 20.42±1.92) and the control group (pretest: 20.95±3.04; posttest: 21.09±2.80). The results indicate an improvement in the future image concept of the intervention group from pretest (19.37±3.31) to posttest (20.70±2.52) and the control group (pretest: 20.37±3.15; posttest: 20.59±2.92). In addition, both the intervention group (pre-test: 16.39±2.43; post-test: 17.39±2.05) and the control group (pre-test: 16.74±2.75; post-test: 16.85±2.64) showed an increase in self-esteem from pre-test to post-test. There was an improvement in support and reassurance from pretest to posttest in both the intervention group (pretest: 11.66±1.89; posttest: 12.11±1.53) and the control group (pretest: 12.13±2.05; posttest: 12.18±1.97). In addition, maternal mobilization increased from pretest to posttest in both the intervention group (pretest: 11.86±1.54; posttest: 12.14±1.63) and the control group (pretest: 11.92±2.33; posttest: 12.06±2.11). There was an increase in the decision parameter from pretest to posttest in both the intervention group (pretest: 29.51±3.00; posttest: 31.56±2.99) and the

Table 1:   Characteristics of 350 Pregnant Women Involved in this Study

Characteristics	Groups				Total	
	Intervention		Control			
	n	%	n	%	n	%
Age						
< 25 years	46	26.3	52	29.7	98	28.0
25-35 years	95	54.3	93	53.1	188	53.7
> 35 years	34	19.4	30	17.1	64	18.3
Education						
Elementary	74	42,3	78	44.6	152	43.4
Secondary	49	28.0	60	34.3	109	31.1
Tertiary	45	25.7	34	19.4	79	22.6
University	7	4.0	3	1.7	10	2.9
Income						
< RMW	135	77.1	146	83.4	281	80.3
≥ RMW	40	22.9	29	16.6	69	19.7
Parity						
1	36	20.6	46	26.3	82	23.4
2	58	33.1	50	28.6	108	30.9
≥ 3	81	46.3	79	45.1	160	45.7

Abbreviation: RMW, regional minimum wage.

Table 2:   The Average Parameters of Pregnant Women Empowerment

Variables		Groups			
		Intervention (n=175)		Control (n=175)	
		Mean±SD	Min-Max	Mean±SD	Min-Max
Self-efficacy	Pre-test	19.25±2.40	8 – 26	20.95±3.04	7 – 28
	Post-test	20.42±1.92	16 – 28	21.09±2.80	14 – 28
	Change	1.17±1.66	0 - 10	0.14±0.64	0 – 7
Future image	Pre-test	19.37±3.31	13 – 28	20.37±3.15	13 – 28
	Post-test	20.70±2.52	14 – 28	20.59±2.92	14 – 28
	Change	1.33±2.13	0 - 11	0.22±0.77	0 – 6
Self-esteem	Pre-test	16.39±2.43	11 – 24	16.74±2.75	10 – 24
	Post-test	17.39±2.05	13 – 24	16.85±2.64	10 – 24
	Change	1.01±1.67	-1 - 10	0.11±0.47	-2 – 2
Support and assurance	Pre-test	11.66±1.89	7 – 16	12.13±2.05	7 – 16
	Post-test	12.11±1.53	9 – 16	12.18±1.97	7 – 16
	Change	0.45±1.02	0 – 6	0.05±0.32	-1 – 3
Mobilization	Pre-test	11.86±1.54	8 – 15	11.92±2.33	6 – 16
	Post-test	12.14±1.63	8 – 16	12.06±2.11	7 – 16
	Change	0.27±0.96	-1 – 3	0.14±0.52	-1 – 4
Decision making	Pre-test	29.51±3.00	22 – 44	30.54±4.80	19 – 44
	Post-test	31.56±2.99	24 – 44	30.83±4.57	20 – 44
	Change	2.05±2.66	-1 – 17	0.29±1.04	-1 – 9
Empowered pregnant women (overall)	Pre-test	107.67±12.17	83 – 152	112.66±15.20	82 – 156
	Post-test	114.32±9.25	101 – 156	113.61±14.11	83 – 156
	Change	6.65±8.32	-2 – 44	0.95±2.52	-3 – 17

Table 3:   The Component Change of Empowered Pregnant Women in Early Detection of Pregnancy Complications

Variables	Group	n	Mean±SD		p-value
			Change	Difference	
Self-efficacy	Intervention Control	175 175	1.17±1.66 0.14±0.64	1.94±0.26	0.001*
Future image	Intervention Control	175 175	1.33±2.13 0.22±0.77	7.09±0.49	0.001*
Self-esteem	Intervention Control	175 175	1.01±1.67 0.11±0.47	1.75±0.26	0.001*
Support and assurance	Intervention Control	175 175	0.45±1.02 0.05±0.32	1.94±0.26	0.001*
Mobilization	Intervention Control	175 175	0.27±0.96 0.14±0.52	7.09±0.49	0.099*
Decision making	Intervention Control	175 175	2.05±2.66 0.29±1.04	1.75±0.26	0.001*
Empowered pregnant women	Intervention Control	175 175	6.65±8.32 0.95±2.52	1.94±0.26	0.001*

*p-value <0.005, analyzed using chi-square tests.

control group (pretest: 30.54±4.80; posttest: 30.83±4.57). Overall, there was an increase in the empowerment parameters of the pregnant women from pre-test to post-test in the intervention group (pre-test: 107.67±12.17; post-test: 114.32±9.25) and in the control group (pre-test: 112.66±15.20; post-test: 113.61±14.11).

The difference in changes in self-efficacy between the intervention and control groups showed a significant difference in self-efficacy (p<0.001), as shown in Table **3**. Similarly, the difference in future image changes between the intervention and control groups indicated a significant difference in future images (p<0.001), leading to the conclusion that SOBUMIL application influences the improvement of future images. In addition, the difference in self-esteem between the intervention and control groups showed a significant difference in self-esteem (p<0.001). A significant difference in support and assurance (p<0.001) was found between the intervention and control groups.

Conversely, no significant difference in changes in mobilization of pregnant women was observed between the intervention and control groups (p=0.099). However, a significant difference in changes in mobilization of pregnant women was found between the intervention and control groups (p<0.001), suggesting an influence of SOBUMIL application on the improvement of mobilization. The difference in decision making between the intervention and control groups

indicated a significant difference in decision making in pregnant women (p<0.001). Finally, the difference in changes in empowered pregnant women between the intervention and control groups showed a significant difference in changes in empowered pregnant women (p<0.001). Overall, the differences in improvement in the empowered pregnant women component of early detection of pregnancy complications are shown in Figure **2**.

4. DISCUSSION

A total of 350 pregnant women were enrolled, most of whom were between the ages of 25 and 35; the majority had only primary school education, and a significant proportion reported incomes below the regional minimum wage. Almost half of the pregnant women had at least three children. Notably, the characteristics of pregnant women in the intervention and control groups were not significantly different. The research showed a significant effect of SOBUMIL application in increasing the overall parameters of empowered pregnant women in the early detection of pregnancy complications in Bogor Regency (p<0.001).

Our findings align with the study by Krismawati *et al.*, [15], which demonstrates that implementing the Sahabat Ibu Hamil (ASIH) application can significantly improve knowledge scores, compliance with iron tablet consumption, and attitudes. Another study indicates that using the Sobumil application can substantially reduce complaints during the first trimester of
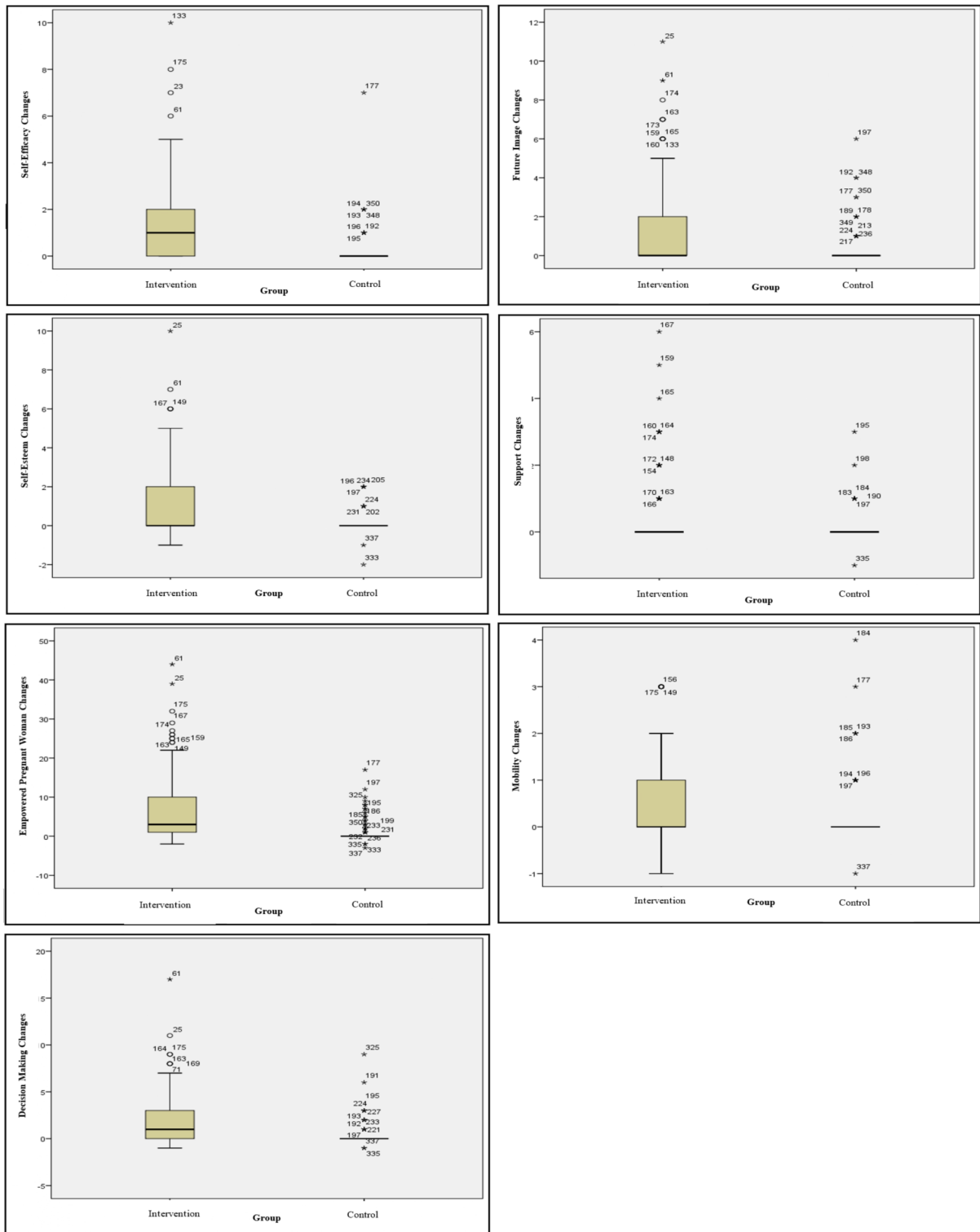
Figure 2: Differences in the improvement of the variable of empowered pregnant women in early detection of pregnancy complications.

pregnancy [16]. The observed changes are undoubtedly influenced by external and internal factors. External factors include support from healthcare professionals, support from community health workers, and family support, especially from the spouse.

Furthermore, internal factors involve characteristics of pregnant woman, such as age, education, knowledge, attitude, occupation, parity, and self-motivation. As the levels of both internal and external factor increase, pregnant women are more likely to adhere to

recommendations, leading to enhanced knowledge and attitudes [17]. This is supported by the findings of Ismaniar *et al*., [18] and Yadav *et al*., [19], explaining that higher levels of education influence individuals' behavior to participate in maternal health programs.

A significant difference in the change in decision-making was found between the intervention and control groups, indicating a difference in the change in decision-making among pregnant women (p<0.001). Therefore, it was found that the SOBUMIL application influences on improving the decision-making of pregnant women. Similarly, a significant difference in the change in the empowerment of pregnant women was observed between the intervention and control groups (p<0.001), leading to the conclusion that the SOBUMIL application has an impact on enhancing the empowerment of pregnant women. The results of this study indicate an influence of the SOBUMIL application on the improvement of empowerment of pregnant women in the early detection of pregnancy complications in Bogor Regency (p<0.001).

This study indicates that both the intervention and control groups experienced changes in the empowerment of pregnant women. This study could be attributed to other factors influencing pregnant women in the control area, such as the active participation of pregnant women in maternal classes that use the Maternal and Child Health Handbook (KIA book), support from spouses and the community, as well as the role of healthcare providers. Additionally, mothers might actively obtain information from sources other than the KIA book in the control area.

Empowering women enables them to make decisions regarding their well-being, including detecting pregnancy complications. The use of smartphone applications for health education, known as mobile health (m-health), is beneficial. One of the advantages of m-health is that it allows individuals to monitor their health without visiting a hospital or meeting with a doctor. Through the SOBUMIL application, pregnant women can detect early risks during their pregnancy without the need for direct interaction with healthcare providers. This application empowers pregnant women to determine access to healthcare services according to their pregnancy conditions.

This study aligns with the research conducted by Ismayanti *et al*., [20], which suggests that the Early Pregnancy Risk Detection Application (DDILAN) can empower pregnant women to monitor their pregnancy

conditions independently, enabling them to receive guidance on healthcare facilities that align with their pregnancy conditions. The findings of this study are also consistent with the research by Dalton *et al*., [21], which states that increased use of mobile applications can enhance women's understanding and knowledge of personal health healthcare and improve their capabilities, thereby empowering pregnant women to make informed decisions.

5. CONCLUSIONS

This study demonstrated a significant positive impact of the SOBUMIL application on empowering pregnant women for early detection of pregnancy complications. The findings support the notion that mobile health applications, such as SOBUMIL, contribute to enhancing pregnant women's ability to monitor and address pregnancy-related risks independently. Overall, the study underscores the potential of m-health interventions in empowering pregnant women and improving maternal healthcare outcomes.

REFERENCES

[1] Ozimek JA, Kilpatrick SJ. Maternal Mortality in the Twenty-First Century. Obstetrics and Gynecology Clinics of North America 2018; 45(2): 175-86.
https://doi.org/10.1016/j.ogc.2018.01.004

[2] World Health Organization. Maternal mortality Evidence brief 2019; (1): 1-4.

[3] Kusnandar V. Angka Kematian Ibu Mencapai 7 ribu pada tahun 2021, terbesar karena covid 19. Databooks.katadata.co.id 2022; 2022.

[4] ASEAN S. ASEAN Socio-Cultural Community in Facts and Figures 2022.

[5] Say L, Chou D, Gemmill A, Tunçalp Ö, Moller AB, Daniels J, *et al.* Global causes of maternal death: A WHO systematic analysis. The Lancet Global Health 2014; 2(6): 1-11.
https://doi.org/10.1016/S2214-109X(14)70227-X

[6] Galle A, De Melo M, Griffin S, Osman N, Roelens K, Degomme O. A cross-sectional study of the role of men and the knowledge of danger signs during pregnancy in southern Mozambique. BMC Pregnancy and Childbirth 2020; 20(1): 1-14.
https://doi.org/10.1186/s12884-020-03265-4

[7] WHO. World Health Statistic 2021: Monitoring Health for SDGs 2021; 7: 6.

[8] Waller A, Bryant J, Cameron E, Galal M, Symonds I, Sanson-Fisher R. Screening for recommended antenatal risk factors: How long does it take? Women and Birth 2018; 31(6): 489-95.
https://doi.org/10.1016/j.wombi.2018.01.005

[9] Ashar H, Latifah L, Kusrini I, Tjandrarini DH. Relationship between ante natal care and pregnancy classes with selection of place and birth attendant in Indonesia. Jurnal Kedokteran dan Kesehatan Indonesia 2019; 10(3): 271-80.
https://doi.org/10.20885/JKKI.Vol10.Iss3.art10

[10] Terefe AN, Gelaw AB. Determinants of Antenatal Care Visit Utilization of Child-Bearing Mothers in Kaffa, Sheka, and

Bench Maji Zones of SNNPR, Southwestern Ethiopia. Health Services Research and Managerial Epidemiology 2019; 6: 233339281986662.
https://doi.org/10.1177/2333392819866620

[11] Goncalves AS, Ferreira IM, Pestana-Santos M, Prata AP, McCourt C. Antenatal care policies for low-risk pregnant women in high-income countries with a universal health system: A scoping review protocol. JBI Evidence Synthesis 2020; 18(7): 1537-45.
https://doi.org/10.11124/JBISRIR-D-19-00197

[12] Indonesian Health Ministry. Basic Health Research (Riskesdas) National Report 2018; 2018.

[13] Eerdewijk A Van, Newton J, Tyszler M, Wong F, Vaast C. A Conceptual Model of Women and Girls' Empowerment. Bill & Melinda Gates Foundation 2017; 1-12.

[14] World Bank. World Development report 2012: Gender Equality and Development 2012.
https://doi.org/10.1596/978-0-8213-9575-2

[15] Krismawati E, Widjanarko B, Rahfiludin MZ. Pengaruh Aplikasi Sahabat Ibu Hamil (ASIH) terhadap Kepatuhan Minum Tablet Fe dan Kadar Hb Ibu Hamil. Jurnal Keperawatan 2022; 14(1): 121-8.
https://doi.org/10.32583/keperawatan.v14i1.44

[16] Wulandhari Y, Sekarwana N, Hidayat YM. Pengaruh Penerapan Aplikasi Sahabat Ibu Hamil (ASIH) terhadap Penurunan Keluhan Trimester I Kehamilan. JURNAL KESEHATAN PERINTIS (Perintis's Health Journal) 2019; 6(2): 146-52.
https://doi.org/10.33653/jkp.v6i2.346

[17] Ariyani NW, Wirawan IMA, Pinatih GNI, Kusuma AANJ. The effect of an application-based educational intervention with a social cognitive theory model on pregnant women in Denpasar, Bali, Indonesia: a randomized controlled trial. Osong Public Health and Research Perspectives 2022; 13(2): 153-61.
https://doi.org/10.24171/j.phrp.2021.0209

[18] Ismainar H, Subagio HW, Widjanarko B, Hadi C. To What Extent Do Ecological Factors of Behavior Contribute to the Compliance of the Antenatal Care Program in Dumai City, Indonesia? Risk Management and Healthcare Policy 2020; 13: 1007-14.
https://doi.org/10.2147/RMHP.S242724

[19] Yadav AK, Sahni B, Kumar D, Bala K, Kalotra A. Effect of Women's and Partners' Education on Maternal Health-care Services Utilization in Five Empowered Action Group States of India. International Journal of Applied & Basic Medical Research 2021; 11(4): 231-7.
https://doi.org/10.4103/ijabmr.ijabmr_121_21

[20] Ismayanty D, Sugih S, Aziz MA, Sastramihardja HS. Pengaruh aplikasi deteksi dini risiko kehamilan (DDILAN) terhadap peningkatan pengetahuan dan sikap tentang risiko kehamilan to improvement knowledge and attitudes about the risk of pregnancy. Jsk 2019; 5(71): 129-33.

[21] Dalton JA, Rodger D, Wilmore M, Humphreys S, Skuse A, Roberts CT, *et al*. The Health-e Babies App for antenatal education: Feasibility for socially disadvantaged women. Beiki O, editor. PLOS ONE 2018; 13(5): e0194337.
https://doi.org/10.1371/journal.pone.0194337