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Meta-Analysis
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Meta-Analysis: Effectiveness of mHealth Utilization on Antenatal Care

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ABSTRACT

Background: An antenatal visit is the presence of pregnant women at health facilities to check their pregnancy and get information about their pregnancy. The use of mobile health interventions (mHealth) such as SMS, voice messages, videos, and interactive mobile phones can provide behavioral support and health education needs of pregnant women. This study aims to determine the effectiveness of the use of mHealth on the improvement of antenatal visits.
Subjects and Method: Systematic reviews and meta-analyses were conducted using PRISMA guidelines and PICO models which included Population = pregnant women; Intervention= mHealth, Comparison= does not use mHealth; Outcome= antenatal visit. Articles are collected through databases such as Google Scholar, PubMed, BMJ, Plos One, Plos Digital Health, JMIR, JPHIA, HSPRJ, JIO, Journal of Midwifery and Traditional Health. Keywords used: mHealth or Telemedicine or Phone or Mobile Phones or Mobile Telephone or Short Message Service or Whatsapp Group, Antenatal Visite or Antenatal Care or Pregnancy or Pregnant or Prenatal or Mother Health. A total of 13 articles that met the inclusion criteria were meta-analyzed and assessed using RevMan 5.3.
Results: Meta-analyses from Tanzania, Kenya, India, Brazil, Peru, Bangladesh, Nigeria, Uganda, and Indonesia showed that pregnant women who used mHealth services were 2.94 times more likely to have antenatal visits compared to not using mHealth and the effect was statistically significant (OR= 2.94; CI95%= 2.19 to 3.94; p <0.001).
Conclusion: The use of mHealth may increase antenatal visits.

Keywords: mHealth, antenatal visits, and meta-analysis

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BACKGROUND

Health services during pregnancy, childbirth, and after childbirth are important for the survival and well-being of mothers and newborns (Tobe et al., 2022). The use of timely and appropriate antenatal services can prevent complications and improve better maternal and newborn health services (Masoi et al., 2023).

WHO increased the number of contacts a pregnant woman had with a health care provider during her pregnancy from four focused antenatal visits (fANC) to eight contacts. A pregnant woman's contact with

an antenatal provider is not just a simple visit, but rather the provision of services and support during pregnancy to improve perinatal outcomes and women's care. Recommendations are designed to be adaptable and flexible, so that countries with different situations can adopt and implement recommendations based on the context of the country and the needs of the community (WHO, 2018). Globally, more than 40% of pregnant women receive antenatal services four times during their pregnancy, this is due to a lack of access to quality services before, during and after childbirth, especially in some low and lower-middle-income countries (WHO's, 2018).

According to the 2018 Nigerian Health and Demographic Survey, 57% of pregnant women received a minimum of four ANC visits during pregnancy. 65% of pregnant women in Tanzania had four or more antenatal visits (TDHS, 2022). 58% of pregnant women in Uganda attended a minimum of four antenatal visits.

In 2021, the coverage of services (K4) for pregnant women in Indonesia nationally has reached the 2021 RPJMN target of 88.8% of the target of 85%. Of the 34 provinces in Indonesia, there is still an achievement gap between provinces and there are 17 provinces that have not met the RPJMN target of four or more antenatal visits, the highest in DKI Jakarta Province: 114.5%, West Java: 98.8% and Banten 95.7% while the lowest is in West Papua Province: 16.8%, Papua: 34.1% and DI Yogyakarta: 60.4% (Ministry of Health of the Republic of Indonesia, 2021).

The factors that cause pregnant women not to have four or more antenatal visits in Tanzania (TDHS, 2022), are: education, wealth and housing. Meanwhile, in Indonesia, namely: inadequate maternal and child health management, inadequate capacity of health workers, georspatial conditions that affect access to health service facilities, socio-economy, and progress of a region (Ministry of Health of the Republic of Indonesia, 2021).

The use of commonly used health-based mobile technology (mHealth) such as short message service (SMS), video messages, voice calls and other internet connectivity that is used consistently can improve monitoring of pregnant women and increase the utilization of maternal health services (Masoi et al., 2023).

Research (Oyeyemi and Wynn, 2014) in Nigeria shows that 43.5% of pregnant women who are given smartphones can increase the use of primary health care facilities compared to pregnant women who are not given smartphones by 36.7% with a significance value (p= 0.001). Research (Benski et al., 2020) in Madagascar showed that mHealth can improve the quality of at least four antenatal visits (Z= 19.9; CI95%= 19.2 to 20.6; p <0.001). Research (Coleman et al., 2020) that evaluated mHealth text messages on maternal and child health service delivery in Africa showed that 72% of women given the intervention had four or more ANC visits compared to 46% in control women (OR= 3.21; CI95%= 1.73 to 5.98; p <0.001). Research (Shiferaw et al., 2016) on the effects of locally developed mHealth on the benefits of childbirth and postnatal care in Ethiopian health centers showed that 27% of women in intervention health centers had a minimum of four antenatal visits compared to 23.4% in women in the control group (AOR= 1.31; CI95%= 1.00 to 1.72).

Previous studies have reported that mHealth interventions are effective in increasing the use of essential maternal health services, especially antenatal visits, but the results have not shown consistent results. A deeper analysis is needed to get a more convincing conclusion. Researchers are interested in conducting research on the effectiveness of the use of mHealth on the increase of antenatal visits by using a

systematic review approach that is relevant from various studies in the world by conducting meta-analysis. This study aims to determine the effectiveness and analyze how effective the use of mHealth is for antenatal visits.

SUBJECTS AND METHOD

1. Study Design

This research was conducted using systematic review and meta-analysis with secondary data from previous research. Articles are collected through databases such as: Google Scholar, PubMed, BMJ, Plos One, Plos Digital Health, JMIR, JPHIA, HSPRJ, JIO, Journal of Midwifery and Traditional Health. Keywords used: mHealth or Telemedicine or Phone or Mobile Phones or Mobile Telephone or Short Message Service or Whatsapp Group, Antenatal Visite or Antenatal Care or Pregnancy or Pregnant or Prenatal or Mother Health. The analysis of this study was carried out using RevMan 5.3 software.

2. Steps of Meta-Analysis

Data analysis is carried out through 5 steps, namely:

1) Formulating research problems using PICO, including: P= pregnant women; I= using mHealth; C= does not use mHealth; O= antenatal visit.
2) Browse literature from electronic databases such as Google Scholar, PubMed, BMJ, Plos One, Plos Digital Health, JMIR, JPHIA, HSPRJ, JIO, Journal of Midwifery and Traditional Health.
3) The quality of the study was assessed using the Critical Apraisal checklist for Randomized Controlled Trial
4) Combining the results of the study using RevMan 5.3 to calculate the Odds Ratio (OR), Confidence Interval (CI) of 95% using the model effect and data heterogeneity
5) Interpret the results of research analysis and draw conclusions

3. Inclusion Criteria

The article used is full-text in English, the study design is Randomized Controlled Trial (RCT) which lists the number of compliance for each group.

4. Exclusion Criteria

Articles not in English and articles published before 2013.

5. Operational Definition

mHealth is a mobile communication technology for health services. Instruments: voice calls, short message services, videos, whatsapp groups. Measurement scale: categorical.

Antenatal visits are the number of visits a pregnant woman makes during pregnancy to get pregnancy care at a health facility. Instruments: KIA book, pregnancy visit records, checklist in medical records. Measurement scale: categorical.

6. Istrument

The instrument used in this study is the Critical Appraisal Checklist for randomized controlled trial.

7. Data Analysis

Data processing was carried out using RevMan 5.3 software by calculating effect size and heterogeneity () to determine the combined research model and the final results of meta-analysisI^2.

RESULTS

The process of searching for articles through journal databases includes Google Scholar, PubMed, BMJ, Plos One, Plos Digital Health, JMIR, JPHIA, HSPRJ, JIO, Journal of Midwifery and Traditional Health with a time span between 2013 and 2023. Keywords used: mHealth or Telemedicine or Phone or Mobile Phones or Mobile Telephone or Short Message Service or Whatsapp Group, Antenatal Visite or Antenatal Care or Pregnancy or Pregnant or Prenatal or Mother Health.

Figure 1 shows the initial search process that displays 1,467 article results, then the deletion of published double articles so that 1,256 articles are obtained, and there are 13 articles that are eligible for full text review

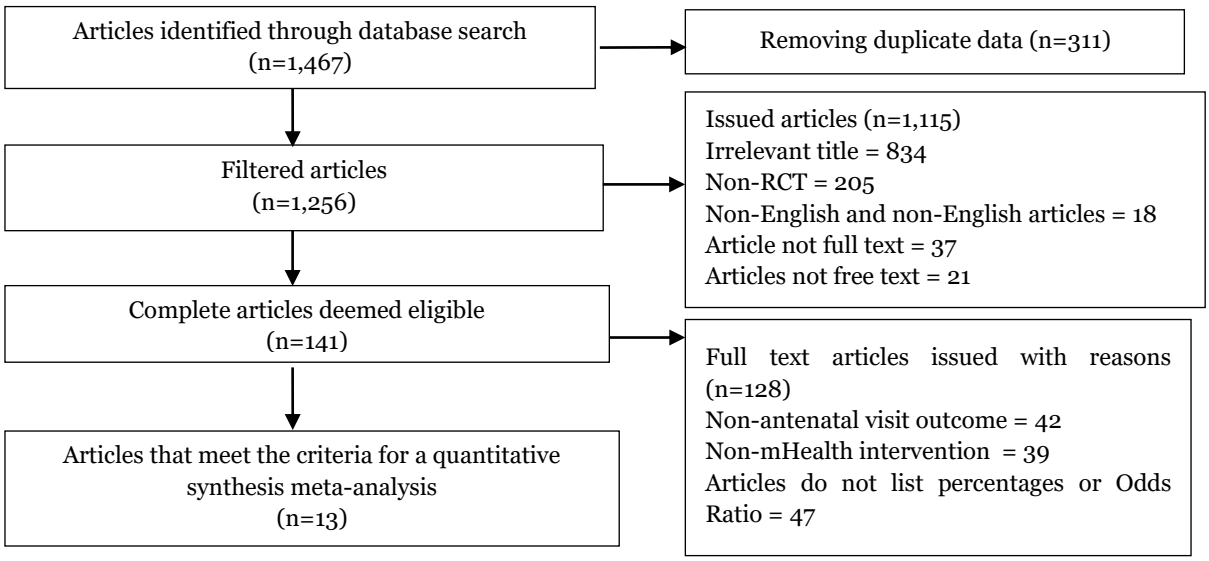

Figure 1. PRISMA Flow diagram

Figure 2. Map of the distribution of research on the effect of workload and work environment on job satisfaction

Figure 2 shows an overview of the location of the research area on the effectiveness of mHealth use against antenatal visits spread across three continents: Asia, Africa, and South America.

Table 1. Quality assessment of the randomized controlled trial study from effectiveness of mHealth use on antenatal visits

No	Researcher Name Year	Criteria														Total
		1				2		3		4			5		6	
		a	b	c	d	a	b	a	b	a	b	c	a	b		
1	Lund *et al.,* 2014	2	2	2	2	2	2	2	2	2	0	2	2	2	2	26
2	Fedha, 2014	2	2	2	2	2	2	2	2	2	2	2	2	2	2	28
3	Bangal *et al.,* 2017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	28
4	Oliviera-Ciabati *et al.,* 2017	2	2	2	2	2	2	2	2	2	0	2	2	2	2	26
5	Murthy *et al.,* 2020	2	2	2	2	2	2	2	2	2	0	2	2	2	2	26
6	Garcia *et al.,* 2021	2	2	2	2	2	2	2	2	2	2	2	2	2	2	28
7	Tobe *et al.,* 2022	2	2	2	2	2	2	2	2	2	2	2	2	2	2	28
8	Osanyin *et al.,* 2022	2	2	2	2	2	2	2	2	2	0	2	2	2	2	26
9	Atukunda *et al.,* 2023	2	2	2	2	2	2	2	2	2	2	2	2	2	2	28
10	Ardiyanti *et al.,* 2020	2	2	2	2	2	0	2	2	2	2	2	2	2	2	26
11	Ummah *et al.,* 2020	2	2	2	2	2	0	2	2	2	2	2	2	2	2	26
12	Sari *et al.,* 2023	2	2	2	2	2	0	2	2	2	2	2	2	2	2	26
13	Maso i *et al.,* 2023	2	2	2	2	2	2	2	2	2	2	2	2	2	2	28

Description of the answer score:

2 = Yes

1 = Doubt

0= No

Question criteria descriptions:

1) Formulation of research questions in the acronym PICO
   a. Is the population in the primary study the same as the population in the PICO meta-analysis?
   b. Is the operational definition of intervention in primary studies the same as the definition intended in meta-analysis?
   c. Is the operational definition of comparison used by the primary study the same as the scheme planned in the meta-analysis?
   d. Is the operational definition *of the* outcome variable studied in the primary study the same as that planned in the meta-analysis?
2) Methods for selecting research subjects
   a. Is the sample selected from the population so that the sample is representative of the population?
   b. Is the allocation of subjects into experimental and control groups done by randomization?
3) Methods for measuring interventions and outcome variables
   a. Were the interventions and outcome variables measured with the same instruments in all primary studies?
   b. If the variables are measured on a categorical scale, are the *cutoffs* or categories used the same between primary studies?
4) Design-related bias
   a. Is double-blinding *carried out*, i.e. the research subject and the research assistant who help measure the outcome variable do not know the status of the intervention of the research subject?
   b. Is there no possibility of "*Loss-to-Follow-up Bias*"?
   c. Have primary study researchers made any effort to prevent or address such biases?

5) Statistical analysis methods
   a. Were the outcome data compared between the experimental group and the control group after the intervention?
   b. Are all data analyzed according to the randomization results?
6) Conflict of interest Is there no possibility of a conflict *of interest* with the research sponsor, which causes bias in concluding the results of the study?

Based on Table 2 of the PICO primary research on the effectiveness of mHealth use on antenatal visits conducted a meta-analysis of 13 articles from 2014 to 2023 that randomized 9,555 pregnant women (n= 5,047, 52.82% in the intervention group; n= 4,508, 47.17% in the control group) with varying locations in the study countries, namely India, Bangladesh, Indonesia, Tanzania, Kenya, Nigeria, Uganda, Brazil, and Peru. Similarities were found in the study, namely the population was pregnant women, the intervention provided was using mHealth (phone calls, text messages, videos, voice messages) with the comparator not using mHealth (routine antenatal care at health care facilities), and the outcome was antenatal visits. However, there was a difference in the number of samples used, which was at least 52 and at most 2,551.

Table 2. Table PICO summary of article on the effectiveness of mHealth Utilization on Antenatal Care

Author	Country	Sample	P	I	C	O
Randomized Controlled Trial						
Lund et al. (2014)	Tanzania	2,550	Pregnant women	Text and phone	Not using mHealth	≥ 4 ANC visits
Fedha, (2014)	Kenya	397	Pregnant women	Cellphone	Not using mHealth	≥ 4 ANC visits and ANC service uptake
Bangal et al. (2017)	India	400	Pregnant women	Cellphone	Not using mHealth	4 ANC visits, and institu-tional delivery and PNC
Oliviera Ciabati et al., (2017)	Brazil	556	Pregnant women	Text messages	Not using mHealth	Coverage of recommended ANC care practices
Murthy et al., (2020)	India	1,515	Pregnant women	Voicemail (mMitra)	Not using mHealth	Impact on maternal health practices, ANC
Garcia et al., (2021)	Peru	1,162	Pregnant women	Text messages (Wewared)	Not using mHealth	≥6 ANC, recommended diet, birth and maternal health outcomes
Tobe et al., (2020)	Bangladesh	2,001	Pregnant women	Text messages and phone calls	Not using mHealth	Neonatal and fetal deaths, LBW, pregnancy complications and referrals, and seeking health services during pregnancy until delivery
Osanyin et al., (2022)	Nigeria	458	Pregnant women	Voicemail	Not using mHealth	≥8 antenatal visits

Author	Country	Sample	P	I	C	O
Atukunda et al., (2023)	Uganda	120	Pregnant women	Text messages (SupportMoms)	Not using mHealth	≥4 antenatal visits
Quasi-Experimental						
Masoi et al., (2023)	Tanzania	450	Pregnant women	Text messages	Not using mHealth	ANC services by skilled health workers, ≥4 ANC, antenatal care according to recommendations
Ardiyanti et al., (2020)	Indonesia	62	Pregnant women	Video message	Not using mHealth	Antenatal visits according to schedule
Ummah et al., (2020)	Indonesia	52	Pregnant women	Video message	Not using mHealth	4 antenatal visits
Sari et al., (2023))	Indonesia	52	Pregnant women	Text messages	Not using mHealth	Antenatal visit compliance

Based on Table 3 which presents the results of the Odds Ratio (OR) and Confidence Interval 95% (CI 95%) of the effectiveness of the use of mHealth for antenatal visits, there is a difference in the 13 primary research results, namely Odds Ratio 1.40 to 14.48, the lower limit of Confidence Interval (CI) 95%= 0.80 to 3.40 and the upper limit of Confidence Interval (CI) 95%= 1.93 to 61.69.

Table 3. Results of primary research on the effectiveness of the use of mHealth on antenatal visits included in the meta-analysis

Author (Year)	aOR	CI 95%	
		Lower Limit	Upper Limit
Lund et al., 2014	2.39	1.03	5.55
Fedha, 2014	2.89	1.51	5.53
Bangal et al., 2017	4.20	2.23	7.90
Oliviera-Ciabati et al., 2017	5.03	1.79	14.10
Murthy et al., 2020	1.51	0.80	2.85
Garcia et al., 2021	1.40	1.02	1.93
Tobe et al., 2020	2.34	1.73	3.17
Osanyin et al., 2022	3.58	2.33	5.50
Atukunda et al., 2023	4.71	1.69	13.13
Ardiyanti et al., 2020	2.95	1.04	8.48
Ummah et al., 2020	6.72	1.92	23.58
Sari et al., 2023	14.48	3.40	61.69
Masoi et al., 2023	3.07	1.67	8.46

a. Forest plot

The Forest Plot in Figure 3 using the Randomized Controlled Trial design shows that there is an effect of the effectiveness of mHealth use on antenatal visits. Pregnant women who used mHealth services were 2.61 times more likely to have antenatal visits compared to not using mHealth and the effect was statistically significant (OR= 2.61; CI95%= 1.91 to 3.58; p <0.001). The Forest Plot also showed high effect estimation heterogeneity between studies (I^2= 65%; p= 0.003). Thus, the effect calculation is carried out with the Random Effect Model approach.

The Forest Plot in Figure 3 using the Quasi Experimental design shows that there is an effect of the effectiveness of mHealth

use on antenatal visits. Pregnant women who used mHealth services were 4.46 times more likely to have antenatal visits compared to no mHealth and the effect was statistically significant (OR= 4.46; CI95%= 2.35 to 8.46; p <0.001). The Forest Plot showed low effect estimation heterogeneity between studies (I^2= 36%; p= 0.190). Thus, the effect calculation is carried out with the Fixed Effect Model approach.

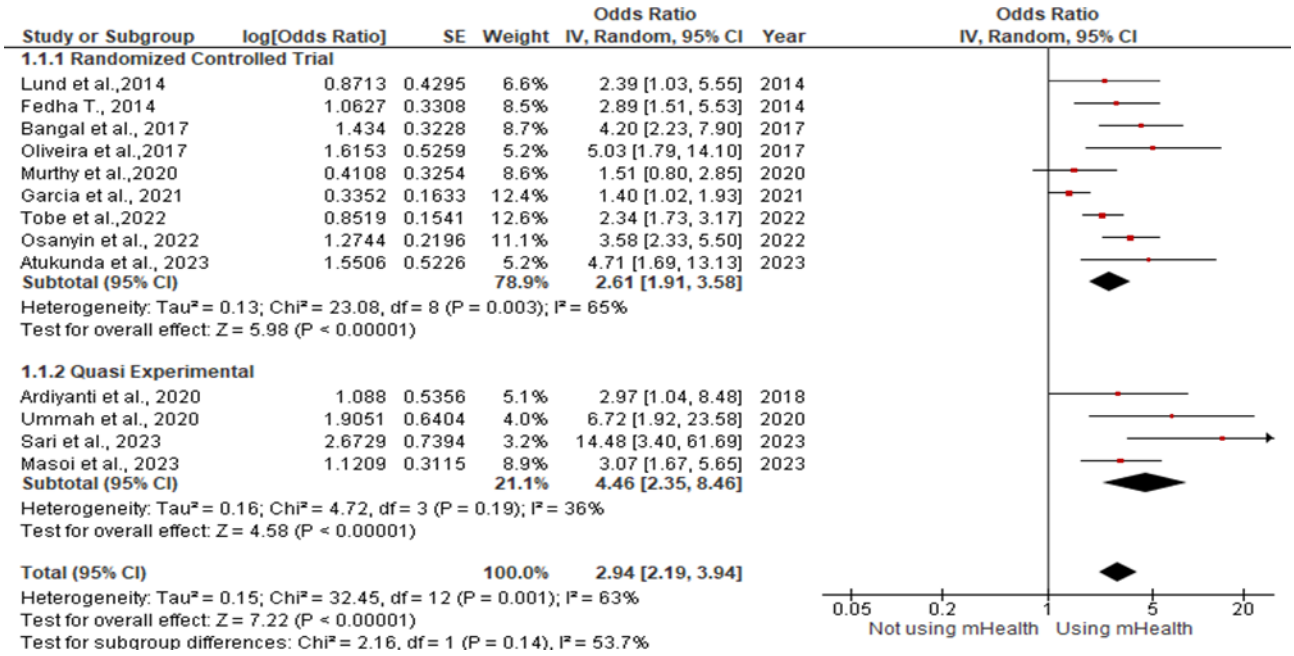

Figure 3. Forest plot meta-analysis of the effectiveness of mHealth use against antenatal visits

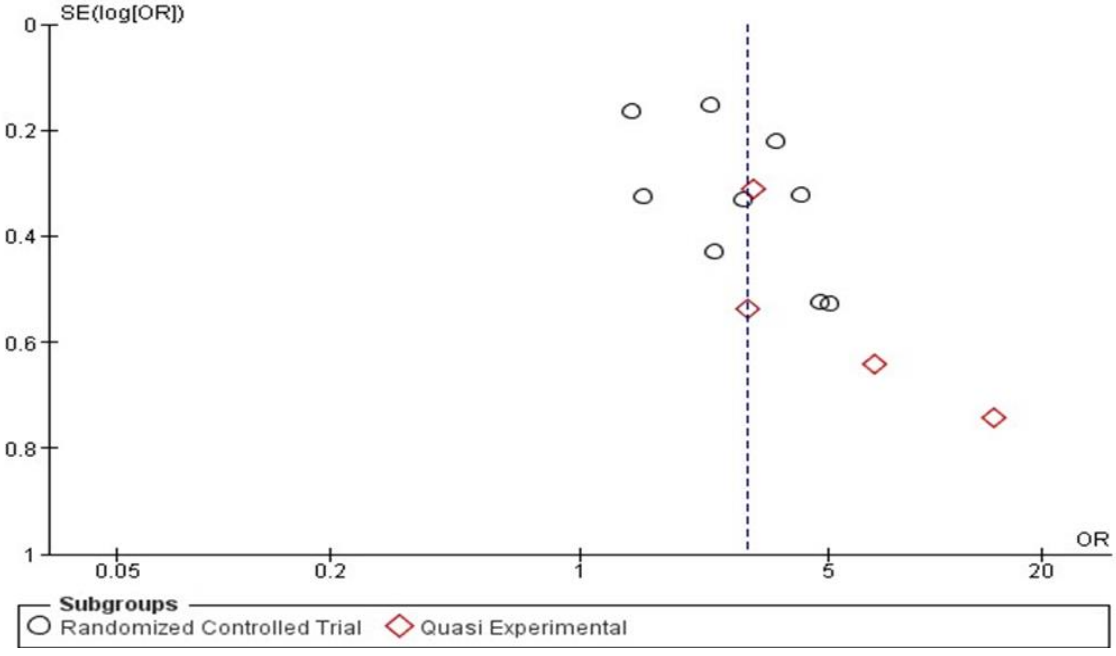

Figure 4. Funnel plot of the effect of workload on job satisfaction in health personnel

The Forest Plot in Figure 3 as a whole shows that there is an effect of the effectiveness of mHealth use on antenatal visits. Pregnant women who used mHealth services were 2.94 times more likely to have antenatal visits compared to not using mHealth and the effect was statistically significant (OR= 2.94; CI95%= 2.19 to 3.94; p <0.001). The Forest Plot also showed high effect estimate heterogeneity between studies (I^2= 63%; p= 0.001). Thus the effect calculation is carried out using the Random Effect Model approach.

c. Funnel plot

The Funnel Plot in Figure 4 shows an unbalanced distribution of effect estimates from the right and left vertical lines of each effect. Thus, the funnel plot shows the existence of publication bias.

DISCUSSION

Increasing the use of essential maternal and child health services is an important strategy to reduce preventable maternal morbidity and mortality. Every year, one third of maternal deaths in the world are caused by lack of care during pregnancy (Masoi et al., 2023). Antenatal service visits are a great time to advise mothers and their families on important pregnancy care and develop a birth plan and preparedness for complications. These approaches improve outcomes for women and can also reduce neonatal birth and death rates.

The use of mobile health interventions such as SMS, voice messages, videos, and interactive cell phones can provide behavioral support and health education needs of pregnant women (Masoi et al., 2023). Mobile technology has the potential to bridge the systemic gap needed to improve access and use of health services in underserved communities (Agarwal et al., 2016).

There are 13 primary research articles related to the effectiveness of the use of mHealth on antenatal visits spread across 3 continents, namely Asia (India, Indonesia, and Bangladesh), Africa (Tanzania, Kenya, Nigeria, and Uganda), and South America (Brazil and Peru). Based on the results of the analysis conducted by systematic review and meta-analysis, it showed high heterogeneity between experiments (I^2= 63%; p= 0.001) so that the analysis used a random effect model. High heterogeneity is due to variation or diversity between populations as seen in the different sample sizes in each intervention group and control group, different interventions between research studies.

The results of a meta-analysis of 13 articles related to the effectiveness of the use of mHealth on antenatal visits were obtained that there was an effect of the effectiveness of the use of mHealth on antenatal visits. Pregnant women who used mHealth services were 2.94 times more likely to have antenatal visits compared to not using mHealth and the effect was statistically significant (OR= 2.94; CI95%= 2.19 to 3.94; p <0.001). There were 9 primary research articles that showed significant value in mHealth research on antenatal visits characterized by not touching the horizontal line of each study with a vertical line on the forest plot contained in the Fedha study, 2014, Bangal et al., 2017, Oliveira-Ciabati et al., 2017, Tobe et al., 2022, Osanyin et al., 2022, Atukunda et al., 2023, Ummah, Kostania, and Rosalina 2020, Sari et al., 2023, Masoi et al., 2023. Some of the factors that affect the significance value in the 9 articles are the number of samples between the same intervention group and the control group so that the number of proportions between the two is balanced.

Several studies have shown the effectiveness of the use of mHealth on antenatal visits, one of which is the Osanyin et al., (2023) study which showed that pregnant women who were given voice message interventions were more likely to

have eight or more antenatal visits (RR= 2.25; CI95%= 1.59-3.18; p <0.001). This contributes to the existing information about the influence of mHealth on the health outcomes of pregnant women and serves as a useful tool to ensure no woman is left behind. Another study by Masoi et al., (2023) conducted in Tanzania on the effectiveness of interactive mobile health technology in improving the utilization of antenatal care services where researchers found that mobile health technology proved to be effective in increasing the coverage of four or more recommended antenatal visits with a significant value of p <0.001, 90.7% in the intervention group and 76.0% in the control group.

This study is consistent with a systematic review that reported that the mHealth intervention had a positive effect and resulted in a 43% increase in recommended antenatal visits among pregnant women (Chen H. et al., 2018). In another systematic review conducted by Wagnew et al., (2018), SMS text messages had a positive effect on the use of four or more antenatal visits (OR= 2.74; CI95%= 1.41 to 5.32).

Antenatal services have been proven to improve maternal quality during pregnancy and birth (WHO, 2019). This can be improved by providing mHealth to pregnant women which can be an important means of communication between the healthy and the sick in many parts of the world (Song H. et al., 2013).

AUTHOR CONTRIBUTION

Nuryuliana the main researcher who selects topics, searches and collects articles, analyzes data and writes manuscripts. Argyo Demartoto and Rita Benya Adriani helped analyze the data and review research documents.

CONFLICT OF INTEREST

There was no conflict of interest in the study.

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