



mHealth Conceptual Model for Providing Quality Antenatal Care in Health Centers during the Coronavirus Disease 2019 Pandemic

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Abstract

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BACKGROUND: In Indonesia, the maternal mortality rate is still high and far from the Sustainable Development Goals target of 305 compared to 70 per 100,000 live births.

AIM: This study aims to design the mHealth concept to improve the quality of antenatal care (ANC) with features that support service workers during the coronavirus disease 2019 (COVID-19) pandemic.

METHODS: The method used was literature study and conceptual design of the mHealth model with Rapid Application Development approach.

RESULTS: The result showed that several factors influence the quality of ANC and the potential for improvement with mHealth. There are nine features of pregnancy services designed to improve the quality of ANC, such as standard operating procedure compliance, maternal health records, clinical decision aids, referral links, teleconsultation, health promotion improvement, alerts, and reminders, real-time reports, and distribution maps for pregnant women. The depicted context diagram consists of four external entities such as pregnant women, midwives, maternal and child health coordinators at Health centers and Health offices in Indonesia as well as the flow of data or information to and from mHealth, and the interface design understands users' role and is executed accordingly.

CONCLUSION: The problems of pregnant women during the COVID-19 pandemic or the new normal were partially resolved with mHealth innovations, teleconsultation features, and improving health promotion. Therefore, all the mHealth features this helps in improving the quality of ANC.

Introduction

One of the goals of the Sustainable Development Goals is to reduce the Maternal Mortality Rate (MMR) and the target to be achieved in 2030 is <70/100,000 live births. Meanwhile, the MMR is estimated to be 211/100,000 live births, or there are 295,000 maternal deaths every year in the world [1]. Meanwhile, in Indonesia, 2015 data show a high MMR of 305 per 100,000 live births, where this figure has not decreased significantly over the past decades [2].

The direct causes of maternal death are complications that occur during pregnancy and the puerperium. Furthermore, the most common complications that account for about 75% of deaths are bleeding, infection, pre-eclampsia, prolonged labor, and unsafe abortion [1]. Besides, there are indirect causes of maternal death at the community level, referred to as late 3 (3T), such as late recognition of danger signs, late referrals, and late optimal service [3]. The delay in recognizing danger signs is due to the mother's lack of knowledge about it and this has resulted in the late arrival and late referral at health services, such that at the time of referral, the condition was already in a

critical state and finally no help could be rendered when she arrived at the hospital [4].

One of the efforts to prevent maternal mortality is through antenatal examination, which aims to prepare mothers for childbirth and infant care. An interesting phenomenon is an increase in antenatal care (ANC) coverage, but it does not lead to a significant decrease in MMR. This condition seems to indicate the low quality of ANC. Meanwhile, its standard in Indonesia is 10T which includes, an examination of height and weight, blood pressure examination, upper arm circumference measurement, uterine fundal height measurement, examination of heart rate and fetal position, screening and administration of TT, routine laboratory examination, administration of Fe and Folic Acid, case management, and interviews (counseling), but only 4% were found to provide 7-10T services [5].

The quality of ANC is a determining factor in reducing maternal morbidity and mortality [6]. Furthermore, a gap between its standard and the services received by pregnant women makes the service less effective and therefore requires a mechanism to monitor the quality of ANC [7]. Factors related to the quality of ANC are the competence of officers, retraining, and the availability of complete

equipment [4], [6]. Other things that play a role in the quality of ANC are supervision, interprofessional cooperation, and the existence of security guarantees for service officers, especially at night and in vulnerable areas [8], [9], [10].

Most health workers that provide antenatal services at the health centers are midwives. Furthermore, the health centers are first-level facilities, and the government has made efforts to make them accessible and affordable to everyone. Health centers also coordinate and foster all health facilities in their working area [11].

The coronavirus disease 2019 (COVID-19) pandemic has severely disrupted ANC due to large-scale social distancing and (PSBB) policies. It was reported that 10% of health centers' services stopped, while at the community level, 75% of Posyandu were closed, 41% of home visits were stopped, and 46% of antenatal services at Posyandu stopped [12]. However, pregnant women are reluctant to go to health service facilities for fear of contracting COVID-19. As a result, it is, therefore, necessary to change the pattern of ANC following the current conditions of the COVID-19 pandemic.

The use of internet-based technology is beneficial in increase the efficiency and productivity of work, with automation facilitating work processes and communication between individuals from different places. One of the applications of this technology in the health sector is mHealth, which can improve officers' performance, the quality of ANC, and the coverage of these services. Furthermore, the use of mHealth during pregnancy has a positive effect on the increase in knowledge, motivation, and behavior of mothers in ANC [13], [14]. Furthermore, it also useful as an early detection tool for pregnancy risk, therefore assisting service providers in providing adequate ANC [15].

This study aims to design the mHealth concept to improve the quality of ANC, to add features that support service workers during the COVID-19 pandemic. The new in this modeling compared to the previous mHealth is that several features are developed in a single application, whereby supporting the functional relationship between pregnant women, midwives, maternal and child health (MCH) coordinator at health centers, and health offices.

Methods

The research method used is as follows:

1. Literature study in the form of a scoping review
A literature review was conducted on the factors that influence the quality of ANC
2. Conceptual design of the mHealth model according to the Rapid Application

Development approach, in which the following steps are taken [16]:

- a. Designing features to improve the quality of ANC based on the results of a literature study
- b. Designing the mHealth context diagram for ANC
- c. Designing the mHealth interface that midwives will primarily use.

Results

Literature study

It was found from the ProQuest, Springer Link, and Google scholar database that the factors influence the low quality of ANC and the potential for improvement with mHealth. The results of this literature study are summarized in Table 1, and the information from this table is then used to design the mHealth model.

Table 1: Factors affecting the low quality of ANC and potential improvement with mHealth

| Factors affecting the low quality of ANC | Reference | Potential increase with mHealth | Reference |
|--|------------|--|------------------|
| Lack of knowledge, skills, lack of communication skills of officers | [17], [18] | Clinical decision aids, early detection of pregnancy complications | [19], [20], [21] |
| Excess workload, availability of visit times | [22], [23] | Send messages to pregnant women, provide health promotion materials, provide information | [15] |
| Lack of practice | [24], [25] | Strengthen health promotion, send messages to officers | [26] |
| Lack of facilities and infrastructure | [10], [27] | Compliance with standard operating procedure (SOP) | [20] |
| Low level of officer compliance and lack of supervision | [28] | SOP compliance and notification when there are SOPs that have not been implemented | [20] |
| Lack of access for pregnant women to health facilities, lack of cooperation between officers | [29], [30] | Teleconsultation and mapping of the geographic location of pregnant women | [31] |

ANC: Antenatal care.

Designing the mHealth model

Features to improve the quality of ANC

There are nine mHealth features designed to improve the quality of ANC, which are as follows:

1. Adherence to SOPs for ANC
 2. Digital health records
 3. Clinical decision aids
 4. Referral link
 5. Strengthen health promotion
 6. Alerts and reminders
 7. Real-time reports
 8. Teleconsultation
 9. Distribution map of pregnant women.
- mHealth is equipped with artificial intelligence that uses expert systems to improve the quality of

ANC, and also to display clinical decision aids, such as the detecting of risk factors in pregnant women and possible diagnoses and recommendations for handling cases for officers. Pregnant women also conduct risk detection against themselves based on the data filled in mHealth. For pregnant women by entering the data of last menstruation, mHealth automatically processes the estimated date of delivery and gestational age, as well as recommendations for pregnancy care.

Context diagram of mHealth ANC

Four external mHealth entities were designed, which includes, pregnant women, midwives, MCH health centers coordinators, and health offices. The external entities that function as mHealth data providers are pregnant women and midwives, while those which functions as recipients of mHealth reports are the MCH coordinators at health centers and health offices.

Meanwhile, mHealth is in the middle and functions to organize as well as integrate incoming data. Furthermore, the context diagram shows how data flows from mHealth. Furthermore, the arrows show the flow of data or information to and from mHealth and external entities. Diagrammatically, the mHealth context for ANC is shown in Figure 1.

mHealth interface

The mHealth system interface design includes input (form design) and output (dashboard design) interfaces. mHealth is designed to use a Progressive Web application; hence, the appearance of the mobile application is different from that on the web platform, and there are also differences for each group of users. In addition, the individual components are shown in Figure 1. To ensure the security and confidentiality of thus it is not used by, each user group displays a different menu depending on their role. Furthermore, each user is provided with a password. Therefore, before logging

in, they must select their role on mHealth and then register. Meanwhile, when registering pregnant women the ID number is used as a unique code to differentiate them. For midwives and doctors, fill in the STR or SIP, which indicates that they already have a license to practice.

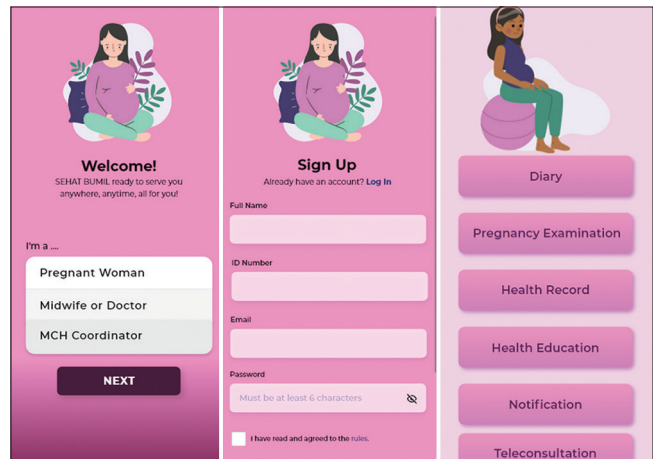


Figure 2: The menu shows the role of users as pregnant women

Figure 2 shows the design of the mHealth interface for mobile application users, such as pregnant women. Furthermore, features that are accessible to mothers include registration, filling in pregnancy history data, maternal health records, notifications, health education, and recommendations. After users have registered and logged in, their appropriate menu is been chosen by them, in which the data entry feature is used to complete the previous pregnancy and maternal health history. The medical records for medical history during pregnancy follow the services of the facilities in which the antenatal examinations are conducted. In addition, the notification feature is a reminder of the schedule for re-examining pregnant women and taking health medication, including advice and information on pregnancy care and preparation for delivery.

Figure 3 shows several menus that midwives use to support health services for pregnant women. The

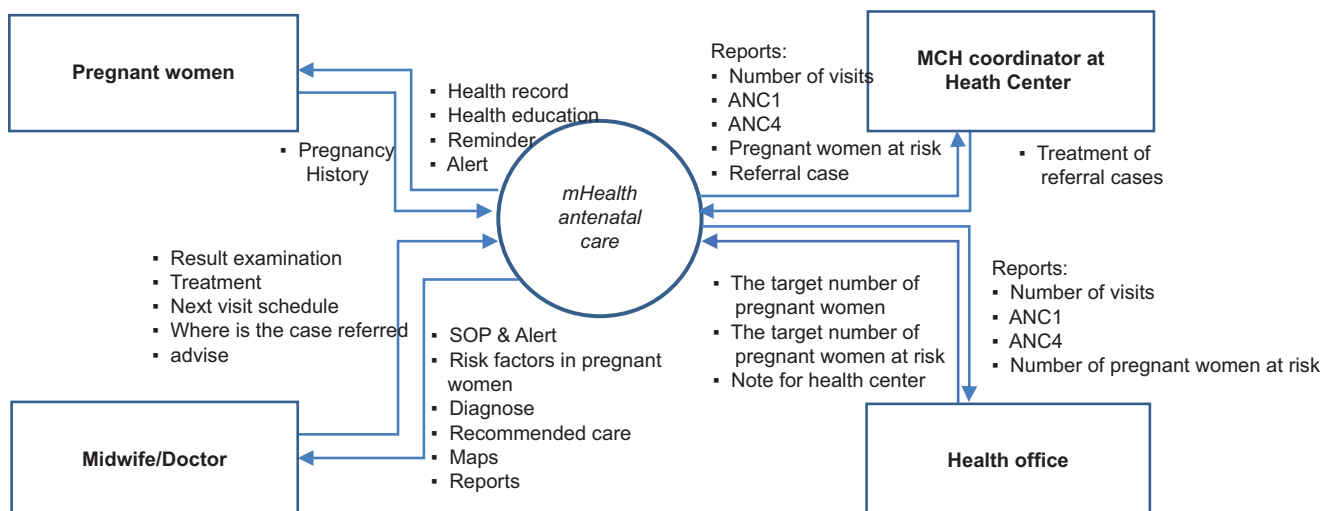


Figure 1: Context diagram of mHealth antenatal care

mHealth for midwives is designed to manage maternal health programs, from the arrival of the pregnant women to completion of services, and contains all routine records. Furthermore, the midwifery menu includes examinations, medication, referrals, reports, and maps of pregnant women, and the examination menu provides all the necessary assessment tools during ANC, which helps midwives present complete data. The report menu is helpful for monitoring services and as a daily or monthly report that would be accessed in real-time. Besides, there is also a cohort of pregnant women that midwives use to describe the mother's health status during pregnancy.

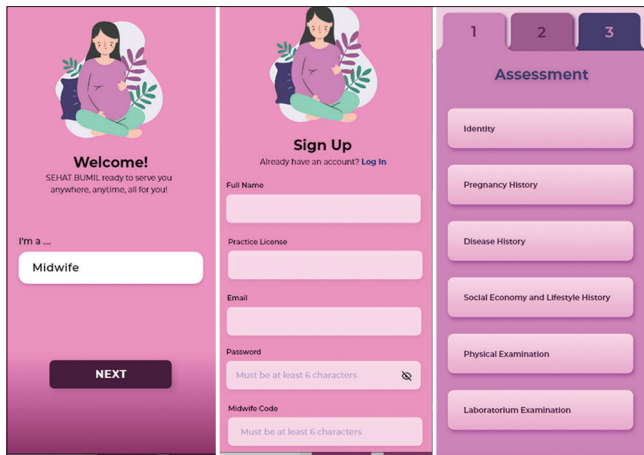


Figure 3: *mHealth* menu for midwives

A distribution map for pregnant women is helpful for the MCH Coordinator and the Health Office to know where pregnant women are at risk and to monitor the achievements and performance of the maternal health service program in each midwife that practices independently in the sub-district health centers.

Discussion

Quality ANC is needed to improve the ability of pregnant women to care for pregnancy and prepare for delivery. Based on the literature study, several factors influence the low quality of ANC. The literature study also reveals the potential and the nine features of mHealth that improve the quality of ANC.

The compliance feature of SOP guides health workers in its consistent implementation, and mHealth warns if the staff does not comply with the 10T standard of service. Data show that the percentage of pregnant women who received 7-10T services at the ANC4 visit was 2%, and most pregnant women (68%) only received 1-4T services [32]. Furthermore, the same report was provided by other studies, which found a low implementation of the 10T service standard, such as 4%, where the least service received by pregnant women was counseling at 23%, whereas ANC4 visits

had reached 85% [33].

Pregnant women require health record feature as pregnancy history, and when there is a record pregnant women's health records (PHR), the health of pregnant women should be better monitored [15]. Thus far, the recording of maternal health in the mother's book (MCH book) was successfully carried out. Data from the National Health Survey (Sirkesnas) in 2016 show that the distribution of MCH books has reached 94% of regions in Indonesia, 81.5% of pregnant women already have them, but only 60.5% of pregnant women are able to show their MCH books. In addition, only 18% of these books were filled [34]. With PHR on smartphones always carried by pregnant women, it is hoped that these health records will be filled and also increases the mother's knowledge because of the habit of pregnant women who often open their smartphones. The Health Record feature also presents a list of questions for pregnant women about pregnancy and medical history, as well as health complaints that pregnant women feel.

AI with expert systems displays clinical decisions based on knowledge and logic to present new facts and recommendations following existing data in the system [35]. Based on the user's answers to questions in the system, it will provide conclusions and recommendations using the IF-THEN rules. The feature is expected to solve the imbalance of officers' competence or the lack of focus in providing services because it was discovered that the competence of health workers is not as expected [36]. Therefore, having mHealth support with clinical decision aids in ANC improves staff skills and increases pregnant women's participation and trust in health workers [21].

The referral link helps in communication between health workers or facilities, thereby speed up the referral process hence pregnant women receive faster services. When midwives refer patients to health centers, the goal is to receive notification and details of referred cases. When patients arrive, they can be served immediately. Therefore, this link also assists MCH managers in monitoring referral cases and as a program evaluation tool [31].

Strengthening health promotion is needed to empower pregnant women by increasing knowledge and preparation for childbirth. Furthermore, the limited time for midwives to conduct visits makes the information conveyed during the visit incomplete. Therefore, the health promotion features are prepared to help pregnant women get correct information about their pregnancy, prepare them for childbirth, and involve husbands and families [26].

Alerts and reminders are required for pregnant women and midwives. In the case of midwives, this warning will appear when they forget or do not implement 10T ANC standards also when there are data on the risk of pregnant women. In addition, the reminder notifies pregnant women to visit and schedule for medication/vitamins. Furthermore, one of them

includes iron (Fe), which pregnant women should be consumed daily. The data show the low compliance of pregnant women in consuming Fe.

Real-time reports simplify the work of service personnel by eliminating the need to manually create various kinds of records and reports. In the past, officers have always been bothered by writing various notes, thus consuming a lot of staff time and wasting paper. With mHealth, there will be the automation of recording and reporting work [15]. Therefore, it becomes easier for managers and health offices to monitor and evaluate, thereby eluding cases of late reporting, as well as finding out the map of pregnant women at risk and facilitate planning for program development.

The teleconsultation feature facilitates communication between pregnant women and midwives, therefore specific reasons that prevent pregnant women from visiting takes advantage of this feature either because of access difficulty or other reasons, thereby enabling them to consult through chat or video call. The difference between this feature and other chat or video call applications is that when chatting or video calling, the midwife knows the health history of pregnant women based on their health records on mHealth to provide the right advice.

During the COVID-19 pandemic, the provision of maternal services needs to be a concern to avoid increasing maternal morbidity and mortality. The existence of the risk of COVID-19 transmission makes pregnant women worried about visiting health services. Based on reports, there has been a decrease in physical visits by pregnant women to health facilities, as well as guidelines from the Ministry of Health to reduce non-urgent visits of pregnant women to service facilities [12]. Meanwhile, a decrease in antenatal visits reduces ANC1 and ANC4 performance from the nine features designed for mHealth. Therefore, teleconsultation and health promotion strengthening features are expected to be very useful during the COVID-19 pandemic and in new normal conditions.

In anticipation of a deterioration in services for pregnant women during the COVID-19 pandemic, the government has issued service guidelines for both those suspected to be infected and non-infected with COVID-19 pregnant women (People Under Monitoring category, People Without Symptoms), or Patients Under Supervision) or those who have been confirmed to have COVID-19 infection [37]. Innovation in antenatal services is needed to provide services and maintain their quality during a pandemic. In this case, mHealth antenatal services, especially the teleconsultation feature, are deemed necessary.

The problems of pregnant women during the COVID-19 pandemic were partially resolved with the teleconsultation feature. When a pregnant woman that is positive for COVID-19 without or with mild symptoms undergoes self-isolation, the presence of mHealth antenatal services makes it easier to monitor

this. Furthermore, when the case is not an emergency, but the pregnant woman needs a consultation, one alternative is a virtual visit. Therefore, they are being consulted from home using the teleconsultation feature.

Despite the social distance, pregnant women will be provided with information or advice about pregnancy care and preparation for childbirth with the health promotion features available on mHealth. The feature reduces a mother's chances of receiving misinformation from social media or believing in myths that affect her pregnancy.

Conclusion

The design of the mHealth concept is supported by features that are considered to improve the quality of ANC, which include, SOP compliance, maternal health records, clinical decision aids, referral links, teleconsultation, strengthening health promotion, alerts, and reminders, real-time reports, and maps — distribution of pregnant women.

During the COVID-19 pandemic, mHealth antenatal services provided significant support to pregnant women and their staff, especially with the teleconsultation feature, which allows close communication between pregnant women and midwives to maintain access to ANC services still. Meanwhile, another important feature here that is a continuation of teleconsultation is the health promotion strengthening feature. Considering this result, the mHealth conceptual model for antenatal is to be continued as a prototype for physical application.

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