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Trimestra: Developing a Web-Based Application for Monitoring Pregnancy Nutrition and Physical Activity

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Abstract

Background. Pregnancy is a critical period that requires special attention to maternal health, particularly in terms of balanced nutrition and appropriate physical activity.Aim. This study aims to developing a web-based application called Trimestra which is specifically designed to help monitor nutrition and physical activity in pregnant women.Methods. The method designed in this study consists of data collection as the main idea for application design. The application has two main features and is designed based on user flow diagrams. The design is implemented through the creation of apps. The type of data used is quantitative data. This data is used as an initial survey for the design of mHealth apps. Data was taken from one of the midwifery practices in Surabaya with a scheme for organizing a pregnant women's class attended by 13 participants.Results. The creation of Trimestra, a web-based platform, has effectively combined functionalities for tracking nutritional intake and physical activity throughout pregnancy. Developed using the Laravel framework, the system ensures efficient performance with smooth and responsive operation. Its interface was deliberately structured to be clear and accessible, enabling expectant mothers to conveniently monitor their daily diet as well as their physical exercise routines.Conclusions. The conclusion of this study is that the development of Trimestra can integrate balanced nutritional needs and encourage the creation of a healthy lifestyle by monitoring physical activity habits during pregnancy.

Keywords: *Digital Technologies, App Innovation, Health, Pregnant.*

Introduction

Nutrition and physical activity during pregnancy are essential because the mother's nutritional status is causally related to the growth pattern of the fetus (Marshall et al., 2022). Malnutrition in pregnant women can cause various problems such as miscarriage, low birth weight, premature babies, and can even cause infant death. During the delivery process, it can result in a long labor process, posing a risk of bleeding, infection, and various other problems that can lead to surgery. Conversely, overeating food during pregnancy can lead to obesity, large babies, and preeclampsia (pregnancy poisoning) (Rahmah et al., 2022). Physical inactivity and excess weight gain are at risk of pregnancy obesity and are linked to Gestational Diabetes Mellitus complications. Although the majority of pregnant women are worried about doing physical activity because it can cause miscarriage, there is no evidence that regular physical activity can cause miscarriage, poor fetal growth, musculoskeletal injury, or premature birth (Activity & Pregnancy, 2020).

In Indonesia, the number of unmet nutrition in pregnant women is still very high. Based on Riset Kesehatan Dasar (Riskesdas), in 2018, showed that 23% of babies born in Indonesia are stunted. This is due to several nutritional problems in pregnant women. The high anemia in pregnant women 48.9%, the high rate of chronic energy deficiency 17.3%, and 28% of pregnant women risk complications that can lead to death. Balanced nutrition focuses on optimizing weight gain. The mandatory weight gain during pregnancy is at least 8 kg. This weight includes fetal development, placenta, amniotic fluid volume, and maternal tissue adaptation (uterus, breast, and blood volume). The calorie intake needed

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by mothers every day reaches 300 kcal/day. So, during pregnancy, it is estimated that 80,000 kcal is required to support the increase in maternal and fetal metabolism and fetal and placental growth. Energy needs in the first trimester are the same as those of non-pregnant women, while in the second trimester, they increase by 340 kcal and in the third trimester around 452 kcal (Kominiarek & Rajan, 2016). Calorie needs are not the same for each person, depending on the age, Body Mass Index (BMI), and activity of each individual.

Until now, the overall level of physical activity for pregnant women is unclear, but the UK's four Chief Medical Officers recommend 150 minutes of moderate-intensity activity each week (Hillyard et al., 2021). According to a study conducted on 299 pregnant women, only 48.5% continued the exercise habit that had been done since before pregnancy. This is because there is a fear of miscarriage (Hailemariam et al., 2020). Furthermore, the committee of The American College of Obstetricians and Gynecologists provides a solution to the problem by recommending physical activity that has been observed to be safe and provide benefits (Activity & Pregnancy, 2020) For pregnant women, including walking, stationary cycling, aerobic exercises, dancing, resistance exercises, for example, exercises that use weights and elastic bands, stretching exercises, hydrotherapy, and water aerobics. The recommendation is proven to be implemented with data on pregnant women's most common physical activity are slow walking, dancing, and pregnancy gymnastics classes. While cycling, lifting weights is not a habit that is done. Running, swimming, and climbing hills are minor activities (Hailemariam et al., 2020).

Various efforts by the government and different institutions in Indonesia have been carried out to prevent malnutrition in pregnant women. Before pregnancy, efforts to provide nutritional supplements/nutrients moringa oleifera, folic acid, and iron, specific nutrition, lipid-based nutritional supplements, PM2A nutritional PROCOMIDE before pregnancy, iron antenatal supplements, and folic acid. Prenatal micronutrients affect the reduction of stunting in children (Sukmawati et al., 2021). In addition, audiovisual media counseling or education about moringa leaf ice cream and early nutrition has also been conducted (Sukmawati et al., 2021). For the pregnancy stage, the government has enacted Rencana Aksi Nasional Pangan dan Gizi (RAN-PG) program in 2021-2024 (Kementrian Perencanaan Pembangunan Nasional/ Badan Perencanaan Pembangunan Nasional (Bappenas), 2021). Another program is Pemberian Makanan Tambahan (PMT), which the Ministry of Health will make from local food for pregnant women and toddlers in 2022. In pregnant women's health services, there are also classes for pregnant women to improve their skills regarding pregnancy, childbirth, postpartum care, and newborn care through practice.

In terms of information technology, the government also provides a website as a guide to processing local food into nutritious, high-protein food and the Ayosehat Chatbot service as the official health education channel of the Ministry of Health, which can be accessed through the WhatsApp application.

Despite preventative measures, maintaining the nutrition and physical activity needed during pregnancy still presents challenges, such as expectant mothers' lack of awareness, difficulty accessing healthcare professionals or nutritionists regularly, and a lack of personalized tools that consider each pregnancy's unique needs.

In today's era of technological development, more and more digital technology is developing, including mobile health (mHealth) apps (Ameyaw et al., 2024). Most mHealth is implemented through SMS messaging with a mobile phone. In addition, mHealth is only considered adequate in several areas, such as overcoming pregnancy anxiety and depression, diabetes in pregnancy, gestational weight management, maternal health service use, behavior modification towards quitting smoking, and controlling drug use during pregnancy. In addition, the available mHealth tends to be intended for mothers or families with high incomes.

The findings of the assessment of the effectiveness of the mHealth apps show that no apps are effective in improving the habit of integrating the balance of nutrition and physical activity. Furthermore, the uneven use of apps for low-income mothers is due to a lack of access capabilities such as ease of application and language. Only a few apps suit the language needs and ease of access, especially for low-income mothers.

In this study, we intend to design a web-based app that can be accessed via mobile phone. The app will have two main features: maternal nutrition monitoring services during pregnancy and regular physical activity monitoring, whose data input is generated from the acquisition of sensor recognition. Our primary focus will be on these apps' ease of access and user security.

Methods

The method designed in this study consists of data collection as the main idea for application design. The application has two main features and is designed based on user flow diagrams. The design is implemented through the creation of apps. The type of data used is quantitative data. This data is used as an initial survey for the design of mHealth apps. Data was taken from one of the midwifery practices in Surabaya with a scheme for organizing a pregnant women's class attended by 13 participants. The technique used to disseminate data is the distribution of questionnaire instruments (Yasin et al., 2024). The content of the questionnaire includes:

Self-Identity

Information about identity consists of questions about name, age (date of birth), address, occupation, gestational age, and how many children are pregnant.

Nutritional Intake of Pregnant Women

Questionnaires related to nutritional intake are stated in the Food Frequency Questionnaire (FFQ). (Rothenberg et al., 2021) FFQ is used to identify a person's diet. With the division into four food groups, namely staple foods, side dishes, vegetables, and fruit. Each food group consists of 13-23 types of food. Every kind of food is given six options for its average frequency, namely days, weeks, months, and never at all. In FFQ, portion sizes are not provided, so this can be a feature for application design.

Physical Activity of Pregnant Women

Based on the recommendations for regular physical activity during pregnancy discussed in the previous section and some references to the form of the international physical activity questionnaire (Donen, 2005; Schuhl, 2014; WHO, 2012), a questionnaire was produced for this study consisting of the type of physical activity, calorie level, frequency, and time. The list of physical activity and calorie levels is presented in *Table 1*. Meanwhile, frequency and time variables are variables that respondents must fill in.

Table 1. List Of Physical Activities of Pregnant Women Used in the Study

Physical Activities	Kcal/kg/hour
Standing	0.1
Sleeping	1.5
Sitting	0.4
Walking	0.9
Jogging	7.0
Aerobic	7.0

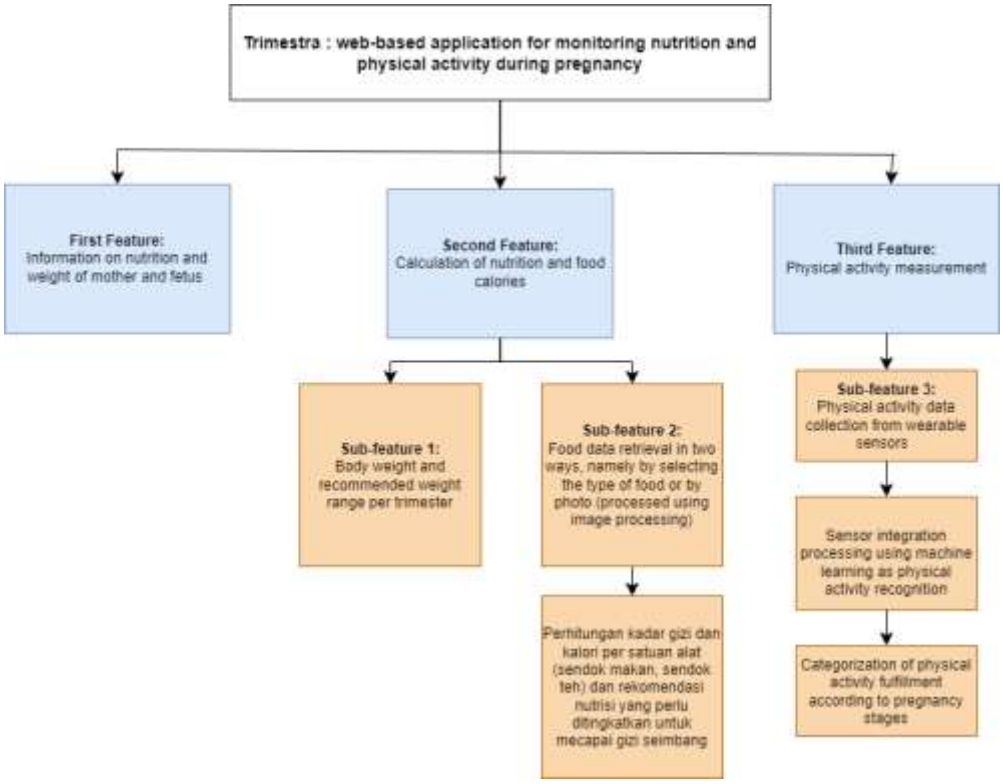

Figure 1. Key Component of Web-Based Application

Based on Figure 1 there are three main components of the web-based application in this study (*Figure 1),* namely:

Nutrition and weight information for the mother and fetus

The first feature is information related to nutrition and weight for the mother and fetus.

Maternal nutrition during pregnancy

Like an application that aims to monitor nutrition, this component also contains maternal weight calculations, food menu input processes, nutrition calculations, nutrition monitoring and results, and food menu recommendations so that pregnant women's nutrition is sufficient. All of these inputs and calculations are adjusted based on nutritional adequacy figures for each trimester or time of pregnancy. A unique feature distinguishing this app from other apps is the ability to input food automatically from the mobile phone camera. The resulting images are then processed using image processing algorithms to recognize the type of food and portion consumed. This feature is expected to make it easier for users who often find it difficult to determine the amount of food consumed.

Physical activity of the mother during pregnancy

Although no clear rules on physical activity affect pregnancy, we are trying to normalize physical activity to become an excellent healthy lifestyle habit for pregnant women.

In designing this application, the data input for physical activity can be in the form of two options: the first option comes from the data selected in the application, and the second option comes from the instrumentation we designed to recognize the daily physical activity of pregnant women. Typical instruments used to monitor physical activity are accelerometers, pedometers, heart-rate monitors, and armbands. However, in this research, we will design our instrumentation composed of sensors and microcontrollers integrated with machine learning. This additional option serves to recognize physical activity more accurately.

Web application creation uses the Laravel (https://laravel.com/) framework. Laravel provides an advantage by making PHP programming easier. The systematics of creating a website with Laravel is explained in several steps:

Install Laravel

Database Configuration

The databases used are MySQL (https://www.mysql.com/) and Apache modules.

Adding Bootstrap to Laravel

Database table creation

Creation of designed pages

Upload Laravel to hosting

Results

Respondent Data

Most respondents who took part in the pregnant women class were between 20 and 29 years old (54%) and had a gestational age of 13-27 weeks or the second trimester (77%). Most of the pregnancies (54%) were also not the first. Respondents to this study also mostly have jobs described as private employees (38%), teachers (8%), administrators (8%), and factory workers (8%). Based on work data, it is known that most working people's sleep activities are only carried out once, namely at night, while sitting activities are often carried out. Daily gymnastics is also the most done by respondents who have jobs. In addition, there are additional activities for working respondents, such as going up and down the stairs. Furthermore, using the reference data, the app feature's content design also requires additional sources, such as the calculation of FFQ results, to classify pregnant women's nutritional adequacy for each trimester.

App View Results

The Application View is created using Laravel, a web application framework that uses PHP programming language. The MVC (Model, View, Controller) concept is used by Laravel to group and find faulty parts or bugs on the website (Sinaga & Samsudin, 2021). In the system to be built, there are 2 levels of users. The first step is admin. The admin level has a role in all Updates and monitoring activities in the system. The next level is the user level. The user tier has a role to interact with the system display. The following are the roles of each user tier of the built system:

User

User enters the first page of the application

Users can choose to register an account into the application by entering personal data in the form of full name, email, and password

Users can also log in if they have registered an account before.

User enters the home page

Users can select the Nutrition or Exercise menu on the home page

In the Nutrition menu, users can choose to go to the current weight input menu, food menu input, nutrition calculation, monitoring and results, and food menu recommendations

On the Exercise menu, users can choose to continue to the physical activity input menu, physical activity recognition results, and physical activity recommendations

Users can change and complete the account profile, which contains blood type, gestational age, how much the child is pregnant, estimated date of birth, the first day of the last menstruation, menstrual cycle, duration of sleep, and diseases that have been/are suffering

Admin

Admin logs in by entering username and password

Admins can update data and interfaces on the system

Admins can monitor the application for errors or bugs

The system testing stage is the checking stage, where it is questioned whether the system is running according to the cooling level.

Register Page

Figure 1 is the initial view when the user enters the application. Users will be presented with an initial display in the form of a register display to register an account if they do not have an account for the application. Users can fill in several fields on the page, including full name, email address, password, and password (again).

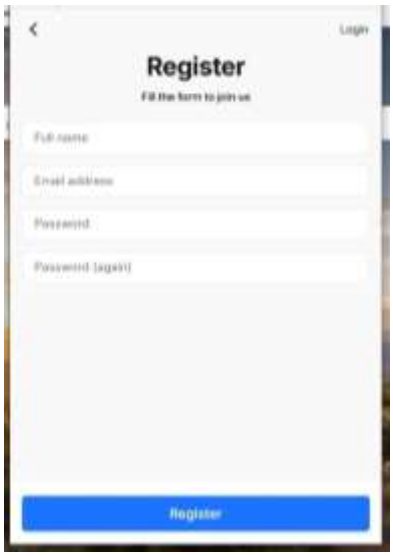

Figure 1. Register page for users

Login Page

Suppose the user already has an account or has registered an account before. In that case, the user can select the login menu in the registration page's upper right corner. After that, the user will be redirected to a new page, namely the login page. On the login page display, users can fill in their previously registered email address and password to log in to the account that the user has. In *Figure 2*, you can see the login page display.

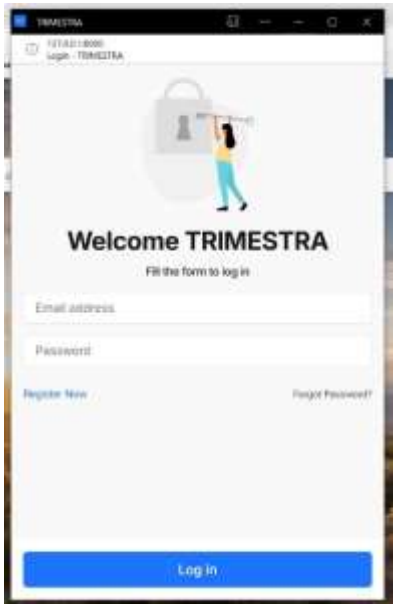

Figure 2. Login page for users

Profile page

After the user enters the previously registered account, they are redirected to the home page. A reminder on the home user page is displayed to fill in the profile so the system can process the data. After the user chooses to fill in the profile, the user will be redirected to the profile filling page. On the profile page, users can change and fill in the data needed by the system to work optimally, such as:

Name

Address

Date of birth

Mobile number

Height

Weight

Blood type

Gestational age

What is the child's pregnancy

Estimated date of birth

First day of the last menstruation

Menstrual cycle

Duration of sleep each day

Diseases that have been/are suffering from

Then, the user can press the save button to save the data that the user has already filled out. The profile page and its contents can be seen in *Figure 3*.

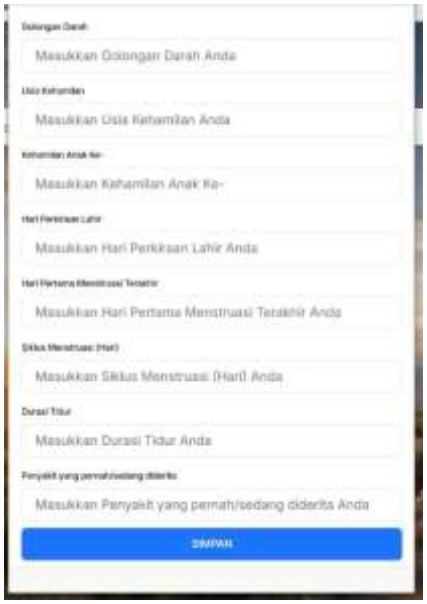

Figure 3. Profile page for users

Home Page

If the user has filled in and saved the profile data, the user will be redirected back to the home page. Users who have filled in or have filled in a profile before will then be displayed on the home page a new display that contains a reminder of how many weeks the user's pregnancy has arrived. The reminder explains the fetus's condition and describes what it looks like. Users are also presented with several new menus that they can choose from, namely the nutrition menu and the exercise menu. The new home page can be seen in *Figure 4.*

Figure 4. Home page for users

Nutrition Page

If the user selects the nutrition menu, the user will be redirected to a new page, namely the nutrition page. On the nutrition page, there are several sub-menus that users can access, including the current weight input menu, the food menu input menu, the nutrition calculation menu, the monitoring and results menu, and the food menu recommendation menu. When the user selects one of the sub-menus, the user will be redirected to each sub-menu page. In the current weight input menu, the user can enter the user's current weight number and see the daily progress in the form of a graph. Then, on the food menu input menu, users can enter the food menu that they plan or have eaten that day by selecting the option of manual input or automatic input. On the manual user input page, a food types and nutritional content database is divided into 4 options: breakfast, lunch, dinner, and snack/other. Users can select several food menus from the database as input to the user's food menu. On the automatic input page, users are asked to activate the mobile phone camera to take pictures of food. The food image will be sent to the database to be processed using image processing and will be identified by its type, amount, and calories by matching it with the database. Furthermore, in the nutrition calculation menu, users are presented with data that the system has processed through nutritional calculations and calculations. After that, in the monitoring and results menu, users can see calorie reports and goals according to trimester (in days and weeks) and nutrient reports and goals according to trimester (in days and weeks). Lastly, in the food menu recommendation menu, users will be given information in sentences about whether the user's calories are enough or lacking. Users are also provided information about nutrition from the fetus, whether it has been fulfilled or lacking. Users will be given food menu recommendations for breakfast, lunch, dinner, and snacks that support nutritional fulfillment.

Excercise Page

Furthermore, if the user selects the exercise menu on the home page, the user will be redirected to a new exercise page. On the exercise page, there are several sub-menus that users can access, including the physical activity input menu, the physical recognition result menu, and the physical activity recommendation menu. When the user selects one of the sub-menus, the user will be redirected to each sub-menu page. The user is asked to activate the physical activity input menu sensor. An active sensor records user activity for 24 hours. The sensor recordings' results are sent to the database and processed by machine learning. Furthermore, in the physical recognition menu, the processed machine learning data will be displayed on the physical activity input menu as physical activity data for one day, along with the details of each time. Users are also given information about their trimester. Finally, in the physical activity menu, users will be presented with recommendations from expert opinions that support normal childbirth. They will also be given a link to pictures or videos of physical activities suitable for the trimester.

Discussion

The development of the Trimestra application demonstrates that the platform is designed to combine balanced nutritional needs while encouraging a healthy lifestyle by monitoring the physical activity of pregnant women. Regular physical activity is important because it plays a role in preventing excessive weight gain, maintaining physical fitness, and facilitating a smooth delivery (Chen et al., 2025; Hove et al., 2025). Through this monitoring system, pregnant women can more easily determine whether their diet and activity patterns are in accordance with medical recommendations. Therefore, Trimestra not only functions as a health support tool but also serves as a learning tool that raises awareness of the importance of a healthy lifestyle during pregnancy.

Technologically, the application is equipped with image processing and machine learning-based activity recognition features. Both technologies are used to produce more precise and efficient monitoring. Furthermore, the application is developed using the Laravel framework, which allows for continuous updates according to user needs. The use of Laravel also provides added value in terms of security, stability, and flexibility, allowing the application to continuously adapt to technological developments and user needs in the long term (Alfarisi et al., 2023; Sekarini & Widhiyanti, 2023). The application interface is designed to be simple, lightweight, and easy to operate, making it user-friendly. The intuitive design makes it easy for pregnant women to access a variety of information related to nutritional needs, physical activity recommendations, and tracking health developments. This design makes the app not only a health monitoring tool but also a convenient and rewarding user experience. Therefore, Trimestra is expected to become a comprehensive digital solution to support the health of pregnant women.

One of the digital solutions offered by Trimestra is a nutritional monitoring feature for pregnant women. A balanced nutritional intake plays a vital role in maintaining maternal health and supporting fetal growth and development (Perumal & Gernand, 2025). Nutritional imbalances, whether deficient or excessive, can lead to a number of problems, such as anemia, preeclampsia, gestational diabetes, low birth weight (LBW), and macrosomia (A. Prasad & K. Sylvester, 2025). Through regular monitoring, macronutrient (carbohydrate, protein, and fat) and micronutrient (such as iron, folic acid, calcium, and vitamin D) needs can be adjusted to the pregnant woman's condition. This contributes to maintaining maternal health, supporting optimal fetal development, preventing complications, and accelerating postpartum recovery (Juliastuti et al., 2024).

In addition to nutritional monitoring, Trimestra also emphasizes the importance of monitoring physical activity for pregnant women. Light to moderate activity, such as walking, prenatal exercise, or yoga, has been shown to improve fitness, maintain weight, improve blood circulation, reduce discomforts such as back pain and constipation, reduce stress, and improve sleep quality (Anam et al., 2020). Measured physical activity can also reduce the risk of obesity during pregnancy, prevent gestational diabetes, and prepare the immune system for labor (Dewi et al., 2025).

The integration of nutritional monitoring and physical activity is a key aspect of creating a healthy pregnancy. These two factors complement each other, with adequate nutrition supporting energy for daily activities, while physical activity helps optimize nutrient utilization in the body. This integrated approach enables healthcare professionals to provide more precise recommendations and detect potential health problems early, resulting in a safer, healthier pregnancy and a smoother delivery.

Conclusions and Perspectives

A web-based app targeted at women during pregnancy was developed in Indonesia to reduce the high rate of stunting. This app integrates balanced nutritional needs and encourages the creation of a healthy lifestyle by monitoring the habit of physical activity during pregnancy. This physical activity is needed to prevent excess weight and facilitate childbirth. Using the current technology, namely image processing algorithms and recognition of physical activity through machine learning, two main features of this application were developed. The development of this application uses the implementation of the Laravel framework, which can be updated continuously. The results of the display of applications that use the Laravel framework also tend to be simpler and lighter. The application display can also help users manage their nutrition, and the amount of physical activity experts suggest. Nonetheless, further studies are needed to review the standardization of physical activity that can be validated to benefit pregnancy. In addition, it is necessary to test the use of integrated applications and related instruments so that the design of this system can be assessed for its effectiveness through several schemes: first,

without an application; second, using an application but both features are input by users manually; and third, using input according to the design in this study.

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