ONLINE FIRST

ORIGINAL ARTICLE

Early Detection Application for Assessing Pre-Eclampsia Risk in Expectant Mothers

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doi: 10.22442/jlumhs.2025.01215

ABSTRACT

OBJECTIVE: This study aimed to evaluate the effectiveness of the early detection of pre-eclampsia in pregnant women.

METHODOLOGY: This study focuses on pregnant women in Tanggamus Regency, Lampung, using early detection of pre-eclampsia and anthropometric examination tools. A total of 198 participants were enrolled in the 3rd to 4th trimester. Statistical analysis was used to create an online model for estimating pre-eclampsia risk. The application uses the waterfall method, which involves requirements, design, implementation, verification, and maintenance.

RESULTS: The findings from the data analysis conducted following the ISO 25010 standards evaluated two specific dimensions, namely functional suitability and usability. It was determined that the Pre-eclampsia Early Detection application software achieved an overall score of 88%. Using this model, the risks that pregnant women and the interventions they will experience will be known early, and pregnant women must undergo early detection of pre-eclampsia.

CONCLUSION: Pre-eclampsia is associated with various factors including maternal age, the number of previous pregnancies (parity), the interval between pregnancies, body mass index (BMI), obesity, a history of chronic health conditions, dietary habits, levels of physical activity, smoking status, nutritional well-being, attendance at antenatal care (ANC) visits, the presence of family support, as well as maternal knowledge and attitudes towards pregnancy.

KEYWORDS: Application, Early Detection, Effectiveness, Pre-Eclampsia, Pregnant Women, Risk

INTRODUCTION

Pre-eclampsia is one of the most serious complications of pregnancy, characterized by hypertension and organ damage that can affect both the mother and fetus. According to the World Health Organization (WHO), pre-eclampsia contributes to 10-15% of all maternal deaths in developing countries and affects approximately 5-8% of all pregnancies [1]. Delays in the detection and management of pre-eclampsia can result in severe complications, such as eclampsia and HELLP syndrome, which are often fatal if left untreated. Appropriate treatment and early detection are essential to reduce the morbidity and mortality associated with this condition [2].

Early detection is key to effective management of pre-eclampsia. Traditionally, detection is performed using blood pressure measurements and urine tests for proteinuria. However, this method is often not sensitive and specific enough to detect the risk of pre-eclampsia at an early stage [3]. Therefore, recent research has focused on the development of technologies to improve early detection.

With advancements in technology, mobile health applications have shown great potential in improving the early detection and management of various medical conditions. Apps specifically designed for early detection of pre-eclampsia use more comprehensive data and advanced algorithms to assess risk in real time. For example, new apps integrate data from daily blood pressure monitoring, laboratory results, and other health parameters to provide more accurate risk assessments [4]. This technology not only enables more proactive monitoring, but also provides recommendations based on the data collected, enabling more effective early intervention [5]. Research by [6] highlights the effectiveness of this technology in improving the accuracy of pre-eclampsia detection and reducing the workload of medical personnel.

Mobile-based health applications are emerging as potential tools for pre-eclampsia monitoring and early detection [7]. The app uses advanced algorithms to analyze health data in real-time and provides more accurate risk assessments. For example, some recent applications integrate data from blood pressure monitoring, laboratory results, and other health parameters to provide notifications and recommendations to patients and healthcare providers [5]. This technology not only allows for more proactive monitoring but also enables quicker intervention if a risk of pre-eclampsia is detected [4].

Multiple studies have shown that health apps can improve pregnancy outcomes by facilitating early detection and management of pre-eclampsia. For example, research by[8] demonstrated that mobile-based applications could improve the accuracy of pre-eclampsia detection and reduce the time required for diagnosis and intervention. In addition, this technology can speed up medical response and reduce the workload of medical personnel [9].

This study aimed to evaluate the effectiveness of early pre-eclampsia detection in identifying pre-eclampsia risk in pregnant women. With a better understanding of the effectiveness of this app, it is hoped that it can be more widely integrated into clinical practice to improve pregnancy outcomes and reduce the risks associated with pre-eclampsia.

METHODOLOGY

Study Design

The study design employed in this research is a quantitative approach utilizing a cross-sectional design. This design is particularly suited for examining the relationships between independent variables and the dependent variable, which, in this case, is the occurrence of pre-eclampsia among pregnant women. A cross-sectional study allows for the collection of data at a single point in time, providing a snapshot of the population's characteristics and the prevalence of pre-eclampsia. This methodology is advantageous for identifying potential risk factors associated with pre-eclampsia, as it facilitates the analysis of various demographic and health-related variables concurrently.

Time and Location

The research is conducted in Tanggamus Regency, Lampung, Indonesia. This geographical focus is significant as it allows for an in-depth examination of the specific health challenges faced by pregnant women in this region. The study period spans from January to June 2024, providing a defined timeframe for data collection and analysis. This temporal aspect is crucial for ensuring that the findings are relevant to the current health landscape and can inform local health policies and interventions aimed at reducing the incidence of pre-eclampsia.

Sampling Technique

The population of the study was 392 pregnant women. The sampling technique used in this study was based on the Slovin Formula with a margin of error of 5%.

$n = N / (1 + (N * e^2))$
$n = 392 / (1 + (392 * 0.05^2))$
$n = 392 / (1 + (392 * 0.0025))$
$n = 392 / (1 + 0.98)$
$n = 197{,}979$ rounded to 198

A statistical method for determining sample size in health research. This formula yielded a sample size of 198 respondents, specifically pregnant women in their third to fourth trimesters. This sampling method ensured that the study included a representative sample of the population, allowing for generalization of the findings to a broader group of pregnant women in Tanggamus Regency. The focus on pregnant women in the final stages of pregnancy is particularly relevant, as this is the stage where the risk of pre-eclampsia increases.

Data Analysis

For data analysis, the study employs statistical software capable of performing univariate and bivariate analyses. Univariate analysis will be conducted descriptively to summarize the characteristics of the study population. In contrast, bivariate analysis will utilize the chi-square statistical test to examine the relationships between independent variables and the occurrence of pre-eclampsia. The use of statistical software enhances the rigor of the analysis, allowing for accurate calculations and interpretations of the data. The choice of a 95% confidence level for the chi-square test further underscores the study's commitment to statistical validity and reliability.

In the current study, data analysis will be systematically conducted using sophisticated statistical software (SPSS), which enables the performance of both univariate and bivariate analyses. The univariate analysis serves a descriptive function, summarizing key demographic and clinical characteristics of the study population (e.g., age, body mass index, and parity), thereby establishing a foundational understanding of the sample before delving into more complex relationships.

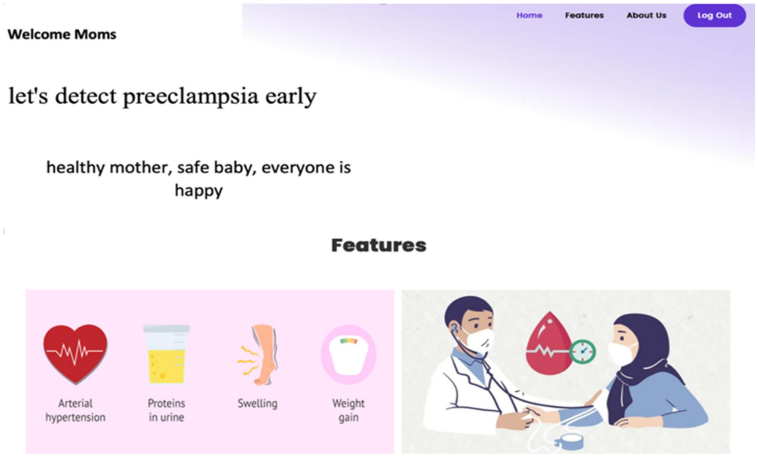
For bivariate analysis, the chi-square test will be employed to elucidate associations between independent variables, such as maternal age and the incidence of pre-eclampsia. This test

assesses whether there is a statistically significant relationship at a predetermined 95% confidence level, allowing researchers to reject or fail to reject the null hypothesis that no association exists. By leveraging the capabilities of statistical software, the study aims to achieve precise calculations, ensuring that any interpretations drawn from the data are both valid and reliable.

Application

The waterfall method is used to create applications. This is often referred to as the 'waterfall' method because of its sequential nature and shape, similar to a waterfall. This process involves developing an information system by analyzing user needs (requirements), in which the researcher collects data from system users regarding the features and menus that are needed in the information system to be created. The next stage is information system design (design), which describes an information system in the form of system charts and databases, such as a flowchart, data flow diagram, and entity relationship diagram. The next stage is the implementation stage, namely, the researcher coding the system using the PHP programming language and MySQL database. The next step is system testing, using the concept of verification with users. The last stage is the system repair and maintenance stage (maintenance).

Figure 1: General view of the application



Process of making an application

Requirements (User Needs Analysis): This stage is the main stage in the waterfall method, where researchers conduct user needs analysis through interviews and coordinate directly with users in the development of the information system. Furthermore, all the information obtained will be analyzed for an information system design at the next stage. Analysis of user needs needs to be carried out in a good and detailed structure, so that the resulting information system meets user needs. A good system will also support and increase the motivation for pregnant women's visits to health service facilities, especially midwives' practices or posyandu.

Design (System Design Chart): At the researcher and developer stage, the information system design stages are described in the form of a flow chart, data flow diagram, and entity relationship diagram. This is an essential stage in which the results will influence the stages of creating the information system (coding).

Implementation (System Implementation): At this stage, the researcher created an information system with a programming language (coding) using the PHP language, and MySQL was chosen. After completing the coding of the information system, the researcher conducted a small trial to assess the suitability of the resulting information system to

minimize errors during the coding process. To assist the system coding process, researchers used text editor applications, namely Visual Studio Code and Sublime Text 3.

Verification (System Verification and Testing): After this, the completed information system enters the stage of installing and testing the information system (testing) for system users. Based on the test results, users can determine whether the system is acceptable or whether any improvements are needed. If the system has been agreed upon, the next step is to implement or install the system at the research site, namely, Independent Midwife Practice.

Maintenance: The information system or software that has been developed enters the system maintenance and repair stages. This stage is essential for maintaining the quality of the system so that it can fulfil all desired aspects. They can always be used to help users with their work.

Inclusion and Exclusion Criteria

The inclusion and exclusion criteria established for the study on pre-eclampsia focus on specific demographic and health parameters to ensure both relevance and rigor. Participants must be women in their third or fourth trimester of pregnancy, residing in Tanggamus Regency, Lampung, Indonesia, to address local health challenges. An age range of 18 to 40 years is specified, aligning with the typical reproductive age group. Additionally, informed consent is mandatory, safeguarding ethical standards. Conversely, the exclusion criteria aim to eliminate potential confounders that may skew results. Women with pre-existing medical conditions such as chronic hypertension or renal disease are excluded to mitigate confounding variables. The study also excludes participants with multiple pregnancies and those who have experienced pre-eclampsia in prior pregnancies to focus on the risks associated with single gestations. Lastly, individuals who demonstrate non-compliance or withdraw consent during the study period are excluded, ensuring adherence to study protocols.

Data Collection

In this quantitative study utilizing a cross-sectional design, data will be collected through structured questionnaires administered to a sample of 198 pregnant women in their third to fourth trimesters residing in Tanggamus Regency, Lampung, Indonesia. The questionnaires will include both demographic information and relevant health-related variables to assess potential risk factors associated with pre-eclampsia.

To ensure validity and reliability, the questionnaire will undergo a pilot test before the actual data collection. Participants will be approached in health service facilities, where informed consent will be obtained. Data collection will occur from January to June 2024, adhering to ethical guidelines established by the Ethics Committee of Poltekkes Tanjungkarang. Data privacy will be maintained by anonymizing responses and implementing secure data storage practices.

Vulnerable populations, including those with chronic medical conditions and multiple pregnancies, will be excluded to focus on the primary target group. This methodical approach aims to yield representative data on the prevalence and associated factors of pre-eclampsia among the target demographic, thus informing local health interventions.

Categorizing education and physical activity to understand how these variables may correlate with pre-eclampsia status among respondents. Education: Participants were classified into two groups: "Low" educational status and "High" Educational status. Low education includes individuals with lower levels of formal education (such as primary or secondary education), while higher education includes those with higher education (a university or college degree). This dichotomy allowed researchers to evaluate the influence of educational attainment on health outcomes and health literacy, which may be associated with pre-eclampsia risk.

Physical Activity: Respondents were categorized based on their engagement in physical activity, divided into "Organized" and "Irregular." Organized physical activity includes

structured exercise patterns, such as scheduled exercise or participation in sports. In contrast, irregular physical activity refers to casual or daily movement that lacks a consistent exercise pattern. This grouping provides insight into how structured physical activity may contribute to the risk or management of pre-eclampsia, as regular physical activity can impact overall health metrics, including body mass index (BMI) and cardiovascular health.

Ethical Clearance

The Ethics Committee of the Poltekkes Tanjungkarang has granted ethical approval for this study, with number 399/KEPK-TJK/IV/2024. This approval guarantees that the study is carried out in compliance with relevant ethical guidelines, safeguarding the participants' rights and welfare. To ensure openness, security, and equity in the research process, ethical approval is an essential step in studies involving human subjects.

Every participant in this study gave their informed consent. The goal of the study, the steps to be taken, the possible risks, and the potential rewards were all explained in detail to the participants. Participants were also made aware of their freedom to leave the study at any moment without facing any repercussions. Regarding data privacy considerations, all sensitive health data will be treated with the utmost care and following applicable data protection regulations, such as the Personal Data Protection Act. Data will be encrypted and will only be accessed by authorized researchers.

Every participant in this study gave their informed consent. The goal of the study, the steps to be taken, the possible risks, and the potential rewards were all explained in detail to the participants. Participants were also made aware of their freedom to leave the study at any moment without facing any repercussions.

RESULTS

This graph compares the prevalence of Pre-eclampsia vs Non-Preeclampsia based on key demographic factors. The red line shows the percentage of cases with Pre-eclampsia (39.3% for extreme age groups vs 18.3% for the normal age group), while the blue line shows cases without Pre-eclampsia. Notable findings: Extreme age groups (<20 or >35 years) have higher Pre-eclampsia rates (39.3%), Higher education correlates with slightly higher Pre-eclampsia risk (27.9%), and Economic status shows minimal difference in Pre-eclampsia prevalence

Graph 1: Characteristics of respondents

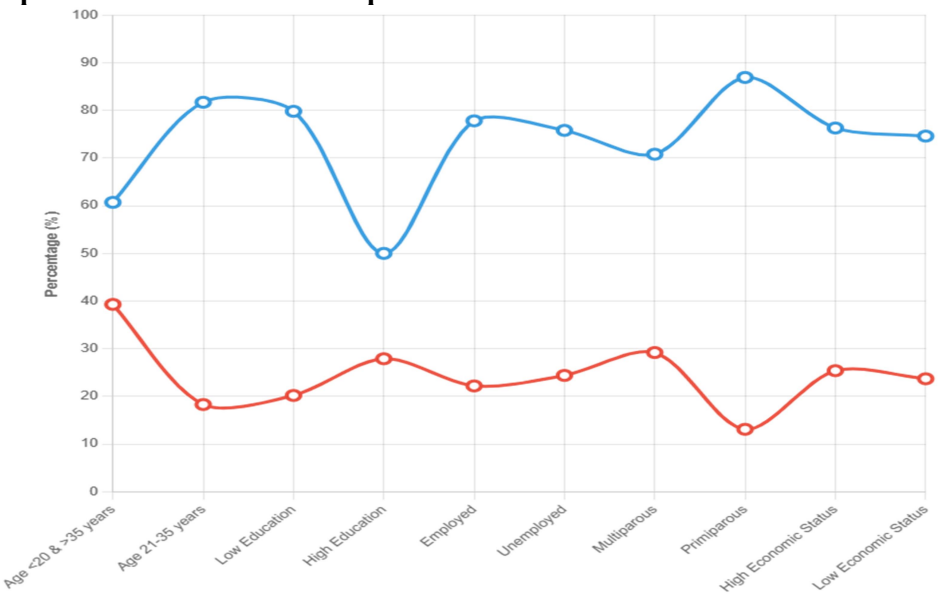


Table I presents the attributes of the participants, encompassing factors such as age, educational attainment, employment status, number of children, body mass index (BMI), obesity prevalence, chronic disease history, dietary practices, levels of physical activity, smoking behaviors, nutritional condition, antenatal care (ANC) visits, family support systems, knowledge base, attitudes, and economic status of the family. Additional information is available in **Table I**.

Table I: Characteristics of respondents

Variable	Pre-eclampsia status				Total
	Pre-eclampsia		Not Pre-eclampsia		
	n	%	n	%	
Pregnancy spacing					
– < 24 months	2	6,7	28	93.3	30
– > 24 months	46	27.4	122	72.6	168
BMI					
– Underweight and Overweight	24	33.3	48	66.7	72
– Normal	24	19.0	102	81.0	126
Obesity					
– Normal	24	19.0	102	81.0	126
– Underweight	11	28.2	28	71.8	39
– Obesity	13	39.4	20	60.6	33
History of chronic disease					
– Yes	24	85.7	4	14.3	28
– No	24	14.1	146	85.9	170
Eating habits					
– Good	46	27.7	120	72.3	166
– Poor	2	6.2	30	93.8	32
Physical activity					
– Organized	15	15.3	67	67.0	98
– Irregular	33	33.0	83	84.7	100
Smoking habit					
– Passive and active smokers	42	84.0	8	16.0	50
– Not a smoker	6	4.1	142	95.9	148
Nutritional status					
– Good	46	95.8	126	73.3	172
– Poor	2	7.7	24	92.3	26
ANC visit					
– Complete	4	2.7	143	97.3	147
– Incomplete	44	86.3	7	13.7	51
Family support					
– Good	4	2.8	141	97.2	145
– Poor	44	83.0	9	17.0	53
Knowledge					
– Good	4	2.7	143	97.3	147
– Poor	44	86.3	7	13.7	51
Attitude					
– Positive	40	22.2	140	77.8	180
– Negative	8	44.4	10	55.6	18

Table II shows the relationship between Age, Parity, Pregnancy Spacing, Body Mass Index (BMI), Obesity, History of Chronic Disease, Diet, Physical Activity, Smoking Habits, Nutritional Status, Antenatal Care (ANC) Visits, Family Support, and Level of Knowledge and Attitude towards the occurrence of pre-eclampsia ($p < 0.05$). Meanwhile, Education,

Occupation, and Economic Status did not show any relationship with the occurrence of pre-eclampsia ($p > 0.05$).

Table II: Relationship between Pre-eclampsia and the dependent variable

Variable	p-value	OR
	Pre-eclampsia Occurrence	
Age	0.002	2.88
Education	0.208	
Work,	0.834	
Parity	0.015	6.45
Pregnancy spacing	0.015	0.189
BMI	0.024	4.11
Obesity	0.026	2.41
History of chronic disease	0,000	36.50
Eating habits	0.009	0.174
Physical activity	0.004	5.43
Smoking habit	0,000	124.4
Nutritional status	0.035	5.46
ANC visit	0,000	224.7
Family support	0,000	172.3
Knowledge	0,000	224.7
Attitude	0.036	7.56
Family Economic Status	0.791	

User Calculations of Pre-Eclampsia Early Detection Applications with ISO 25010 Software

The mobile application designed for the early detection of pre-eclampsia was evaluated for its suitability following ISO 25010 standards. This assessment involved 198 pregnant women who responded to a set of eight questions. Among these, two questions pertained to Functional Suitability, which assesses the software's ability to deliver functions that fulfil user needs under specific conditions. The remaining six questions focused on usability, measuring how effectively, efficiently, and satisfactorily a particular user can utilize the product or system to achieve designated goals within a specific context. Each question was accompanied by a set of response options, with scoring ranging from Strongly Agree (5) to Strongly Disagree (1).

$$\text{ISO 25010 percentage} = \frac{\text{actual score}}{\text{ideal score}} \times 100\%$$

$$= \frac{4972}{5680} \times 100\%$$

$$= 88\%$$

The outcomes derived from the questionnaire were subsequently evaluated against the established score interpretation criteria to ascertain the results concerning these criteria. The data analysis conducted using the ISO 25010 framework, focusing on two dimensions, such as functional suitability and usability, revealed that the Pre-eclampsia Early Detection application software achieved an overall score of 88%. This score indicates that the application is highly effective for use, following the performance score ranges specified in **Table III**, which are aligned with the standards set forth by ISO 25010.

Table III: Range of interpretation criteria based on ISO 25010

No	Criteria Range	Criteria
1	0% - 20%	Very Poor
2	21% - 40%	Poor
3	41% - 60%	Intermediate
4	61% - 80%	Very good
5	81% - 100%	Superior

Table IV presents a metric analysis for the pre-eclampsia early detection app, revealing the tool's performance through four key parameters: Sensitivity, Specificity, Positive Predictive Value (PPV), and Negative Predictive Value (NPV). Sensitivity, which reflects the proportion of true positives among all cases of the disease, was calculated using the formula 40/(40+8), yielding a value of 0.833 or 83.3%. Specificity, measured using the formula 140/(140+10), was 0.933 or 93.3%, illustrating the app's ability to identify individuals who are negative for the disease. Positive Predictive Value (PPV), which assesses the accuracy of a positive result, was obtained from 40/(40+10), obtaining a value of 0.800 or 80%. Finally, Negative Predictive Value (NPV), which indicates the proportion of true negatives, was calculated using 140/(140+8), yielding a value of 0.946 or 94.6%.

Table IV: Clinical Validation of Pre-Eclampsia Early Detection Applications

Metric	Value	Percentage
Sensitivity	0.833	83.3%
Specificity	0.933	93.3%
Positive Predictive Value (PPV)	0.800	80%
Negative Predictive Value (NPV)	0.946	94.6%

DISCUSSION

Table II showed that there was a relationship between Age, Parity, Pregnancy Interval, BMI, Obesity, History of Chronic Disease, Diet, Physical Activity, Smoking Habits, Nutritional Status, ANC Visits, Supporting Family, Level of Knowledge and Attitudes on the incidence of pre-eclampsia (p value <0, 05. Meanwhile, Education, Employment, and Economic Status were not related to the incidence of pre-eclampsia ($p > 0.05$). The results of data processing in the ISO 25010 test, which tested two aspects, functional suitability and usability, indicate that the Pre-eclampsia early detection application software has an overall percentage of 88%, indicating that the application is very good for use based on the range of performance scores to be used.

Healthcare technology has advanced rapidly in recent years, and one important innovation is the use of mobile applications for the early detection of pre-eclampsia. Pre-eclampsia is a serious pregnancy condition that requires immediate medical attention to avoid severe complications[10], and it has emerged as an effective tool for monitoring these risks by providing real-time health monitoring for pregnant women. Recent research shows that pre-eclampsia early detection apps offer significant benefits in terms of accuracy and ease of use. The app uses data-driven algorithms that integrate information such as blood pressure and laboratory results to provide accurate risk evaluations [11]. This app allows early detection of pre-eclampsia symptoms, which is essential for preventing the development of more serious conditions.

The rapid advancement of healthcare technology has significantly impacted the early detection of pre-eclampsia, a serious pregnancy complication characterized by high blood pressure and potential damage to other organ systems. Mobile applications designed for this purpose have emerged as effective tools for real-time health monitoring of pregnant women, facilitating timely interventions that can prevent severe complications associated with the condition [12]. These applications leverage data-driven algorithms to integrate critical health information, such as blood pressure readings and laboratory results, thereby enhancing the accuracy of risk evaluations for pre-eclampsia [13].

Recent studies underscore the importance of early detection in managing pre-eclampsia. For instance, research indicates that early identification of women at risk can significantly reduce the incidence of severe morbidity and mortality associated with the condition [14]. The use of mobile applications not only improves awareness among pregnant women regarding the signs and symptoms of pre-eclampsia but also promotes adherence to preventive measures, such as low-dose aspirin therapy, which has been shown to mitigate the risk of developing the condition [15]. Moreover, the integration of biomarkers and clinical algorithms within these applications enhances their predictive capabilities, allowing for a more tailored approach to monitoring and intervention [16].

The effectiveness of these mobile applications is further supported by evidence from various studies that highlight their role in facilitating continuous surveillance and early detection of pre-eclampsia [17]. For instance, the combination of serum biomarkers and clinical parameters has been shown to improve detection rates significantly, with some studies reporting up to 91% detection rates for early-onset pre-eclampsia when using comprehensive screening algorithms [18]. This level of accuracy is crucial, as timely detection can lead to interventions that prevent the progression of the disease, thereby safeguarding maternal and fetal health [19].

The early detection app also allows pregnant women to monitor their health independently, a feature that has been shown to increase user compliance [20]. The use of the app allowed pregnant women to track symptoms and receive early warnings about potential risks without the need for regular visits to health facilities. This has the potential to reduce the burden on the health system and increase access to care. The early detection app also allows pregnant

women to monitor their health independently, a feature that has been shown to increase user compliance [20]. It was found that the use of the app allowed pregnant women to track symptoms and receive early warnings about potential risks, without the need for regular visits to health facilities. This has the potential to reduce the burden on the health system and increase care accessibility.

According to [21], Early detection apps can provide real-time notifications and data-based recommendations that help pregnant women and medical personnel make fast and informed decisions. With the ability to monitor data continuously, the app supports early intervention and reduces the risk of complications associated with pre-eclampsia.

The ease of use of early detection applications is also a key factor for their effectiveness. Apps designed with intuitive and user-friendly user interfaces could increase the compliance and usage rates of pregnant women [22]. A good design ensures that pregnant women can easily enter the data and understand the information provided. Although these applications offer various advantages, it is essential to ensure that the applications have adequate clinical validation, which emphasizes that the app must go through a clinical validation process to ensure its accuracy and reliability. This is important to avoid misdiagnosis and to ensure that the application provides reliable information.

By allowing pregnant women to monitor for early signs of pre-eclampsia, this app can help reduce the incidence of serious complications associated with this condition. Early detection applications can reduce the workload of medical personnel by enabling more efficient and automated health monitoring. By reducing the need for frequent physical examinations, the application allows medical personnel to focus on cases that require special attention [23].

In terms of data security, the importance of protecting the privacy of app users was highlighted. As health apps often collect sensitive data, app developers must ensure that user information is protected from potential leaks and misuse. Early detection apps can help to monitor the long-term health of pregnant women [24]. By providing ongoing information about health risks and pre-eclampsia, the app supports more proactive and responsive health management

The app also provides educational features that help pregnant women understand the risks of pre-eclampsia and the necessary precautions. These features can increase pregnant women's knowledge and compliance with medical recommendations, contributing to better pregnancy outcomes. Pre-eclampsia early detection applications have the potential to be used globally, including in areas with limited access to health services. This app can improve healthcare accessibility and provide significant benefits to pregnant women worldwide. Early detection applications must be continuously updated and validated based on the latest research to maintain their effectiveness. Continuous validation is essential to ensure that the app remains relevant and able to meet new health challenges [25].

Various applications available in the market have different qualities and features. Therefore, it is essential to choose an app that has received positive reviews and a good track record in terms of effectiveness and reliability. Overall, the pre-eclampsia early detection app offers an excellent solution for monitoring and managing the risk of pre-eclampsia independently. With technological advances and application design continuing to develop, it is hoped that this application will continue to improve and increase its benefits for maternal health.

Research has shown that implementing early detection of pre-eclampsia is effective in identifying the risk of pre-eclampsia in pregnant women. These applications usually use algorithms that process pregnant women's health data, such as blood pressure, urine protein levels, and medical history, to predict the risk of pre-eclampsia. In addition, several studies have shown that the use of pre-eclampsia early detection applications can also increase the regularity of pregnancy control [26]. It is essential to ensure that the application is easy to use and accessible at all levels of society.

A limitation of this study lies in the use of a cross-sectional design, which may hinder a thorough understanding of changes that occur over time. Cross-sectional designs only provide a snapshot of the status of variables at a single point in time, thus failing to capture the dynamics or direction of change in the effects of the interventions studied. Future research is recommended to employ a longitudinal study design, which allows for observation of the same variables over a longer period. This approach is expected to reveal stronger causal relationships and validate the effectiveness of the pilot application. By using a longitudinal design, researchers can examine the stability and durability of intervention effects and increase the generalizability of findings to a broader population.

CONCLUSION

The statistical analysis results are presented in the context of data processing according to the ISO 25010 framework, focusing on two key dimensions: functional suitability and usability. The pre-eclampsia Early Detection application software achieved an overall score of 88%, indicating that it is deemed effective for use based on the established interpretation score range. This application is designed to estimate the risk of pre-eclampsia in pregnant women and is accessible online via mobile devices at the following URL: https://ptprinci.com/. Utilizing this model allows for the early identification of risks that pregnant women may face, as well as the interventions they may require. Pregnant women must engage in early detection of pre-eclampsia. Factors such as age, parity, pregnancy interval, body mass index (BMI), obesity, history of chronic diseases, dietary habits, physical activity levels, smoking behaviors, nutritional status, antenatal care (ANC) visits, family support, knowledge, and attitudes have been associated with the incidence of pre-eclampsia.

Ethical permission: Poltekkes Kemenkes Tanjung Karang, Indonesia, ERC letter No. 399/KEPK-TJK/IV/2024.
Conflict of interest: The authors declare no conflict of interest.
Financial Disclosure/Grant Approval: No funding agency was involved in this research.
Data Sharing Statement: The corresponding author can provide the data proving the findings of this study on request. Privacy or ethical restrictions bound us from sharing the data publicly.

AUTHOR CONTRIBUTION

Anita A: The process involves data acquisition, analysis, interpretation, drafting, revising, and final approval.
Aprina A: Analyzing the data for the project, creating the work, and editing the manuscript
Astuti T: Revising the manuscript

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