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Original Article

Survey on the Use of E-Application for Anaemia in Pregnant Women at Midwifery Clinic

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Abstract

Background: Among pregnant women, anaemia is a common health issue, as nutritional requirements increase to support fetal growth. Anaemia during pregnancy can have serious consequences, including an increased risk of preterm birth, low birth weight, and complications during delivery. This article aims to analyse the extent to which health promotion and accessibility to healthcare services influence anaemia in pregnant women. **Methods:** This study adopts a quantitative approach using a cross-sectional research design. The research was conducted to test a system developed using the waterfall method, in the form of utilising information technology in a knowledge-based system. The population in this study consisted of pregnant women who visited the Midwifery Clinic, with a total of 52 pregnant women from August to October 2024. **Results:** The significance test p=0.000 confirms that this relationship is statistically significant, indicating that the application has great potential to help effectively detect anaemia in pregnant women. Based on the ANOVA test, the regression model used in this study is statistically significant with a significant value p=0.000. The significance value p=0.000 emphasises that the application plays an important role in enhancing the accuracy of anaemia detection based on hemoglobin levels. The analysis shows an R Square value of 0.695, indicating that about 69.5% of the variation in HB test results can be explained by the application results, reinforcing the application's role in predicting HB test outcomes. **Conclusion:** The use of the E-Application influences identifying pregnant women with anaemia.

Keywords: *Anaemia; Accessibility to Healthcare Services; Health Promotion*

Introduction

Anaemia is a condition in which the number of red blood cells is insufficient to meet the body's physiological needs. These needs vary for each individual and are influenced by factors such as gender, living environment, smoking habits, and the stage of pregnancy. According to the WHO, anaemia in pregnant women is characterised by a hemoglobin (Hb) level below 11 g/dL. Meanwhile, the Centers for Disease Control and Prevention (CDC) defines anaemia in pregnant women as an Hb level below 11 g/dL in the first and third trimesters, below 10.5 g/dL in the second trimester, and below 10 g/dL in the postpartum period (Lee & Okam, 2011; Benson, Lo & Caughey, 2024).

Anaemia is one of the major factors that increase the risk of mortality in pregnant women. Women in developing countries have a risk of death from anaemia that is approximately 23 times higher compared to women in developed countries. Overall, the prevalence of anaemia in pregnant women is much higher in developing countries than in developed countries. For example, in the United States, about

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11% of pregnant women experience anaemia, while in France, the rate is only around 11.46%. In developing countries, the prevalence of anaemia in pregnant women is much higher; for instance, in India, about 41% of pregnant women suffer from anaemia, in Cambodia, nearly 50%, and in Myanmar, the prevalence rate reaches as high as 59.1% (WHO, 2011).

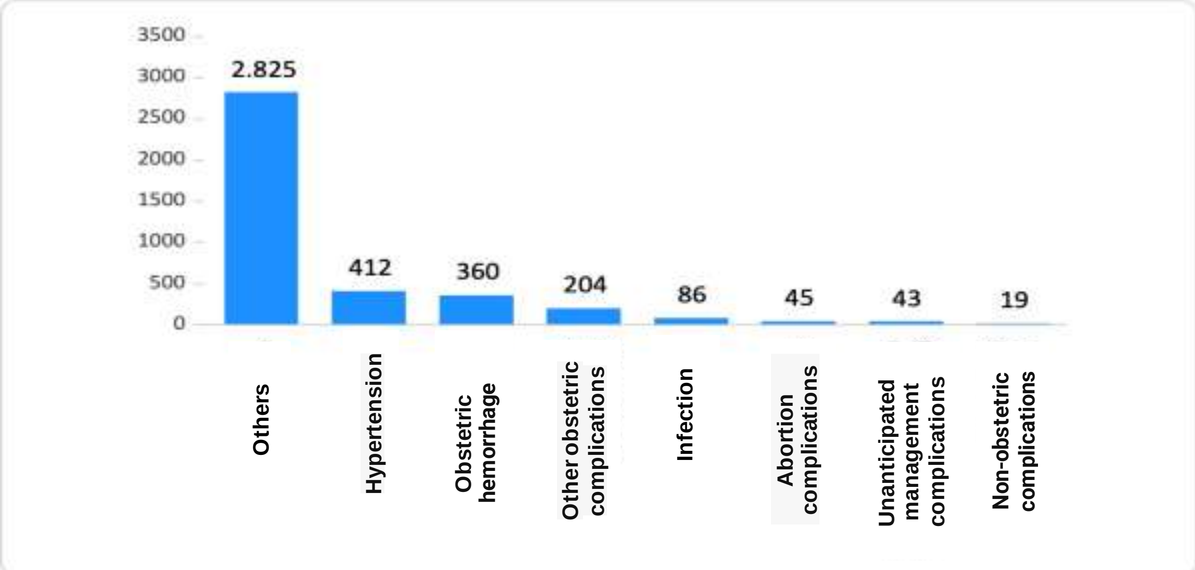

Figure 1: Cause of Maternal Mortality in Indonesia (2023)

Source: Directorate General of Health, Ministry of Health of the Republic of Indonesia, (Kemenkes RI, 2024)

Based on the Figure 1 above, in 2023, the leading cause of maternal death was hypertension during pregnancy with 412 cases, followed by obstetric hemorrhage with 360 cases, and other obstetric complications with 204 cases. One of the causes of hemorrhage is the contribution of anaemia during pregnancy. Anaemia in pregnant women increases the risk of preterm birth, maternal and neonatal death, and vulnerability to infectious diseases. Iron deficiency, which causes anaemia in pregnant women, can also affect fetal or infant growth and development, both during pregnancy and after birth. According to the 2023 Indonesian Health Survey, 27.7% of pregnant women in Indonesia experience anaemia. When looking at age groups, the highest prevalence of anaemia in pregnant women occurs in the 35-44 age group, at 39.6%, followed by the 25-34 age group at 31.4% (Kemenkes, 2024).

Anaemia is a medical condition characterised by a low number of red blood cells or hemoglobin levels in the blood, which can lead to a decreased supply of oxygen to the body's tissues. This condition can actually be detected early through several simple examination methods, such as a complete bloo d test that measures hemoglobin levels, hematocrit, and the number of red blood cells. Early detection of anaemia is crucial because, if not properly managed, it can lead to various health complications, such as chronic fatigue, weakness, difficulty concentrating, and, in more severe cases, even organ damage. The early symptoms of anaemia are often mild and easy to overlook, such as fatigue, paleness, and dizziness, which may be mistaken for ordinary tiredness (Lee & Okam, 2011; Mentari *et al*., 2023).

One solution to utilising technology in the healthcare field is by developing expert systems. This system is a form of artificial intelligence that uses references from experts to solve problems. With the support of an expert system, various actions can be taken to address issues, including knowledge delivery, forecasting, control, providing advice, training, design, planning, explanation, regulation, and formulation (Budiyati & Rihyanti, 2022). An expert system is a computer program designed to replicate the decision-making ability of an expert in a specific field. The expert system operates by utilising a knowledge base containing structured information and rules, along with an inference engine that analyses data to generate advice or solutions. With its wide applications in various fields such as healthcare, engineering, finance, and education, expert systems provide benefits such as consistency and efficiency in decision-making, especially with the ability to integrate knowledge from multiple expert sources. Below are some studies conducted using the waterfall method. Ramen Antonov (2021) conducted a study on application design to help predict market demand using the waterfall method. The study aimed to design and develop an application capable of making predictions in collaboration with linear regression (Purba, 2021).

In another study conducted by Nur Hidayati and Sismadi (2020) applied the waterfall model to develop a work training acceptance system. The study aimed to improve the existing system by transforming it from a conventional to a computerised one (Hidayati & Sismadi, 2020). Similarly, Endah Budiyati and Erni Rihyanti (2022) utilised the same method in developing an online application to detect anaemia. Their research helps the community find quick and effective solutions for managing health conditions and symptoms of anaemia (Budiyati & Rihyanti, 2022).

This research was conducted to test the system that has been developed using the waterfall method in the form of utilising information technology in knowledge-based systems. The system aims to demonstrate early screening for pregnant women before additional examinations are carried out and health education is provided based on the specific needs of the pregnant women.

Methodology

Search Strategy

This study adopts a quantitative approach using a cross-sectional research design, aimed at collecting data at a specific point in time from a defined population or sample. This allows researchers to explore and analyse relationships between various variables. Through this design, researchers can identify patterns and associations among these variables without involving interventions or manipulations, which are often conducted in experimental studies. Additionally, the cross-sectional approach is highly useful for addressing research questions related to the prevalence or distribution of certain characteristics within a population and for providing a general overview of the issue being studied (Sugiyono, 2013).

The population in this study consisted of pregnant women who visited Midwifery Clinic for antenatal check-ups, totaling 52 pregnant women from August to October 2024. The sample size in this study was determined using the Slovin's formula, which is a commonly used method in research to calculate the required sample size based on the desired level of precision (Tamara, Hermansyah & Marleni, 2024). The formula is as follows:

$$n = \frac{N}{1 + N\,(d^2)}$$

$$n = \frac{52}{1 + 52(0{,}05^2)}$$

$$n = \frac{52}{1 + 0{,}13}$$

$$n = 46.02$$

Rounded to 46

Description:

n = Sample size

N = Population size

d = Desired margin of error or degree of precision, set at 0.005

Criteria in this Study

The inclusion criteria in this study are:

a. Pregnant women

b. Undergoing check-ups at Midwifery Clinic

c. Within the period of August to October 2024

d. Willing to participate as respondents

The exclusion criteria in this study are:

a. Experiencing illness during data collection

Table 1: Operational and Measurement Variables

Variable	Indicator	Scale
Anaemia Detection Application	1. System quality 2. Risk and no-risk classification 3. Availability of clear information 4. Access to easily obtainable information	Ordinal
Anaemia	1. Relevance 2. Comparability	Ordinal

Results

a. Univariate

Respondent Characteristics

Table 2: Frequency Distribution of Respondents' Age in the Implementation of the Application for Detecting Anaemia in Pregnant Women

Mother's Age	Frequency(*f*)	Percentage(%)
20 Year	11	24
21 – 35 Year	25	54
35 Year	10	22

Source: Processed primary data (2024)

Based on the data in Table 1 and Table 2, the majority of respondents fall within the age range of 21 to 35 years, with 25 individuals or 54% of the total respondents. This age group dominates the data, indicating that most respondents in this study are individuals in the productive age category

Table 3: Frequency Distribution of Gestational Age of Respondents in the Implementation of Application-Based Detection of Anaemia in Pregnant Women

Gestational age	Frequency(*f*)	Percentage(%)
0 – 12 week	14	31
13 – 27 week	19	41
28 – 40 week	13	28

Source: Processed primary data (2024)

Based on the data presented in Table 3, the majority of respondents were in the gestational age range of 13 to 27 weeks, accounting for 19 individuals or approximately 41% of the total respondents. This indicates that most respondents were in the second trimester, the mid-phase of pregnancy, where preparations for childbirth typically begin, and the fetus approaches near-full maturity. This gestational age range is also commonly associated with an increased frequency of health check-ups for both the mother and fetus to ensure optimal conditions in anticipation of delivery.

Table 4: Frequency Distribution of Respondents' Educational Age in the Implementation of Application-Based Detection of Anaemia in Pregnant Women

Education Level	Frequency(f)	Percentage(%)
Elementary School/Equivalent	10	22
Junior High School/Equivalent	8	17
Senior High School/Equivalent	21	46
Diploma/Bachelor's/Master's Degree	7	15

Source: Processed primary data (2024)

Based on the data presented in Table 4, the majority of respondents had completed senior high school or an equivalent level of education, accounting for 30 individuals or 50% of the total respondents. This indicates that half of the respondents were at the upper secondary education level. This level of education may influence respondents' understanding of pregnancy health, including knowledge of self-care and access to relevant health information.

b. Normality Test

The normality test is a statistical method used to determine whether the data being analysed follows a normal distribution. A normal distribution is a symmetric, bell- shaped data pattern where most values are clustered around the mean, with decreasing frequencies as values move further from the mean. This study conducted a normality test because the data analysis utilised parametric statistical tests. The results of the normality test are as follows:

Table 5: Normality Test

HB Test Results		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	*df*	Sig.	Statistic	*df*	Sig.
Application Result 1	1	0.094	26	0.200	0.958	26	0.351
	2	0.118	20	0.200	0.952	20	0.407

Source: Processed primary data (2024)

As Table 5 shows the results of the normality test for hemoglobin (HB) levels are presented in the table above. Using the Kolmogorov-Smirnov and Shapiro-Wilk tests, the Kolmogorov-Smirnov test yielded a statistic value of 0.094 with a significance *p* value of 0.200, while the Shapiro-Wilk test showed a statistic value of 0.958 with a *p* value of 0.351. For the second dataset, the Kolmogorov-Smirnov test produced a statistic value of 0.118 with a *p* value of 0.200, and the Shapiro-Wilk test showed a statistic value of 0.952 with a *p* value of 0.407. Since all *p* values exceed the 0.05 threshold, we conclude that the HB data in both datasets follow a normal distribution, allowing for the continuation of parametric analysis.

c. Bivariate

Table 6: Test of the Relationship between the Use of E-Application for Anaemia in Pregnant Women at TPMB I

Varients	HB Test Results	Application Results
Person Correlation HB Test Results	1.000	0.834
Application Results	0.834	1.000
Sig. (1-tailed) HB Test Results	-	0.000
Application Results	0.000	-
NHB Test Results	46	46
Application Results	46	46

Source: Processed primary data (2024)

In Table 6 the Pearson correlation results between the HB test results and the application results indicate a strong relationship between the two variables, with a correlation coefficient of 0.834. This value represents a high positive correlation, meaning that the results from the application are closely related to the HB test results. The significance of the test *p* is 0.000 (1-tailed), indicating that this relationship is statistically significant at a 95% confidence level. With a sample size (N) of 46 for both variables, these results enhance the validity of the data, suggesting consistency between the HB test results and the outcomes obtained from the application.

Tabel 7: Residual Statistics

Varients	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	0.78	2.34	1.43	0.418	46
Residual	-0.633	0.490	0.000	0.277	46
Std. Predicted Value	-1.575	2.168	0.000	1.000	46
Std. Residual	-2.262	1.748	0.000	0.989	46

Source: Processed primary data (2024)

The statistics in Table 7 provides an overview of the predicted values and residuals in the model. The predicted values range from 0.78 to 2.34, with a mean of 1.43 and a standard deviation of 0.418, indicating variation in the predicted outcomes within the model. The residuals range from -0.633 to 0.490, with a mean of zero and a standard deviation of 0.277, reflecting the difference between the actual and predicted values, with the mean difference approaching zero as expected. For the standardised predicted values and standardised residuals, both have a mean of zero and standard deviations close to one (1.000 and 0.989), indicating data normalisation. The sample size (N) for each value is 46, which strengthens the reliability of these statistical results.

d. Uji Multivariate

Table 8: Regression Model Adequacy Test for the Survey on the Use of E-Application for Anaemia in Pregnant Women at Midwifery Clinic

Model	Sum of Squares	*df*	Mean Square	*F*	*P* value
Regression	7.854	1	7.854	100.169	0.000[a]
Residual	3.450	44	0.078		
Total	11.304	45			

Source: Processed primary data (2024)

The Table 8 above shows the results of the variance analysis for the regression model. The Sum of Squares for regression is 7.854 with 1 degree of freedom (*df*), resulting in a Mean Square value of 7.854. Meanwhile, the Residual Sum of Squares is 3.450 with 44 degrees of freedom, yielding a residual Mean Square of 0.078. The *F* value is 100.169 with a significance *p* value of 0.000. Since the significance value is less than 0.05, it can be concluded that this regression model is statistically significant, meaning that the application results have a significant effect on the HB test outcomes.

Table 9: Regression Coefficient Adequacy Test for the Survey on the Use of E-Application for Anaemia in Pregnant Women at Midwifery Clinic

Model	Unstandardised		Standardised Coefficients	t	*p*
	B	Std. Error	Beta		
1 (Constant)	-0.198	0.168		-1.177	0.246
Application Results	0.004	0.000	0.834	10.008	0.000

Source: Processed primary data (2024)

The Table 9 above presents the regression coefficients for the model predicting HB test results based on application outcomes. The constant (intercept) value is -0.198 with a standard error of 0.168, and it is not statistically significant (*p* = 0.246), indicating that the constant is not significantly different from zero. The coefficient for the application result is 0.004 with a very small standard error of 0.000. The beta coefficient (Beta) of 0.834 indicates a strong positive relationship between the application results and HB test outcomes. The t-value for the application result is 10.008 with a significance *p* of 0.000, which indicates that the effect of the application results on HB test outcomes is statistically significant at a 95% confidence level. This suggests that improvements in application results are significantly correlated with improvements in HB test outcomes.

Table 10: Autocorrelation for the Survey on the Use of E-Application for Anaemia in Pregnant Women at Midwifery Clinic

Model	R	RSquare	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	*F* Value	df^1	df^2	Sig. F Change
Dimension 0	0.834[a]	0.695	0.688	0.280	0.695	100.169	1	44	0.000

Source: Processed primary data (2024)

The Table10 above presents a summary of the regression analysis results, with a correlation coefficient (R) of 0.834, indicating a strong relationship between the predictor variable (application results) and the HB test outcomes. The R Square value of 0.695 shows that approximately 69.5% of the variation in HB test results can be explained by the application results. The Adjusted R Square value of 0.688 reinforces this interpretation by accounting for the number of predictor variables and the sample size. The standard error of the estimate is 0.280, which indicates the average deviation of the predictions from the regression line. The change in R Square of 0.695, with an *F* value of 100.169 and a significance (Sig. F Change) of 0.000, indicates that this regression model is statistically significant, with 1 degree of freedom (df) for the predictor variable and 44 for the error.

Discussion

Based on the data analysis results in this study, several key points related to the implementation of the application in detecting anaemia occurrences in pregnant women are as follows:

The majority of respondents were in the age range of 21 to 35 years (54%) and in the second trimester of pregnancy (41%). This indicates that most of the pregnant women who participated in the survey are individuals in their productive age and at a stage of pregnancy that generally requires more intensive medical attention. Additionally, the majority of respondents had completed high school (50%), which may influence their understanding of the importance of health check-ups and the use of applications to monitor their health condition. The normality test results show that the hemoglobin (HB) data in both datasets (application results) are normally distributed, with significance values greater than 0.05. This allows for the further use of parametric statistical analysis, supporting the validity of the data used in this study. The Pearson correlation results show a strong positive relationship (0.834) between the HB test results and the application outcomes, indicating that the application can be used to monitor HB levels with high accuracy. The significance test (p = 0.000) confirms that this relationship is statistically significant, suggesting that the application has great potential in effectively detecting anaemia in pregnant women. Based on the ANOVA test, the regression model used in this study is statistically significant with a significant value (p = 0.000). This indicates that the application results have a significant effect on the HB test outcomes. The regression coefficient shows a strong positive relationship between the application results and the HB test outcomes (Beta coefficient = 0.834). The significance value (p = 0.000) reinforces that the application plays a crucial role in improving the accuracy of anaemia detection based on hemoglobin levels. The analysis shows an R Square value of 0.695, which means that approximately 69.5% of the variation in the HB test results can be explained by the application results, further strengthening the role of the application in predicting HB test outcomes (Wekalao *et al*., 2024).

Therefore, the application used in this study has been shown to have a significant impact on detecting anaemia in pregnant women, with high accuracy and a strong correlation with HB test results (Qiao *et al.,* 2024). The implementation of this application can be a highly valuable tool for monitoring the health of pregnant women, particularly in preventing and detecting anaemia more effectively and efficiently. The use of technology in healthcare, particularly mobile applications, has proven to have a positive impact on raising public health awareness and facilitating real-time monitoring of medical conditions (Oyeniyi, 2024). In the context of maternal health, mobile applications can serve as an effective tool for monitoring various medical conditions, including anaemia. One of the main benefits of this application is its ability to remind users to perform routine checks, such as hemoglobin tests, which are essential for detecting anaemia in pregnant women. Additionally, the application can provide relevant information about healthy eating, particularly iron-rich foods, which are necessary to prevent or treat anaemia.

According to health technology theory, the use of mobile applications in monitoring maternal health not only increases awareness but also supports efforts in the prevention and management of health issues. Mobile applications allow for continuous monitoring of medical conditions and provide pregnant women with access to accurate and personalised information. This is crucial because pregnant women often face challenges in accessing up- to-date and relevant health information. With a mobile application, pregnant women can easily track their health status, including hemoglobin levels, and receive healthier dietary recommendations to help prevent anaemia. Research conducted by Liu *et al*. (2018) also shows that the use of applications for monitoring maternal health can significantly reduce the risk of complications, including anaemia. This study highlights the importance of technology in supporting public health efforts, particularly in preventing anaemia in pregnant women. The mobile application used in this study has had a positive impact on increasing pregnant women’s awareness of the importance of monitoring hemoglobin levels and adopting healthy eating habits. With the availability of routine reminders and easily accessible information, pregnant women can be better informed and more proactive in maintaining their health during pregnancy (Mbunge & Sibiya, 2024; Atnafu *et al*., 2015).

The book Mobile Health (mHealth) and Telemedicine: A Systems Perspective by Eren and Webster (2015), published by CRC Press, provides a comprehensive view of mobile health (mHealth) applications and telemedicine. This is further supported by the theory written by Eren and Webster (2015), which states that current mobile technology can support non-invasive diagnosis, treatment, and health monitoring, particularly relevant for areas with limited access to healthcare facilities. With a system- based approach, the authors explain technical aspects such as data integration, networking, security, and information management in mHealth. The discussion covers technical and operational challenges, as well as the potential social impacts of these applications, from training to supporting infrastructure.

One web-based study conducted by Manik in 2021 highlights that the development of web-based applications, such as the Sumiferos application model, enables monitoring at any time to enhance pregnant women's understanding. Based on educational activities, pregnant women can effectively use the Sumiferos application, leading to improved compliance with iron tablet consumption (Manik, 2021). The research conducted by Wahyuni and ZA in 2024 shows that the multimedia "Edukasi Anaemia" has an impact on the knowledge and attitudes of pregnant women in preventing anaemia ($p<0.05$). The use of the "Edukasi Anaemia" multimedia is easier for pregnant women to access information on anaemia prevention compared to conventional educational media provided by midwives ($p<0.05$) (Wahyuni & ZA, 2024).

The researcher’s assumptions regarding the implementation of applications in anaemia detection in pregnant women are as follows: The application is considered to make it easier for pregnant women to access information related to anaemia, iron-rich diets, and the importance of monitoring hemoglobin levels. Mobile technology can support non-invasive diagnosis and health monitoring, especially in areas with limited access to healthcare services. Applications such as Sumiferos and "Edukasi Anaemia" improve compliance with iron tablet consumption among pregnant women, which has implications for reducing the risk of anaemia. The application used in the study shows a high and statistically significant correlation with hemoglobin test results, confirming its accuracy. The application helps raise awareness among pregnant women about the importance of regular check-ups and the adoption of a healthy lifestyle, which serves as a preventive measure against anaemia.

Conclusion

Based on the data analysis, this study concludes that the application for anaemia detection in pregnant women shows significant results in improving the accuracy of hemoglobin (HB) level monitoring. The majority of respondents are within the productive age range (21–35 years), with most being in the second trimester of pregnancy (13–27 weeks). The normality test and Pearson correlation show that the data is normally distributed and there is a strong relationship between the HB test results and the application. The regression model also indicates that the application has a significant impact on the HB test results, with 69.5% of the variation in HB levels explained by the application. This suggests that this application has great potential to enhance the detection and prevention of anaemia in pregnant women.

Conflict of Interest

The authors declare that they have no conflict of interest.

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