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Digital health literacy on pregnancy danger signs among pregnant women using mobile health applications: a cross sectional study

Desriva N[1], Herawati M[1], Wati YS[1], Nadia F[1], Purba TJ[2], Fitria L[3], Pesa YM[4], Elektrina O[5], Siagian DS[6], Rahayo AOS[1]

[1]*Department of Midwifery, Faculty of Health, Institut Kesehatan dan Teknologi Al Insyirah, Riau, Indonesia*
[2]*Faculty of Midwifery, Institut Kesehatan Deli Husada Deli Tua, Deli Serdang, Indonesia*
[3]*Department of Midwifery, Institut Kesehatan Helvetia Pekanbaru, Riau, Indonesia*
[4]*Departmen of Midwifery, STIKes Tengku Maharatu, Riau, Indonesia*
[5]*Faculty of Public Health, Universitas Diponegoro, Central Java, Indonesia*
[6]*Department of Midwifery, Faculty of Health Sciences, Abdurrab University, Riau, Indonesia*

ABSTRACT

Introduction: Maternal mortality remains a major public health concern, particularly in low- and middle-income countries (such as Indonesia. Delayed recognition of pregnancy danger signs contributes substantially to preventable maternal deaths. As mobile health (m-Health) platforms increasingly disseminate maternal health information, digital health literacy, the ability to search for, evaluate, and apply online health content, has emerged as a pivotal factor influencing maternal knowledge and decision-making. This study aimed to assess the level of digital health literacy among pregnant women, evaluate their knowledge of pregnancy danger signs, and examine the association between digital health literacy and knowledge of danger signs. **Methods:** A community-based cross-sectional study was conducted among 422 pregnant women recruited through systematic random sampling at primary healthcare centers. Data were collected using structured questionnaires, including the eHealth Literacy Scale and WHO-based pregnancy danger sign items. Data were analysed using SPSS version 26. **Results**: Overall, 54.5% of participants demonstrated high digital health literacy, while 63.3% had adequate knowledge of pregnancy danger signs. High digital health literacy was significantly associated with better knowledge (aOR=2.81; 95% CI 1.85–4.27; p<0.001). Education also showed a positive association, whereas parity did not emerge as an independent predictor. **Conclusions:** Digital health literacy plays a crucial role in shaping pregnant women's awareness of obstetric danger signs. Strengthening it through targeted interventions embedded in antenatal and community health programs may enhance the timely recognition of complications, contributing to reductions in preventable maternal morbidity and mortality.

Keywords: *Digital health; Health literacy; Pregnancy complications; Women*

INTRODUCTION

Maternal mortality remains a profound global health challenge, with an estimated 287,000 women dying each year from pregnancy-related causes, 90% of which occur primarily in low- and middle-income countries (LMICs)[1]. Sub-Saharan Africa and South Asia alone account for nearly 86% of these deaths. In Indonesia, the situation is equally concerning: the Maternal Mortality Ratio (MMR) stands at 189 per 100,000 live births, significantly above the Sustainable Development Goal (SDG) 3.1 target of fewer than 70 by 2030[2]. Most maternal deaths are preventable, often resulting from delays in recognizing complications and seeking timely care[3,5].

A critical component of maternal survival is the ability of pregnant women to identify danger signs of pregnancy, including vaginal bleeding, severe headaches, blurred vision, convulsions, and reduced fetal movements. These signs serve as early warnings and warrant immediate medical attention to avert life-threatening complications such as hemorrhage, hypertensive disorders, and sepsis[5,6]. Although antenatal care (ANC) services remain a cornerstone for educating pregnant women on recognizing these signs, numerous studies indicate persistent knowledge gaps even among women who attend ANC regularly [7].

Concurrently, the rapid growth of the digital health ecosystem encompassing mobile health (m-Health) applications, health websites, and social media platforms, has transformed how health information is accessed globally[8–10]. In Indonesia,

Corresponding author:
Bd. Nia Desriva
nia.desriva@ikta.ac.id

77% of the population has access to the internet, and smartphone use among women continues to rise, offering unprecedented opportunities to disseminate maternal health information[11]. However, effective utilization of these digital resources hinges on Digital Health Literacy (DHL), the capacity to search for, comprehend, evaluate, and apply health information obtained from digital platforms[12,13].

Emerging evidence underscores the role of DHL in influencing health behaviors and outcomes. Limited DHL has been linked to difficulties in distinguishing credible health information from misinformation, ultimately affecting decision-making and timely care-seeking behaviors[14,15]. Although digital tools are increasingly being incorporated into maternal health promotion, there are limited studies that have explored the association between DHL and pregnant women's awareness of obstetric danger signs, especially in LMICs where inequalities in digital access and health literacy remain prevalent.

Addressing this gap is crucial for informing targeted interventions that leverage digital platforms to improve maternal health literacy and outcomes. Therefore, this study aimed to assess the level of DHL among pregnant women utilizing mobile health platforms, evaluate their knowledge of pregnancy danger signs, and examine the association between DHL and knowledge of danger signs.

METHODS

Study Design

This was a community-based, cross-sectional study conducted between 01 January and 30 April 2025 in Kendal, Central of Java Province, Indonesia.

Study setting

The study was conducted in Kendal Regency, Central Java Province, Indonesia, using selected government primary healthcare centers *(Puskesmas)* as the study sites. *Puskesmas* are frontline public health facilities in Indonesia, providing comprehensive maternal and child health services, including ANC, health education, routine pregnancy monitoring, and referral services.

Kendal Regency was selected due to its relatively high ANC coverage and widespread use of mobile phones and internet-based health information among women of reproductive age. Each *Puskesmas* routinely registers pregnant women within its catchment area and provides scheduled ANC visits in accordance with national maternal health guidelines. Pregnant women typically receive a minimum of six ANC contacts, during which midwives provide health education on pregnancy danger signs, nutrition, birth preparedness, and complication readiness.

Digital health information is increasingly accessed by pregnant women through mobile health applications, official Ministry of Health platforms, and social media channels, which are commonly discussed during ANC visits. This setting therefore provided an appropriate context to examine digital health literacy and its association with knowledge of pregnancy danger signs among pregnant women.

Study Population

The study population consisted of pregnant women in their second and third trimesters who attended ANC visits at selected primary healthcare centers (PHCs) and had experience using mobile health platforms (such as pregnancy tracking apps, health websites, or social media groups for pregnancy information).

Inclusion criteria

Pregnant women were eligible to participate in this study if they were in their second or third trimester of pregnancy, attended ANC services at the selected primary healthcare centers during the study period, had experience using mobile health platforms (including pregnancy-related mobile applications, health websites, or social media) to obtain pregnancy-related information, were able to communicate in Bahasa Indonesia, and provided informed consent prior to participation.

Exclusion criteria

Pregnant women were excluded from the study if they had serious medical or obstetric complications that prevented participation in the interview, were unable to complete the questionnaire due to cognitive or communication difficulties, or declined to provide informed consent.

Sample size calculation

Sample size was calculated using a single population proportion formula with the assumption of 50% proportion (due to absence of prior local data on DHL among pregnant women), a 95% confidence interval, and 5% margin of error, yielding a minimum sample of 384 participants. Considering a possible 10% non-response rate, the final sample was increased to 422 participants.

Sampling technique

A systematic random sampling technique was employed to recruit eligible pregnant women attending ANC services at the selected primary healthcare centers. Based on routine ANC registration records, an average of approximately 500 pregnant women attended ANC services per month across the selected facilities. Over the four-month data collection period, this yielded an estimated total of 2,000 pregnant women attending ANC.

Using the required sample size of 422 participants, the sampling interval was calculated by dividing the estimated

total number of ANC attendees during the study period by the sample size (2,000 / 422), resulting in a sampling interval of approximately five.

At each healthcare center, the daily ANC attendance list served as the sampling frame. On each data collection day, the first participant was selected randomly from the first five eligible women using a simple random method. Subsequently, every fifth eligible pregnant woman was approached for participation. If a selected woman did not meet the inclusion criteria or declined to participate, the next eligible woman was recruited to maintain the sampling sequence. This procedure was repeated daily until the required sample size was achieved.

Data collection tool

Data were collected using interviewer-administered structured questionnaires. The questionnaire consisted of three main sections. The first section assessed socio-demographic and obstetric characteristics, including age, education level, employment status, parity, and frequency of mobile phone use. The second section measured DHL using the validated e-Health Literacy Scale (e-HEALS), which comprises eight items rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), yielding total scores ranging from 8 to 40. Higher scores indicated greater levels of DHL. The third section assessed knowledge of pregnancy danger signs using 10 standard items recommended by the World Health Organization, in which respondents identified key danger signs such as vaginal bleeding, severe headache, blurred vision, and reduced fetal movement. Knowledge scores were categorized as adequate or inadequate based on a cut-off point of ≥70% correct responses.

Study procedures

Prior to data collection, trained midwives who were familiar with digital data capture tools were recruited as data collectors and received standardized training on the study protocol and questionnaire administration. Eligible pregnant women attending ANC services at the selected primary healthcare centers were approached by the data collectors during the study period and were provided with an explanation of the study objectives and procedures. After obtaining informed consent, face-to-face interviews were conducted in Bahasa Indonesia using tablets preloaded with KoBo-Collect to ensure standardized data entry and minimize data entry errors. Completed questionnaires were reviewed for completeness and accuracy before being securely stored for subsequent data analysis.

Ethical consideration

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Health Research Ethics Committee, Ministry of Health, Semarang Health Polytechnic (1026/EA/KEPK/2024).

Written informed consent was obtained from all participants prior to data collection. Participation was voluntary, and confidentiality and anonymity of the respondents were strictly maintained throughout the study.

Data Analysis

Data were collected electronically using KoBo-Collect and initially entered directly into the KoBo-Collect platform. The completed datasets were exported in CSV format and subsequently imported into IBM SPSS Statistics version 26 for data cleaning and analysis. Descriptive statistics were computed for all variables. Bivariate analyses using chi-square tests were conducted as an initial screening to examine associations between DHL levels and knowledge of pregnancy danger signs. Variables that were theoretically relevant and/or statistically significant in the bivariate analysis were included in the multivariable logistic regression model. Multivariable logistic regression analysis was performed to assess the independent association between DHL and adequate knowledge of pregnancy danger signs, while adjusting for age, education, parity, and frequency of mobile phone use. Adjusted odds ratios (AORs) with 95% confidence intervals were reported, and statistical significance was set at $p < 0.05$.

RESULTS

Socio-demographic and obstetric characteristics

A total of 422 pregnant women participated in the study, yielding a response rate of 100%. The mean age was 28.7 ± 5.1 years, with the majority (62.1%) aged between 25–34 years. Approximately 56% had completed secondary education, while 33.8% attained tertiary education. Most participants (70.7%) were multiparous. Regarding mobile phone use, 85.2% reported using it daily for health-related information (Table 1).

Digital health literacy levels

The mean (eHEALS) score was 29.6 ± 5.2. Participants were categorized into high and low (DHL) groups using the mean score as the cut-off point, with scores ≥29.6 classified as high DHL. As depicted in Table 2 based on this criterion, 54.5% of participants were categorized as having high DHL.

Overall, 63.3% of pregnant women demonstrated adequate knowledge of pregnancy danger signs (≥70% correct responses). As depicted in Table 3, the most commonly identified danger sign was vaginal bleeding (91.0%), followed by severe headache (74.5%) and blurred vision (68.1%). Conversely, recognition of reduced fetal movement (51.7%) was comparatively lower.

Bivariate analysis revealed a significant association between DHL level and adequate knowledge of pregnancy danger signs ($\chi^2=18.4$, $p<0.001$). In multivariable logistic

Table 1. Socio-demographic and obstetric characteristics of pregnant women in their second and third trimesters attending antenatal care services at selected primary healthcare centres.

Variable	Frequency (n=422)	Percentage (%)
Age (years)		
<25	96	22.8
25–34	263	62.3
≥35	63	14.9
Education level		
Primary	41	9.7
Secondary	239	56.4
Tertiary	142	33.7
Parity		
Primigravida	123	29.2
Multiparous	299	70.8
Daily mobile phone use		
Yes	360	85.3
No	62	14.7

regression analysis, after adjusting for age, education, parity, and mobile phone use, pregnant women with high DHL were 2.8 times more likely to have adequate knowledge of pregnancy danger signs (aOR=2.81, 95% CI: 1.85–4.27, p<0.001) (Table 3). Women with tertiary education demonstrated significantly higher DHL compared to those with lower educational attainment (p<0.001).

DISCUSSION

This study revealed that more than half of the pregnant women surveyed demonstrated high levels of DHL, and nearly two-thirds had adequate knowledge of pregnancy danger signs. Importantly, higher DHL was significantly associated with better knowledge of danger signs, even after adjusting for education, parity, and mobile phone use. These findings reinforce the growing global evidence that digital competencies are becoming key determinants of maternal health awareness and decision-making [6,16,17.]

The high prevalence of daily mobile phone use (85.2%) among participants reflects Indonesia's rapid digital transformation, where internet penetration has now exceeded 77%[11]. Similar patterns have been documented across other (LMICs), where mobile devices increasingly serve as the primary gateway to health information[18]. However, our results underscore that access alone is insufficient; rather, the ability to critically navigate, appraise, and apply digital health content, captured by DHL, plays a decisive role. This observation aligns with findings from Nigeria, where limited DHL heightened susceptibility to misinformation and delayed care-seeking for obstetric complications and with evidence from Tanzania, demonstrating that higher eHealth literacy improved recognition of danger signs [6,17].

Education emerged as another robust correlate of both DHL and knowledge. Women with tertiary education were significantly more likely to demonstrate high DHL and adequate awareness of obstetric complications, highlighting how formal schooling enhances the cognitive and evaluative capacities essential for interpreting digital health information [19]. Intriguingly, parity did not appear as an independent predictor in this study, diverging from research in Ethiopia where multi-parity correlated with higher awareness [20]. This discrepancy might signal a shifting informational landscape in which experiential learning from previous pregnancies is increasingly complemented, or even overshadowed, by the pervasive influence of digital channels.

From a public health standpoint, these insights carry critical implications. Merely expanding mobile health initiatives without concurrently strengthening foundational digital competencies may fall short of achieving meaningful gains in maternal outcomes. Integrating DHL-enhancement components into existing ANC frameworks or community-based maternal health programs could prove pivotal. Notably, Indonesia's Ministry of Health has recently accelerated the digitization of maternal and child health (KIA) services through platforms under the "Sehat Indonesiaku" initiative. Embedding structured digital navigation sessions or critical appraisal workshops led by midwives into such programs could empower pregnant women to more effectively discern credible online information, thereby improving timely recognition of danger signs.

Nevertheless, this study has several limitations. Its cross-sectional design precludes establishing causality between DHL and knowledge levels. The reliance on self-reported measures also introduces the potential for recall and social desirability biases, which may overestimate both DHL and awareness. Despite these limitations, the study offers valuable baseline data from an underexplored LMIC context, providing an empirical foundation for more rigorous future investigations.

Looking ahead, longitudinal and intervention-based studies are warranted to determine whether enhancing DHL can translate into improved health-seeking behaviors and reduced maternal morbidity. Policymakers and program designers should recognize DHL not merely as a supplementary skill, but as an essential component of maternal health equity in the digital era. By strategically incorporating DHL frameworks into broader maternal health initiatives, there lies significant potential to accelerate progress toward global targets in reducing preventable

Table 2: Assessment of eHealth Literacy among the study participant availing ANC services at Kendal Regency, Central Java Province, Indonesia (n=422)

Assessment of eHealth Literacy	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
I know what health resources are available on the Internet	12 (2.8)	38 (9.0)	64 (15.2)	201 (47.6)	107 (25.4)
I know where to find helpful health resources on the Internet	10 (2.4)	34 (8.1)	59 (14.0)	209 (49.5)	110 (26.0)
I know how to find helpful health resources on the Internet	11 (2.6)	36 (8.5)	61 (14.5)	205 (48.6)	109 (25.8)
I know how to use the Internet to answer my questions about health	9 (2.1)	32 (7.6)	56 (13.3)	215 (50.9)	110 (26.1)
I know how to use the health information I find on the Internet to help me	13 (3.1)	40 (9.5)	66 (15.6)	194 (46.0)	109 (25.8)
I have the skills I need to evaluate the health resources I find on the Internet	18 (4.3)	52 (12.3)	78 (18.5)	183 (43.4)	91 (21.6)
I can tell high quality health resources from low quality health resources on the Internet	20 (4.7)	55 (13.0)	80 (19.0)	175 (41.5)	92 (21.8)
I feel confident in using information from the Internet to make health decisions	14 (3.3)	41 (9.7)	69 (16.4)	198 (46.9)	100 (23.7)
Mean eHEALS score (range 8–40)	29.6 ± 5.2				
Cut-off point for DHL classification	Mean score (29.6)				
Digital health literacy level					
Low DHL (<29.6)	192 (45.5)				
High DHL (≥29.6)	230 (54.5)				

Table 3. Proportion of women recognizing selected pregnancy danger signs

Danger sign	Percentage (%)
Vaginal bleeding	91.0
Severe headache	74.5
Blurred vision	68.1
Reduced fetal movement	51.7

maternal mortality.

CONCLUSIONS

This study underscores the significant association between digital health literacy and pregnant women's knowledge of pregnancy danger signs. Strengthening DHL through tailored interventions within antenatal and community health programs may enhance the early recognition of obstetric complications, ultimately reducing preventable maternal morbidity and mortality. Future research employing longitudinal or experimental designs is warranted to confirm these relationships and evaluate the effectiveness of integrating digital literacy modules into maternal health strategies across diverse LMIC settings.

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AUTHORS CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under:
ND: Conceptualization, design, writing and reviewing munuscript
MH: Conceptualization and review
YSW: Manuscript reviewing and editing
FN:Conceptualization, draft and review
TJP: Conceptualization, design and review
LF: Data collection and analysis
YMP:Review, data collection and analysis
OE:Drafting and review
DSS: Drafting and review
AOSR: Drafting and review
Authors agree to be accountable for all respects of the work in ensuring that questions related to the accuracy and integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

None

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