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**Development and Validation of a Self-Care and Need for Help Based Assessment for  
Early Prevention of Pre-Eclampsia Emergencies**

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**ABSTRACT**

**Background:** The rising prevalence of maternal mortality due to non-communicable diseases (NCDs) emphasizes the need for digital symptom-monitoring tools to reduce mortality risks. **Object:** This study assessed pregnant women's perceptions of digital NCD symptom monitoring and its impact on lowering maternal maternity. **Method:** An associative cross-sectional study was conducted among 117 purposively selected pregnant women. The independent variable was digital NCD symptom monitoring, and the dependent variable was maternal mortality risk, represented by pregnancy complications and emergency admissions. Data were collected using a validated 5-point Likert questionnaire measuring usage frequency and perceived effectiveness. All indicators were valid ( $r > 0.361$ ) and reliable (Cronbach's Alpha: 0.923 for NCD perception; 0.975 for digital application). Inclusion criteria included NCD risk factors, gestational age 4–36 weeks, and smartphone literacy; exclusion was severe comorbidities. Data were analyzed using univariate, bivariate, and simple linear regression tests. **Results:** Strong NCD risk perception significantly correlated with app usage ( $\beta = 0.863$ ,  $p < 0.001$ ). Despite 18% reporting technical challenges, 93.2% adopted digital tools. The Adjusted  $R^2 = 0.742$  indicated that NCD perception explained 74.2% of app usage variance. Regression analysis ( $B = 0.889$ ,  $\beta = 0.863$ ,  $p < 0.001$ ,  $t = 18.303$ ) showed that each 1-unit increase in NCD perception raised app usage perception by 0.889 units. **Conclusion:** Pregnant women with higher NCD risk perceptions were significantly more likely to use digital health applications. Despite minor technical barriers, high adoption rates underscore the potential of digital monitoring to improve NCD management and reduce pregnancy complications.

**Keywords:** Digital Health Intervention, Maternal Mortality, Pregnancy Symptom Monitoring

**BACKGROUND**

The persistently high maternal mortality rate from non-communicable diseases (NCDs) in developing countries presents a critical challenge despite advancements in digital health monitoring. In Indonesia, the maternal mortality ratio remains alarmingly high at 189 per 100,000 live births, with preeclampsia (37%) and gestational diabetes (15%) as predominant NCD-related causes (Firoz et al., 2022; Smapurna et al., 2023). This mirrors global trends where NCDs account for 34% of maternal deaths, particularly in

low-resource settings struggling with dual burdens of infectious diseases and NCDs (Firoz et al., 2022). Digital solutions like Indonesia's ANC Digital app and AI-powered tools such as India's Safe Motherhood program have demonstrated significant potential, with some cases showing 25% mortality reduction (Hossain et al., 2019; Mardiyah et al., 2021; L.O'Mahoney et al., 2024). Their implementation faces systemic barriers that disproportionately affect vulnerable populations.

Key challenges in digital NCD monitoring for pregnant women emerge at multiple levels (Sumarsono et al., 2022). Infrastructure limitations remain significant, with only 65% of pregnant women in Java owning smartphones and persistent internet connectivity gaps in rural areas (Sumiaty et al., 2021). At the institutional level, effectiveness is undermined by two critical issues i.e. poor integration with hospital electronic records and inadequate healthcare worker training (Muchlis et al., 2020; Ullah et al., 2020). Notably, just 30% of midwives currently utilize available digital tools (Ranjbar et al., 2021). User-level barriers compound these issues, with low digital literacy and frequent asymptomatic periods leading to inconsistent engagement (Dinakrisma et al., 2022; Nes et al., 2021). Perhaps most critically, current digital tools often fail to account for pregnant women's perceptions and preferences, missing crucial psychological support components that could improve adherence (Holm et al., 2024).

The research landscape reveals significant gaps this study addresses. Recent studies, such as Green et al. (2021) in the US and Lv et al. (2019) in China, demonstrate digital tools' efficacy in improving clinical markers (Green et al., 2021; Qing et al., 2019). They focus solely on intermediate outcomes rather than mortality reduction a critical limitation given NCDs' role in maternal deaths. Additionally, while Patel et al. (2023) explored urban women's tech acceptance in India, no studies systematically examine context-specific adoption barriers in rural Indonesia, where digital literacy and infrastructure constraints differ substantially (Dhingra et al. 2020; Selvaraju et al., 2022). Existing literature also lacks comprehensive cost-effectiveness analyses for scalable implementation, particularly for hybrid (digital + in-person) models (Davison et al., 2024). This study addressed how perceived usefulness and ease of use

influence adoption crucial factors determining whether digital innovations fulfill their life-saving potential where needed most. It evaluated Indonesia's solutions through dual lenses: healthcare system integration and pregnant women's lived experiences. By linking user perceptions to mortality outcomes a novel approach this study provided actionable insights for resource-limited settings.

This research aims to examine pregnant women's perceptions of digital tracking, as their acceptance and engagement are pivotal to the tool's success. By analyzing both technological efficacy and pregnant women's perceptions, this study identified actionable pathways to optimize existing tools. The implications will inform policy recommendations for hybrid care models that combine digital tracking with community health worker support, aligned with national initiatives like Satu Sehat for unified health data management. It could also potentially reduce NCD-related maternal deaths in underserved regions while advancing progress toward universal health coverage for pregnancy-related care.

## **RESEARCH METHODS**

### **Description of Materials or Research Subjects**

The study involved 117 pregnant women purposively selected from two community health centers (Puskesmas Krembangan Selatan and Pucang Sewu) in Surabaya. Inclusion criteria included gestational age between 4–36 weeks, presence of non-communicable disease (NCD) risk factors, and smartphone literacy. Women with severe comorbidities were excluded. Participants' demographic data covered age, education, occupation, residence, and access to digital health tools.

### **Research Design**

This study applied an observational cross-sectional design with an associative

quantitative approach to examine the relationship between digital NCD symptom monitoring (independent variable) and maternal mortality risk indicators (dependent variables), including pregnancy complications and emergency admissions. Mortality risk was operationalized through medical record reviews. The design aimed to assess real-world engagement with digital tools for early symptom detection and management among pregnant women.

### Research Procedure

Data collection was conducted in two stages. First, participants completed face-to-face questionnaires during prenatal visits, guided by trained enumerators to ensure comprehension. Second, researchers reviewed hospital records to extract objective data on pregnancy complications and emergency admissions. The data collection period ran from April to May 2025. Self-reported data were systematically verified with institutional records to improve accuracy and minimize recall bias.

### Instruments and Equipment

Data collection utilized a validated questionnaire assessing both the frequency of digital monitoring tool usage and perceived effectiveness measured on a 5-point Likert scale. The instrument demonstrated strong content validity (CVI = 0.85) through expert review by obstetric and public health specialists, along with high reliability (Cronbach's  $\alpha$  = 0.82) established during pilot testing. The questionnaire items were designed to capture user engagement patterns and subjective evaluations of the digital tool's utility in symptom recognition and healthcare decision-making.

### Data Collection Methods

Data collection combined face-to-face questionnaires during prenatal visits with retrospective medical record reviews from April to May 2025. The interviews

were conducted to ensure proper understanding of questions, while medical records provided objective clinical outcome data. Self-reported information was systematically cross-referenced with institutional records to enhance data accuracy and minimize recall or reporting biases that could affect the study's validity.

### Data Analysis

The data analysis in this study involved several key steps. First, descriptive statistics were used to summarize the demographic characteristics of the respondents, including age, education level, occupation, residential status, and access to digital tools. Next, validity and reliability tests were conducted for the variables "Perception of Non-Communicable Diseases (NCDs) During Pregnancy" and "Pregnant Women's Perception of Digital Application Use" with Cronbach's Alpha values of 0.923 and 0.975, respectively, confirming the reliability of the indicators. A simple linear regression analysis was performed to examine the relationship between these variables, revealing a significant influence ( $t = 18.303$ ,  $p < 0.05$ ) and an Adjusted  $R^2$  of 0.742, indicating that 74.2% of the variance in digital application perception was explained by NCD perception. Assumption tests, including normality (Kolmogorov-Smirnov test,  $p = 0.094$ ) and heteroskedasticity (scatter plot analysis), confirmed the model's suitability. The findings suggest that perceptions of NCDs during pregnancy significantly shape pregnant women's views on digital health applications.

### Research Ethics

This study received ethical approval from the Health Research Ethics Committee of Poltekkes Kemenkes Surabaya in June 2025 (Approval No: .../2025). All participants provided written informed consent after receiving detailed explanations about the study's purpose,

procedures, potential risks, and benefits. The researchers ensured confidentiality by anonymizing personal data and storing information securely in password-protected databases. Participation was voluntary, allowing withdrawal at any stage without consequences to their medical care. The consent forms were explained verbally in the local language (Bahasa Indonesia) by trained research assistants. The study adhered to Helsinki

Declaration principles, prioritizing participant safety and welfare, particularly given the vulnerable status of pregnant women. Medical record access was granted under strict data protection protocols approved by participating Puskesmas (Krempangan Selatan and Pucang Sewu, Surabaya).

## RESULT AND DISCUSSION

### Demographic Data

Table 1.

Karakteristik Demografi Responden Survei (Total: 117)

Category	Subgroup	F	%	Valid %	Cumulative %
Age	21-40 years old	111	94.9	94.9	94.9
	Less than 20 years old	5	4.3	4.3	99.1
	More than 40 years	1	0.9	0.9	100.0
Education	Bachelor/Postgraduate	37	31.6	31.6	31.6
	Elementary school	4	3.4	3.4	35.0
	High school	61	52.1	52.1	87.2
	Junior High School	15	12.8	12.8	100.0
Employment	Civil Servants/Agencies	4	3.4	3.4	3.4
	Private Sector	42	35.9	35.9	39.3
	Unemployed	71	60.7	60.7	100.0
Residential	Migrant	37	31.6	31.6	31.6
	Surabaya Native	80	68.4	68.4	100.0
Health Center	South Krempangan	64	54.7	54.7	54.7
	Surabaya	53	45.3	45.3	100.0
Pregnancy	Holiday rentals in Surabaya	47	40.2	40.2	40.2
	4-6 months	43	36.8	36.8	76.9
	7-9 months	27	23.1	23.1	100.0
	Less than 3 months				

Table 1 displayed that the population primarily consists of young to middle-aged adults (94.9% aged 21-40 years), with most having at least a high school education (52.1%) and a significant portion holding bachelor/postgraduate degrees (31.6%). A striking 60.7% of respondents were unemployed, while 35.9% worked in the private sector and only 3.4% in government/state-owned

roles. The majority (68.4%) were native Surabaya residents, with 31.6% being migrants. Healthcare access appeared balanced, with 54.7% near Krempangan Selatan Health Center and 45.3% near Pucang Sewu. Pregnancy data showed most respondents in mid-to-late stages (40.2% at 4-6 months; 36.8% at 7-9 months), suggesting the sample captures critical prenatal care periods. Overall, the

demographics depict a young, moderately educated population with high unemployment, predominantly local

residency, and equitable health facility distribution.

### Validity and Reability Test

**Table 2.**  
Validity and Reliability Test Results

Variable	Validity Test (r > 0.361)	Reliability (Cronbach's Alpha)	Conclusion
Perception of Non-Communicable Diseases (NCDs) During Pregnancy	All 10 indicators valid	0.923	High reliability
Pregnant Women's Perception of Digital Application Usage in IT Era	All 10 indicators valid	0.975	Excellent reliability

Table 2 displayed that the validity and reliability tests for the two variables Perception of Non-Communicable Diseases (NCDs) During Pregnancy and Pregnant Women's Perception of Digital Application Usage in the Information Technology Era yielded strong results. For the NCD perception variable, all 10 indicators were valid ( $r > 0.361$ , with examples such as Indicator 1 ( $r = 0.635$ ) and Indicator 8 ( $r = 0.905$ ), while the reliability test showed a high Cronbach's

Alpha of 0.923, confirming excellent internal consistency. Similarly, for the digital application perception variable, all indicators were valid (e.g., Indicator 2,  $r = 0.920$ ; Indicator 6,  $r = 0.940$ ), and the reliability was even higher, with a Cronbach's Alpha of 0.975. These results demonstrate that the measurement instruments for both variables were not only valid but also highly reliable, ensuring accurate and consistent assessment of the constructs.

### Relationship Between NCDs, Smartphone Literacy, and Pregnancy

**Table 3**

Relationship Between NCDs, Smartphone Literacy, and Pregnancy

Variable	Result	Frequency (%)	Key Relationship
NCD Perception	Valid Scale (10 indicators)	$\alpha=0,923$	Strong correlation with app use ( $\beta=0,863$ , $p<0,001$ ). Facilitated health app usage. Primary tool for symptom
Smartphone Access	Owned	117 (100%)	
Health App Usage	Used apps for NCD/Pregnancy monitoring	109 (93,2%)	Tracking.
Pregnancy Stage	4-6 months	47 (40,2%)	
Requested App Features	7-9 months	43 (36,8%)	Majority in mid-late pregnancy
		75 (64,1%)	

Variable	Result	Frequency (%)	Key Relationship
	Health information for pregnancy/NCDs		High demand for educational content

Table 3 revealed significant relationships between NCD awareness, smartphone literacy, and pregnancy management. Participants demonstrated strong perception of NCD risks ( $\alpha=0.923$ ), which significantly correlated with health app usage ( $\beta=0.863$ ,  $p<0.001$ ), indicating that women who recognized NCD dangers were more likely to use digital monitoring tools. While all respondents owned smartphones (100%) and 93.2% used health apps, 18% reported technical difficulties, highlighting a gap between access and usability. Most users were in mid-to-late pregnancy stages (77% at 4-9

months), when NCD complications typically arise, and 64.1% specifically requested app features for NCD and pregnancy education. These findings suggest that smartphone-based interventions are widely accessible and potentially effective for NCD management during pregnancy, though usability improvements and targeted educational content could enhance their impact. The lack of clinical NCD data (e.g., hypertension/diabetes rates) remains a limitation in assessing actual health outcomes.

### Coefficient Determination ( $R^2$ ) Result

Table 4.

Coefficient Determination Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.863a	.744	.742	4.239

a. Predictors : (Constan), Perception on NCD pf pregnancy

b. Dependent Variable : Perception pregnant women on the use of application

Table 4 show that the independent variable (Perception of NCDs during pregnancy) explains 74.2% of the variation in the dependent variable (Pregnant Women's Perception of App Usage). The remaining 25.8% is

influenced by other factors outside the research model.  $R = 0.863$  indicates a very strong correlation between the variables. Standard Error of the Estimate (4.239) reflects the model's prediction error level.

### Simple Linear Regression Result

Table 5.

Simple Linear Regression Results

Model	Variable	Unstandardized Coefficients B	Standardized Coefficients (Beta) Std.Error	t-value	Sig. (p-value)
1	(Constant)	5.575	2.015	-	2.768 0,007

Model	Variable	Unstandardized	Standardized	t-value	Sig. (p-value)	
		Coefficients B	Coefficients (Beta) Std.Error			
	Perception of Non-Communicable Diseases (NCDs) During Pregnancy	0.889	0,049 tahun	0.863	18.303	0.000

Table 5 show that Constant (Intercept): When the independent variable (Perception of NCDs During Pregnancy) is zero, the baseline value of the dependent variable is 5.575. The result is statistically significant ( $p = 0.007 < 0.05$ ). Perception of NCDs During Pregnancy (Independent Variable): Regression Coefficient (B) = 0.889 → For every 1-unit increase in perception of NCDs, the perception of app usage increases by 0.889 units. Beta ( $\beta$ ) = 0.863 → Strong positive influence (standardized effect size). Highly significant ( $p = 0.000 < 0.001$ ) → The variable has a statistically significant effect on the dependent variable. t-value = 18.303 → Confirms the strength of the relationship.

### Discussion

The study highlights two primary issues. First, despite high smartphone ownership (100%) and health app usage (93.2%), technical difficulties (reported by 18%) and gaps in usability hinder effective NCD management during pregnancy. This aligns with prior research showing that digital health interventions often fail due to poor user experience, even when access is widespread (Collins et al., 2023). Second, while NCD awareness strongly correlates with health app engagement ( $\beta=0.863$ ,  $p<0.001$ ), the lack of clinical NCD data (e.g., hypertension/diabetes rates) limits the assessment of actual health outcomes. Previous studies emphasize that self-

reported data alone cannot replace clinical metrics in evaluating intervention efficacy (Low et al., 2021).

The high unemployment rate (60.7%) and reliance on private-sector jobs (35.9%) may exacerbate socioeconomic barriers to consistent healthcare access, as noted in low-income populations (Ahmadi et al., 2021). However, the equitable distribution of health facilities (54.7% vs. 45.3%) and strong NCD risk perception ( $\alpha=0.923$ ) present opportunities for targeted app-based education, addressing the demand expressed by 64.1% of respondents. Earlier research supports tailoring digital tools to late-pregnancy stages (4–9 months), when NCD complications peak (Devi et al., 2020).

To address the identified issues, a multi-faceted approach is needed. First, improving app usability through user-centered design and technical support can reduce difficulties, as poor interface design is a known barrier to digital health adoption (Nasution et al., 2018). Second, integrating clinical NCD data (e.g., blood pressure, glucose levels) into apps would enhance outcome tracking, aligning with evidence that combining self-reported and biometric data improves intervention accuracy (Mohammad et al., 2020). Given the high unemployment rate (60.7%), partnerships with local health centers could subsidize smartphone-based prenatal care for low-income women, a strategy proven effective in similar

settings (Butcher & Hussain et al., 2022). Additionally, targeted educational content on NCDs and pregnancy, requested by 64.1% of respondents, should be prioritized, as late pregnancy stages (4–9 months) are critical for complication management (Reilly et al., 2019). Finally, community-based training on app usage could bridge the literacy gap, leveraging the population's high smartphone ownership (100%) and strong NCD awareness ( $\alpha=0.923$ ). These steps, supported by policy initiatives to expand digital health infrastructure, would maximize the potential of digital interventions in maternal care.

This study has several key limitations. The lack of clinical NCD data (e.g., blood pressure or glucose levels) made it difficult to assess the actual health impact of the app-based intervention, echoing consistent emphasized that self-reported data alone cannot fully evaluate digital health efficacy. Although all respondents own smartphones (100%), 18% reported technical difficulties, highlighting persistent usability issues in digital health interventions. Additionally, the homogeneous sample (pregnant women aged 21–40 years old and urban Surabaya residents) limits generalizability to rural or lower-income settings. These constraints suggest caution in applying the results to broader populations without further validation.

## CONCLUSION

This study successfully assessed pregnant women's perceptions of digital non-communicable disease (NCD) symptom monitoring and its potential impact on reducing maternal mortality in Surabaya. The findings confirmed a significant and positive correlation between a pregnant woman's perception of NCD risks and her likelihood of using digital health applications. Specifically, strong NCD awareness ( $\alpha=0.923$ ) significantly correlated with health app usage, as indicated by the regression

analysis ( $\beta=0.863$ ,  $p<0.001$ ). The high adoption rate observed, with 100% of participants owning smartphones and 93.2% utilizing health apps for monitoring, underscores the substantial potential of integrating digital tools into high-risk pregnancy care. These results affirm the acceptability of technology-driven monitoring as a crucial strategy to improve NCD management and potentially reduce pregnancy complications within urban settings. The evidence suggests that leveraging existing high smartphone access and targeting women's inherent NCD awareness provides an actionable pathway for developing scalable, technology-enhanced health strategies.

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