



User Comfort with the F-KICO (Fetal Kick Count) Tool and Its Correlation with Maternal Fetal Attachment: A Cross-Sectional Study

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ABSTRACT

Background: Monitoring fetal movements is a crucial aspect of prenatal care to ensure fetal health and aids in achieving SDG 3: Good Health and Well-Being by enhancing maternal and fetal health. The F-KICO (Fetal Kick Count) model has been developed and validated through expert review; therefore, a study was conducted to evaluate user comfort and its relationship with maternal fetal attachment (MFA). This study aimed to examine the relationship between user comfort in using F-KICO and MFA.

Method: A study with a cross-sectional design was performed involving 100 pregnant women recruited from four primary health centers in Bantul, Indonesia (Kasihani I, Kasihani II, Bantul II, and Sedayu II). User comfort was measured using the Fetal Movement Monitoring User Comfort Scale (FMM-UCS), while MFA was assessed using an adapted Prenatal Attachment Inventory (PAI). Data were examined employing descriptive statistics, the Kolmogorov-Smirnov normality test, and Pearson correlation analysis.

Result: Most participants reported good comfort in using the F-KICO tool and demonstrated good MFA. Pearson correlation analysis showed a significant positive relationship between user comfort and MFA ($r = 0.462, p < 0.01$), indicating that higher comfort in using the monitoring tool was associated with stronger emotional bonding between mother and fetus.

Conclusion: The F-KICO model demonstrated good user comfort and a significant positive relationship with MFA. These findings suggest that user-centered fetal movement monitoring tools can support maternal engagement and strengthen the MFA. F-KICO shows potential for further development and evaluation in larger studies.

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INTRODUCTION

Monitoring fetal well-being is a crucial strategy for preventing pregnancy complications and reducing perinatal mortality. Fetal movement is considered one of the most sensitive indicators of fetal condition, reflecting neurological activity and physiological well-being in utero (Camacho et al., 2022; Heazell et al., 2018). Decreased fetal movement is commonly acknowledged as a preliminary indicator of potential complications during pregnancy, including placental insufficiency, restricted fetal growth, and stillbirth (O'Sullivan et al., 2025). Fetal movement monitoring is also an important component of antenatal care to support fetal well-being and contributes to achieving SDG 3: Good Health and Well-Being through improved maternal and fetal health. Globally, approximately 1.9 million stillbirths occur each year, with many cases preceded by maternal reports of decreased fetal movement before clinical diagnosis is established (WHO, 2023). These findings emphasize the importance of maternal participation in monitoring fetal movement as a strategy for early detection of fetal compromise (Huang et al., 2025).

In addition to its clinical significance, fetal movement plays an important role in fostering maternal–fetal attachment (MFA), which refers to the emotional connection that develops between a pregnant woman and her unborn child throughout gestation (Wu et al., 2024; Purwati et al., 2024). Strong MFA has been associated with positive maternal health behaviors, including adherence to antenatal care, engagement in healthy pregnancy practices, and readiness for the maternal role (Damri et al., 2024; Mahmoudi et al., 2021, Purwati et al., 2024). Awareness of fetal activity may strengthen this emotional relationship because mothers often perceive fetal movements as an early form of interaction or communication with the fetus (Huang et al., 2025). However, conventional fetal movement counting methods remain limited by recording approaches that are often impractical and uncomfortable to use during daily activities (Purwati, et. al., 2025; Komariah & Wahyuni, 2023).

In line with global efforts to reduce maternal and neonatal mortality through the Sustainable Development Goals (SDGs), innovations in maternal health technologies that promote active maternal engagement are increasingly needed (WHO, 2023). Although several fetal movement monitoring tools have been developed, most primarily focus on clinical monitoring accuracy and rarely consider user experience and user comfort as key determinants of technology acceptance among pregnant women (Heazell et al., 2018; Demirkan et al., 2020; Yudianti et al., 2022; Jagadeeswari & Prasanth, 2020). A needs assessment indicated that pregnant women require monitoring tools that not only facilitate fetal movement recording but also enhance maternal awareness and interaction with the fetus (Purwati, Wahyuntari, et al., 2023). Based on this need, the F-KICO tool was developed as a simple device to assist pregnant women in monitoring fetal movements while encouraging active maternal engagement that may stimulate MFA.

However, evidence regarding the relationship between user comfort in fetal movement monitoring devices and MFA remains limited, as previous studies have mainly focused on detection accuracy and clinical effectiveness rather than user experience and emotional engagement during pregnancy. Previous research developed and validated the F-KICO model through expert review, but further refinement is still needed, particularly in improving sensor sensitivity, belt comfort, and responsiveness in detecting fetal (Heazell et al., 2018; Huang et al. 2025; Spicher et al., 2025). Therefore, this study aimed to evaluate user comfort in counting fetal movements using the F-KICO device and to investigate its relationship with MFA, employing a cross-sectional design. This study highlights the novelty of integrating fetal movement monitoring technology with MFA as an important psychological aspect of pregnancy. The findings are expected to provide preliminary evidence supporting the development of F-KICO as an effective, user-friendly, and maternally engaging fetal movement monitoring innovation.

METHOD

Study Design

This pilot study utilized a cross-sectional design to investigate the association between user comfort in operating the F-KICO tool and MFA among pregnant women (Lama-valdivia & López, 2021). Data collection was conducted between July 10 and October 2, 2025. The cross-sectional approach was selected to evaluate the usability and comfort of the F-KICO model among pregnant women and to provide preliminary evidence regarding the relationship between user comfort and MFA before the implementation of a larger-scale study.

Population and Sample

The intended group comprised pregnant women receiving antenatal care at community health centers in Bantul District, Yogyakarta, Indonesia. Participants were selected through purposive sampling with proportional distribution among the involved health centers. Purposive sampling was employed to ensure that participants met the specific criteria necessary for assessing the F-KICO device and MFA. In this study, 100 pregnant women participated, with 25 participants recruited from each of the five health centers. The eligibility requirements included pregnant women with a gestational age ranging from 20 to 36 weeks, consent to use the F-KICO fetal movement monitoring device, and the capability to provide written informed consent. The exclusion criterion involved the existence of high-risk pregnancy conditions that might affect fetal movement patterns or the psychological responses of the mother. A total sample of 100 participants was considered sufficient to examine the relationship between user comfort and MFA in this cross-sectional study (Totton et al., 2023).

Research Location

The study was carried out in the jurisdiction of the Bantul District Health Office, Yogyakarta, Indonesia. Data collection was carried out at four community health centers providing antenatal care services: Kasihan I Community Health Center; Kasihan II Community Health Center; Bantul II Community Health Center; and Sedayu II Community Health Center. These facilities were selected to represent pregnant women receiving routine antenatal care within the Bantul district.

Instrumentation or Tools

F-KICO Fetal Movement Monitoring Device

The F-KICO device is a fetal movement monitoring tool designed to help pregnant women record fetal movements in a practical and structured manner, thereby supporting maternal engagement in monitoring fetal well-being during daily activities. Before its use in this study, the device underwent expert validation by specialists in obstetrics and gynecology and electromedical engineering, resulting in a feasibility score of 3.55, indicating that the device was suitable for functional testing among pregnant women. Several expert recommendations related to physical comfort and display clarity were incorporated before field implementation.

Fetal Movement Monitoring User Comfort Scale (FMM-UCS)

User comfort in using the F-KICO device was assessed using the Fetal Movement Monitoring User Comfort Scale (FMM-UCS), developed based on usability and user experience concepts in healthcare technologies, including ease of use, physical comfort, functional clarity, safety, and user satisfaction (Choi, 2024). User comfort with the F-KICO device was assessed using a 20-item questionnaire rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The total score ranged from 20 to 100 and was classified into three categories: low comfort (20–46), moderate comfort (47–73), and high comfort (74–100) (Beck, 2019). Validity

testing involving 15 respondents showed item correlation coefficients ranging from 0.47 to 0.82, exceeding the *r*-table value of 0.514 ($\alpha = 0.05$). Reliability testing using Cronbach's alpha yielded 0.91, indicating excellent internal consistency (Kazanskaia, 2025; Sugiarta et al., 2023).

Prenatal Attachment Inventory (PAI)

Maternal-fetal attachment (MFA) was evaluated using the Prenatal Attachment Inventory (PAI), originally developed by Muller and subsequently culturally adapted for Indonesian pregnant women. The instrument comprises 21 items rated on a four-point Likert scale from 1 (rarely) to 4 (almost always). Total scores ranged from 21 to 84 and were categorized as low attachment (21–42), moderate attachment (43–63), and high attachment (64–84) (Suryaningsih et al., 2021).

Data Collection Procedures

Data collection was conducted during routine antenatal care visits at the participating community health centers. Eligible pregnant women received a detailed explanation of the study objectives and procedures before participation and subsequently provided written informed consent. Participants were then introduced to the F-KICO and instructed on its use. After using the device, participants completed the FMM-UCS to assess user comfort and the PAI to measure MFA. All completed questionnaires were checked for completeness before being entered into the dataset for statistical analysis.

Data Analysis

Data analysis was performed using both descriptive and inferential statistical methods. Descriptive statistics were used to summarize participants' demographic characteristics, levels of user comfort, and MFA scores. Data normality was examined using the Kolmogorov-Smirnov test. The association between user comfort with the F-KICO device and MFA was analyzed using Pearson's correlation test for normally distributed data or Spearman's rank correlation test when the normality assumption was not met. Statistical significance was established at $p < 0.05$ (Bocianowski et al., 2024).

Ethical Approval

Ethical clearance for this study was granted by the Health Research Ethics Committee of STIKES Guna Bangsa Indonesia under approval number 060/KEPK/VII/2025. This study also obtained research permission from the Bantul District Health Office, Yogyakarta, Indonesia, number B/500.6.18/02776.

The research procedure is illustrated in Figure 1

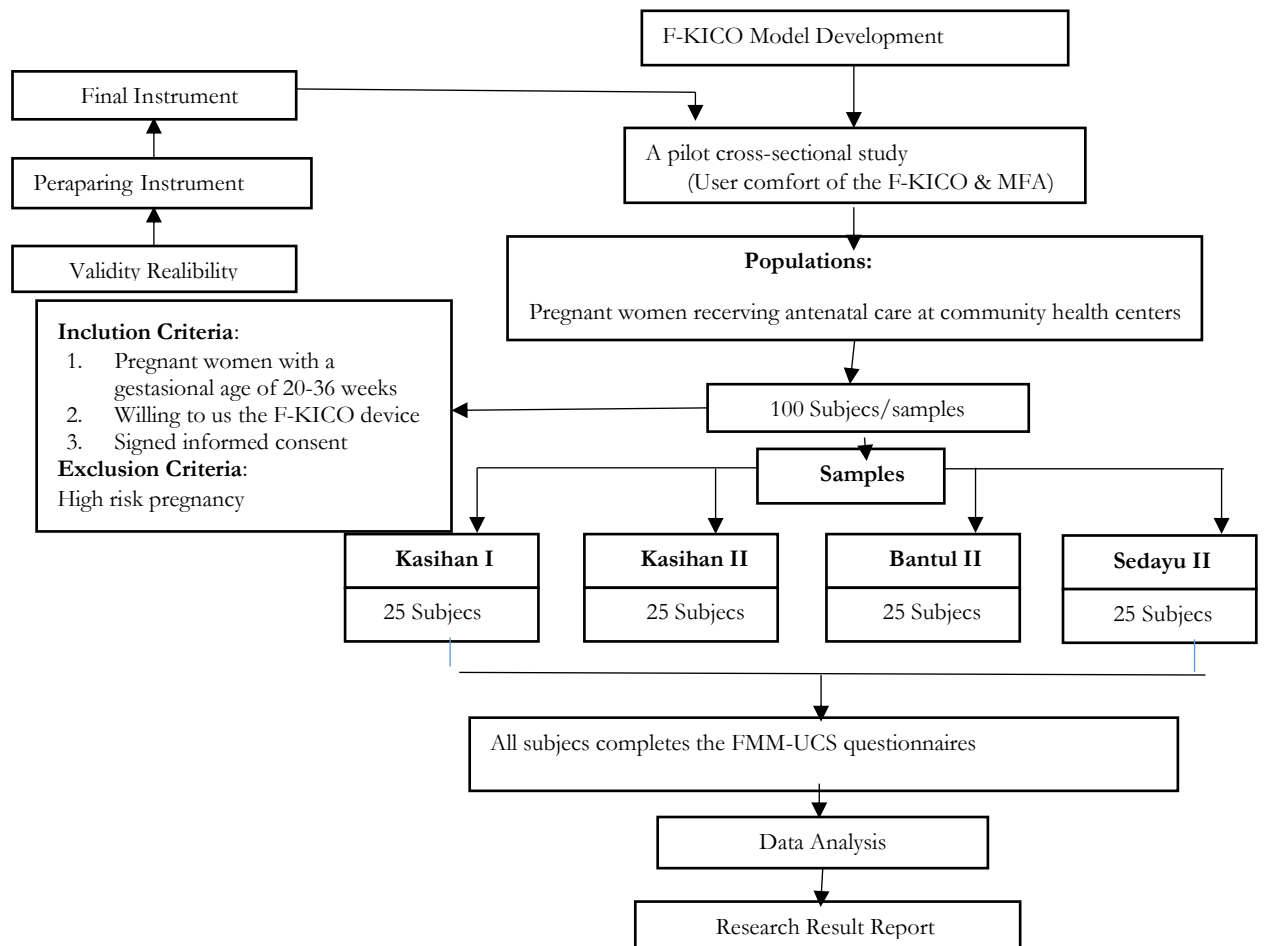


Figure 1. Research Flow

RESULTS AND DISCUSSION

Results

The demographic characteristics of the participants are presented in Table 1.

Table 1. Frequency Distribution of Participant Characteristics

Characteristics	Category	n	%
Maternal age (years)	20-25	32	32
	26-30	36	36
	31-36	32	32
Total		100	100
Gestational age (weeks)	20-24	28	28
	25-30	38	37
	31-36	34	34
Total		100	100
Gravidity status	Gravida I	54	54
	Gravida II	30	30
	Gravida III	16	16
Total		100	100
Maternal occupation	Homemaker	42	42
	Private sector employee	34	34
	Civil servant	24	24
Total		100	100

Table 1. The majority of respondents were aged 26–30 years (36%). Regarding gestational age, most participants were between 25 and 30 weeks of pregnancy (38%). More than half of the respondents were primigravida (54%), and the largest proportion were homemakers (42%).

Table 2. Frequency Distribution of MFA among Pregnant Women

MFA Levels	Score	n	%	Mean	SD	Kolmogorov Smirnov Z	Sig. (p)
Low	21-42	3	3	70,84	7,12	0,087	0,2
Moderate	43-63	28	28				
High	64-84	69	69				
Total		100	100				

As shown in Table 2, most pregnant women exhibited high levels of MFA (69%), reflecting a strong emotional connection with their unborn child. The Kolmogorov–Smirnov normality test yielded a p-value of 0.200 ($p > 0.05$), indicating that the MFA scores were normally distributed.

Table 3. Frequency Distribution of User Comfort with the F-KICO Device

Comfort levels	Score	n	%	Mean	SD	Kolmogorov Smirnov Z	Sig.(p)
Low comfort	20-46	6	6	83,21	6,45	0,094	0,2
Comfort	47-73	32	32				
High comfort	74-100	62	62				
Total		100	100				

Table 3 demonstrates that most respondents reported a high degree of comfort while using the F-KICO device (62%), suggesting favorable user acceptance of this fetal movement monitoring technology. The Kolmogorov-Smirnov test also confirmed the normal distribution of comfort scores ($p = 0.200$; $p > 0.05$).

Table 4. F-KICO User Comfort and MFA

User comfort level in using F-KICO	MFA Level						Total	
	High MFA		Moderate MFA		Low MFA		n	%
	n	%	n	%	n	%		
High Comfort	55	55	7	7	0	0	62	62
Comfort	14	14	18	18	0	0	32	32
Low Comfort	0	0	4	4	2	2	6	6
Total	69	69	29	29	2	2	100	100

The cross-tabulation in Table 4 shows that the majority of pregnant women who reported being very comfortable using the F-KICO device also had a high level of MFA, accounting for 55 respondents (55%). Respondents with lower levels of comfort tended to have lower levels of attachment, with 2 respondent (2%) in this category. This distribution pattern indicates a tendency toward a positive relationship between the comfort of using the fetal movement monitoring device and increased MFA.

Table 5. Pearson Correlation Analysis between F-KICO User Comfort and MFA

Variables	Mean \pm SD	r (Pearson)	p-value
User Comfort Level using F-KICO	84.21 \pm 6.34	0.462	0.001
MFA	71.56 \pm 7.12		

The relationship between user comfort and MFA was examined using Pearson's correlation analysis, as presented in Table 5. The results revealed a statistically significant positive correlation between the two variables ($r = 0.462$, $p = 0.001$). This moderate positive association suggests that greater comfort in using the F-KICO device is related to stronger maternal-fetal attachment.

Discussion

The present study found that the majority of pregnant women experienced high levels of comfort when using the F-KICO fetal movement monitoring device, while most participants also demonstrated high MFA scores. These findings support the notion that maternal sensory awareness of fetal activity contributes substantially to the development of the emotional bond between mother and fetus (Loss et al., 2022). Fetal movement is not only an indicator of fetal well-being but also represents an early form of interaction between the mother and the fetus (Jain & Acharya, 2022). When mothers can feel, understand, and monitor fetal movements, their awareness of the fetus as a living individual increases, thereby strengthening prenatal emotional attachment (Tsakiridis et al., 2022).

The results also show that the comfort level of using the F-KICO device was predominantly categorized as high. Comfort in the use of medical devices is an important factor influencing the acceptance of health technology by users (Stuart et al., 2024). According to the Technology Acceptance Model (TAM), technologies perceived as easy and comfortable to use are more likely to be accepted and utilized consistently by users over time (Shoon et al., 2023). In the context of maternal health services, monitoring devices that are easy and comfortable to use can enhance maternal involvement in fetal health monitoring and increase awareness of changes in fetal condition during pregnancy (Peng et al., 2020). Therefore, the F-KICO innovation has the potential to increase maternal participation in independent monitoring of pregnancy health.

The observed positive association between F-KICO user comfort and MFA ($r = 0.462$, $p < 0.01$) further suggests that enhanced user comfort may facilitate stronger emotional attachment to the fetus. This finding aligns with previous research indicating that increased maternal attention to fetal movements can promote the development of MFA (Nemoto et al., 2026; Ayala et al., 2025). Monitoring fetal movements allows mothers to actively observe the baby's activity in the

womb, thereby strengthening the mother's perception of an interpersonal relationship with the fetus (Nemoto et al., 2026).

The association between fetal movement monitoring and MFA may be understood through the concept of prenatal interaction. Fetal movements serve as one of the earliest forms of communication between the fetus and the mother, stimulating emotional responses and fostering maternal awareness of the developing child (Einspieler, 2021). Mothers who actively monitor fetal movements tend to become more aware of fetal activity, which can strengthen prenatal emotional attachment (Quintero et al., 2020). Previous evidence has demonstrated that prenatal interventions encouraging maternal awareness and monitoring of fetal movements can strengthen maternal-fetal attachment and improve psychological well-being during pregnancy (Einspieler, 2021).

The increase in MFA can also be explained through the maternal role attainment theory, which suggests that maternal involvement during pregnancy helps women adapt to their new role as mothers. Activities such as counting fetal movements, talking to the fetus, or responding to fetal activity in the womb represent forms of maternal engagement in the baby's development prior to birth (Quintero et al., 2020). Therefore, the use of the F-KICO device, which is comfortable and easy to use, may facilitate the psychological adaptation process of mothers to their emerging maternal role.

The results of this study also indicate that respondent characteristics such as maternal age, gestational age, and gravidity status showed relatively weak associations with both the comfort level of device use and the level of MFA. These findings suggest that psychological factors and mothers' subjective experiences during pregnancy may have a greater influence on MFA than demographic factors (Abasi et al., 2021; AlAmri & Smith, 2022). Previous studies have also demonstrated that social support, readiness for motherhood, and positive perceptions of pregnancy are stronger predictors of MFA compared with demographic characteristics (Abasi et al., 2022; Purwati, Pramono, et al., 2023).

This study integrates fetal movement monitoring with psychological aspects, indicating that fetal movement monitoring devices may contribute to enhancing maternal emotional engagement with the fetus. Previous studies have primarily focused on fetal movement monitoring as a clinical indicator of fetal health (Senopati, 2023). These findings suggest that the F-KICO innovation may provide dual benefits, functioning both as a tool for monitoring fetal well-being and as a means of stimulating maternal-fetal interaction.

The clinical implications, the findings suggest that the F-KICO device has the potential to serve as an innovative tool for enhancing antenatal care services. The results are consistent with recommendations from the World Health Organization (WHO), which emphasize active maternal engagement in pregnancy monitoring as an important strategy for the early identification of potential pregnancy complications (WHO, 2023). The integration of user-friendly pregnancy monitoring technologies into antenatal care services may help increase maternal participation in maintaining fetal health while simultaneously strengthening the emotional bond between mother and fetus.

Limitations

Several limitations should be acknowledged. It employed a cross-sectional design and was conducted as a pilot study with a relatively small sample size, which limits the ability to establish causal relationships. Future research is recommended to use longitudinal or interventional study designs with larger sample sizes to more comprehensively evaluate the effectiveness of the F-KICO device in improving MFA and fetal well-being.

Recommendations

Future research is recommended to further refine the F-KICO device, particularly in improving sensor sensitivity, belt comfort, and the responsiveness of fetal movement detection. In addition, comparative studies between F-KICO and conventional fetal movement monitoring methods are needed to evaluate its effectiveness and usability. Interventional studies with larger samples and longitudinal designs are also suggested to examine the impact of F-KICO use on maternal–fetal attachment and fetal well-being during pregnancy.

CONCLUSION

This study found that pregnant women generally experienced a high level of comfort when using the F-KICO device, and a significant positive relationship was identified between user comfort and MFA. These findings suggest that fetal movement monitoring with the F-KICO device may support maternal engagement and strengthen emotional bonding with the fetus during pregnancy. Further studies are needed to refine the device and evaluate its effectiveness in larger-scale studies.

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AUTHOR CONTRIBUTION STATEMENT

YP: Conceptualization, methodology, project administration, writing original draft. DNA: Field coordination, data collection, data analysis, writing original draft, translation of the manuscript into English. NRA: Data collection, data processing, report editing, manuscript editing according to the journal template. NAS: Literature review, writing review and editing, particularly for the background and discussion sections.

AI DISCLOSURE STATEMENT

The authors declare that AI assisted technology (Grammarly) was used to support grammar, spelling, and clarity during manuscript preparation. No generative AI tools (ChatGPT or other large language models) were used to generate content. The use of Grammarly did not influence the scientific content, data interpretation, or conclusions of this manuscript.

CONFLICTS OF INTEREST

The authors declare no financial or commercial conflicts of interest and no competing interests with the funders.

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