

Beyond Knowledge: A Dual-Perspective Needs Assessment of Maternal Health Care-Seeking Barriers and mHealth Design Requirements in Sokoto State, Nigeria

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ABSTRACT

Formative assessment is needed to determine whether maternal mobile health (mHealth) applications should prioritise educational information, support for timely care-seeking, or both. Methods: A descriptive needs assessment included 50 pregnant women and 30 midwives in Sokoto State, Nigeria. Structured questionnaires examined maternal-health knowledge, perceived care-seeking barriers, phone access, communication preferences and proposed app features. Responses were summarised using frequencies, percentages, knowledge scores and weighted rankings. Results: Women obtained a mean score of 10.44/12 (87.0%) on prompted knowledge questions; 49/50 (98.0%) identified reduced or absent fetal movement correctly. However, 22/30 midwives (73.3%) selected failure to recognise danger signs as a care-seeking barrier. Husband/family permission was reported by 38/50 women (76.0%) and 24/30 midwives (80.0%). Of the women, 45/50 (90.0%) preferred Hausa-language information and 39/50 (78.0%) preferred audio only. Danger-sign guidance received the highest reported provider-weighted feature score (105). Conclusion: Prompted knowledge responses and midwives' perceptions indicate potentially different dimensions of care-seeking. The findings support testing a Hausa audio-first application that combines practical danger-sign guidance, facility information, discreet communication and optional household-shareable messages. The descriptive design cannot establish which barrier is causal or most important in the wider population.

Keywords: maternal health, mobile health, danger signs, care-seeking, user-centred design

1.0 INTRODUCTION

Maternal mortality remains a substantial global and Nigerian public-health challenge. The most recent United Nations inter-agency estimates reported approximately 260,000 maternal deaths worldwide in 2023, with nearly 70% occurring in sub-Saharan Africa (World Health Organization *et al.*, 2025). These deaths underscore the importance of accessible, timely and effective maternity care and the Sustainable Development Goal target of fewer than 70 maternal deaths per 100,000 live births by 2030 (United Nations, 2015).

Nigeria contributes substantially to the maternal-mortality burden, and access to maternity services varies markedly by region. Olubodun *et al.* (2024), analysing national survey data from 2008, 2013 and 2018, documented substantial regional differences in health-facility delivery and associations with education, household resources and geography. The Nigeria Demographic and Health Survey 2018 likewise reported regional inequalities in access to maternal healthcare, including facility-based delivery (National Population Commission [NPC] & ICF, 2019). Such patterns make local assessment necessary before introducing a digital intervention.

The Three Delays framework distinguishes delays in deciding to seek care, reaching an appropriate facility and receiving adequate care after arrival (Thaddeus & Maine, 1994). These stages provide a useful way to interpret factors such as recognition of danger signs, household decision-making, transport and facility readiness. In

northern Nigeria, Sinai *et al.* (2024) described the importance of men's roles in decisions about healthcare use, including in urgent situations. Digital interventions can support decisions and referrals, but they cannot independently resolve transport, household power relations or health-system shortages.

Mobile health offers a possible communication channel, although access to a phone does not imply sustained engagement or improved clinical outcomes. A Nigerian quasi-experimental study found that mobile reminders and educational messages improved uptake of postnatal care (Olajubu *et al.*, 2020), while a systematic review reported beneficial but heterogeneous effects of mHealth on antenatal-care utilisation in low- and middle-income countries (Mishra *et al.*, 2023). Dasuki and Zamani (2019) highlighted capability-related constraints on women's use of mobile phones. Nigerian examples of digital maternal-health tools include the Community Maternal Danger Score application and a user-centred educational and monitoring application (Bola *et al.*, 2022; Babatunde *et al.*, 2025). These examples justify examining the needs and circumstances of intended users before development.

A key design question is whether additional information alone is sufficient to support prompt care-seeking. Correct answers to knowledge questions, recognition of symptoms in everyday circumstances and the ability to act on that recognition are related but distinct. Patients and maternity-care providers may also emphasise different barriers. A formative assessment that gathers

both perspectives can identify design priorities and contradictions deserving closer investigation; it cannot, by itself, explain why an individual delayed care.

This study reports a formative, dual-perspective needs assessment in Sokoto State, Nigeria. It examines (1) responses to structured maternal-health knowledge questions; (2) barriers reported by pregnant women and perceived by midwives; and (3) requirements for a proposed maternal mHealth application derived from both respondent groups. The analysis is descriptive, and findings refer to the assessed participants rather than to all pregnant women or providers in the state.

2.0 MATERIALS AND METHODS

2.1 Study Design

A descriptive, cross-sectional assessment formed part of the needs-analysis phase of the proposed user-centred mHealth development process (Göttgens & Oertelt-Prigione, 2021). Separate structured questionnaires were used with pregnant women and midwives. The comparison is descriptive: the instruments elicited prompted knowledge responses from women and perceptions of commonly missed or ignored danger signs from midwives, rather than measuring the same behaviour in matched participants.

2.2 Study Setting

The study was conducted at Specialist Hospital Sokoto and Usmanu Danfodiyo University Teaching Hospital, Sokoto, in north-western Nigeria. These facilities provide antenatal and maternity services. Both facilities contributed women and midwives to the assessment.

2.3 Participants and Sampling

The assessment enrolled 80 participants: 50 pregnant women and 30 midwives. Recruitment and analysis were designed to elicit locally relevant application requirements rather than to estimate population-level prevalence.

Pregnant women were eligible if they were aged 18 years or older, were pregnant and attended an antenatal clinic at either participating facility. The study employed consecutive recruitment of eligible, consenting women on clinic days until the target sample of 50 was achieved. This sampling approach necessarily excluded women who did not attend either clinic.

Thirty midwives providing antenatal, maternity or postnatal services were purposively recruited to obtain clinically informed assessments of care-seeking barriers and proposed application functions. Recruitment sought a range of professional experience. The formative sample sizes were pragmatic; the study was not powered for statistical comparisons or population-level estimates.

2.4 Instruments

The pregnant-women questionnaire recorded age, education, previous pregnancies, timing of first antenatal-care (ANC) attendance, phone ownership and

type, ability to read a short Hausa message, primary language, preferred communication language and format, care-seeking barriers, and privacy-related concerns. Twelve maternal-health items were scored as correct (1) or incorrect (0), with three items in each of four analytical groupings: danger signs in pregnancy (Q1–Q3); postpartum danger signs and recommended pregnancy check-ups (Q4–Q6); nutrition and supplementation (Q7–Q9); and practices during pregnancy (Q10–Q12). The recommended-check-ups item was not used as a direct measure of knowledge about first-trimester ANC initiation.

The midwives' questionnaire recorded cadre, professional experience, smartphone access and work-related phone use; perceived barriers to care; danger signs believed to be commonly missed or ignored; ranked preferences for six proposed application features; provider question-and-answer (Q&A) feasibility; priority health-information topics; cultural considerations; and perceived trust factors. Both instruments included household permission as a barrier and asked about related maternal danger signs, but these questions assessed different respondent perspectives. The team's questionnaire documentation describes review for face validity by two maternal-health practitioners; formal psychometric validation was not undertaken.

2.5 Data Collection

Data collection took place from June to August 2026 at the two participating hospitals. As described in the study procedures, two trained Hausa-speaking research assistants interviewer-administered the questionnaires; Hausa translation and back-translation were used to support consistency with the source instrument. Responses were recorded on paper and subsequently entered into a spreadsheet for descriptive analysis. Interviews were conducted during antenatal or maternity-service visits, with arrangements intended to preserve privacy and minimise disruption to care.

2.6 Data Analysis

Data were analysed descriptively. Counts and percentages used the respective sample denominators of 50 pregnant women and 30 midwives. The twelve dichotomously scored knowledge-item totals were used to calculate item-level proportions, four three-item mean scores and the overall mean score out of 12. On the basis of the reported item frequencies, the 12 items yielded 522 correct responses among the 50 participants, equivalent to an overall mean of 10.44/12 (87.0%). Multiple-response items were summarised separately, so their percentages need not sum to 100%. The available tabulations did not include respondent-level cross-classifications; no individual-level associations or inferential tests were calculated.

Six proposed application features were ranked using the specified weighted scale: first = 5 points, second = 4, third = 3, fourth = 2, fifth = 1 and sixth = 0. The maximum possible score for any one feature is 150 points

(30 midwives $\times$ 5). The six recorded feature totals add to 421 points, compared with 450 points for 30 fully completed six-position rankings. The tabulated scores were retained as confirmed aggregate results, but the aggregate report does not establish how the difference arose; the rank-completion pattern cannot be inferred. Consequently, the scores are interpreted as an ordering of reported preferences rather than evidence that all respondents provided complete rankings. Written responses were available only as coded aggregate themes, without verifiable respondent-level quotations. The two groups' results were compared descriptively and were not treated as matched observations. The women's knowledge-item responses and the midwives' perceptions of signs being overlooked are different measures; they must not be directly subtracted, interpreted as individual-level discordance or used to infer a causal association. Similarly, data from a single respondent group were not used to estimate the prevalence of barriers in the other group.

2.7 Ethical Considerations

Approval for the survey was granted by the Sokoto State Health Research Ethics Committee and communicated

by the Sokoto State Ministry of Health on 20 May 2026 (ethical-clearance protocol SKHREC/073/2026; ministry correspondence reference SMH/1580/V.IV). The study documentation reports administrative permission from the participating facilities, voluntary participation and verbal informed consent before questionnaire administration. The analysis used de-identified aggregate responses. The approval letter requested that the completed survey results be forwarded to the committee for documentation and further action.

3.0 RESULTS

3.1 Participant Characteristics

The assessed women were predominantly 25–34 years old (31/50, 62.0%), and 40/50 (80.0%) reported secondary education. Among women, 48/50 (96.0%) owned a phone, 44/50 (88.0%) used a smartphone and 47/50 (94.0%) identified Hausa as their primary language. All 30 healthcare providers were midwives; 23 (76.7%) reported at least six years of professional experience. Forty-eight women (96.0%) reported first attending ANC after 12 weeks. The high technology-access figures describe this facility-based sample, not women in the wider community.

Table 1: Characteristics of pregnant women (n = 50) and midwives (n = 30)

Group	Characteristic	n	%	Note
Pregnant women	Aged 18–24	14	28.0	—
—	Aged 25–34	31	62.0	Modal band
—	Aged 35–45	5	10.0	—
—	No formal education	1	2.0	—
—	Primary education	5	10.0	—
—	Secondary education	40	80.0	Modal level
—	Tertiary education	4	8.0	—
—	Owns a phone	48	96.0	—
—	Uses a smartphone	44	88.0	—
—	Hausa as primary language	47	94.0	—
—	Fulfulde as primary language	1	2.0	See Section 4.7
—	Can read a short Hausa message	44	88.0	—
—	Three or more previous pregnancies	26	52.0	—
—	First ANC attendance after 12 weeks	48	96.0	See Section 4.2
Healthcare providers	Midwife	30	100.0	Entire sample
—	0–5 years' experience	7	23.3	—
—	6–10 years' experience	14	46.7	—
—	11 or more years' experience	9	30.0	—
—	Owns a smartphone	29	96.7	—
—	Regular work-related phone use	25	83.3	—

Description: Percentages use denominators of 50 pregnant women and 30 healthcare providers. ANC = antenatal care.

3.2 Maternal Health Knowledge

Women recorded a mean maternal health knowledge score of 10.44 out of 12, equivalent to 87.0% of the maximum. Item-level correct-response

rates are given in Figure 1. Performance was highest on the obstetric danger-sign grouping (Q1–Q3, mean 2.76 of 3, 92.0%) and declined across the postpartum and antenatal-schedule grouping (Q4–Q6, 2.74, 91.3%), nutrition and supplementation

(Q7–Q9, 2.50, 83.3%) and safe practices (Q10–Q12, 2.44, 81.3%). At item level, the strongest result was recognition of reduced or absent fetal movement, answered correctly by 49 of 50 women (98.0%), followed by heavy bleeding after birth at 48 of 50 (96.0%). The weakest items were heavy lifting during pregnancy at 37 of 50 (74.0%) and the purpose of iron tablets at 39 of 50 (78.0%).

All 12 prompted knowledge items had correct-response rates of at least 74%. The sum of the

reported item totals reproduces the overall score (522 correct item responses ÷ 50 participants = 10.44 correct responses per woman on average). These results indicate generally strong responses on this particular checklist, not necessarily unprompted recognition of symptoms or correct decisions during an actual emergency. The aggregate summary does not allow the distribution of individual women's scores to be described.

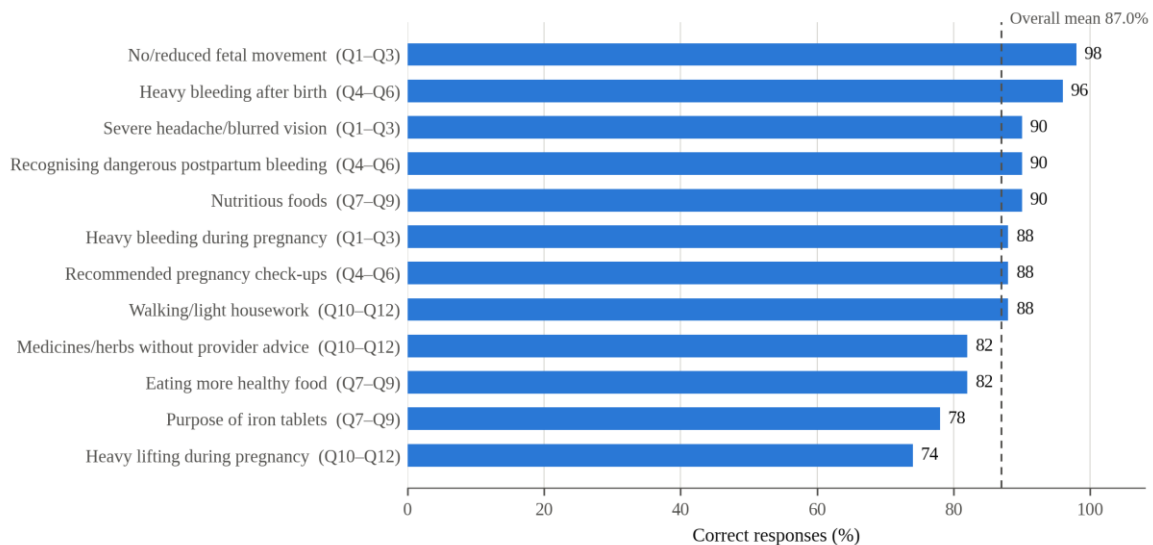


Figure 1: Correct-response rates for the 12 maternal-health knowledge items (n = 50)

Description: Bars show the percentage of women answering each item correctly, ordered from highest to lowest. The dashed line marks the overall mean of 87.0%. Analytical grouping is given in parentheses after each item.

3.3 Comparing Women's Knowledge Responses With Midwives' Perceptions

Midwives were separately asked which maternal danger signs they considered commonly missed or ignored in practice. The two groups were not matched, and their responses measure different constructs. For example, 49/50 women (98.0%) correctly answered the question about reduced or absent fetal movement, while 12/30 midwives (40.0%) selected the sign as commonly missed or ignored. For heavy bleeding during pregnancy the

corresponding figures were 44/50 (88.0%) and 18/30 (60.0%); for severe headache or blurred vision, 45/50 (90.0%) and 16/30 (53.3%). For dangerous postpartum bleeding, 45/50 women (90.0%) answered the relevant recognition item correctly and 20/30 midwives (66.7%) identified the sign as missed or ignored (Figure 2). These percentages must not be read as individual-level discrepancies or directly comparable rates of recognition. In addition, 22/30 midwives (73.3%) identified failure to recognise danger signs as a barrier to timely care, while 17/30 (56.7%) identified inadequate information or awareness. The contrast with women's prompted responses raises a useful hypothesis about knowledge and action; it does not establish that women who answered correctly had ignored symptoms.

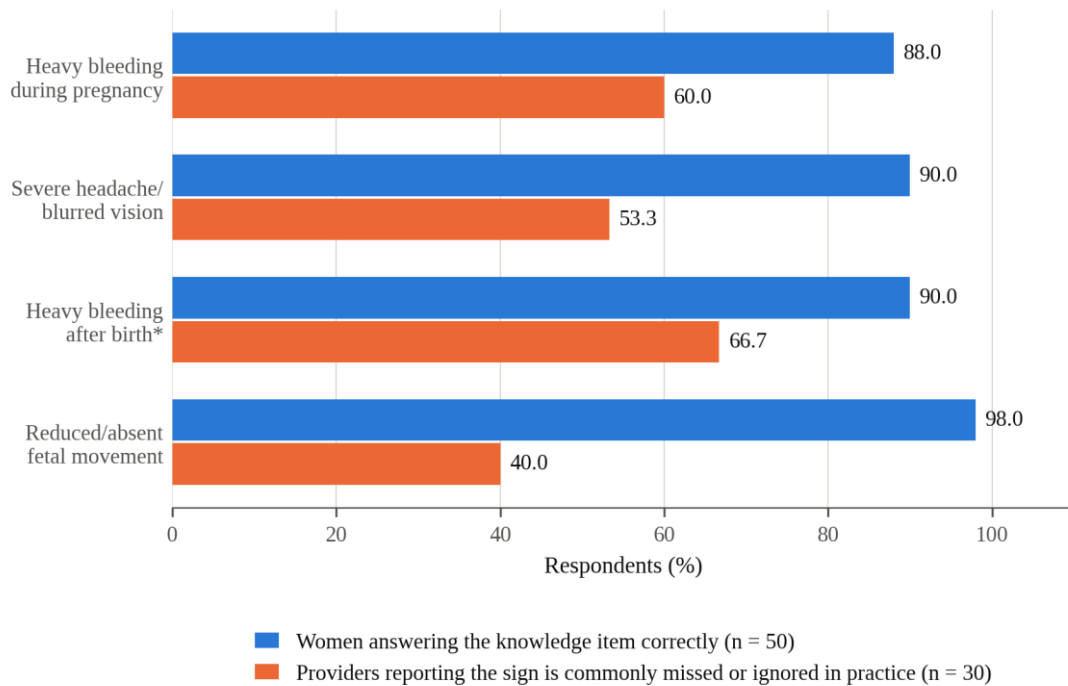


Figure 2: Women's correct responses and midwives' perceptions of commonly missed danger signs

Description: Blue bars show the percentage of women (n = 50) answering the corresponding knowledge item correctly. Orange bars show the percentage of providers (n = 30) reporting that the sign is commonly missed or ignored by women presenting for care. The two bars measure different constructs and are placed together to show divergence, not to be subtracted from one another. *The women's value for this sign is taken from the knowledge item on recognising dangerous postpartum bleeding.

midwives (80.0%): this was the only barrier category recorded in both groups using comparable wording. Lack of money was recorded among 12/50 women (24.0%). The percentages describe response frequencies rather than population prevalences.

Midwives also selected failure to recognise danger signs (73.3%) and inadequate awareness (56.7%) as perceived first-delay barriers, transport or difficulty reaching a facility (60.0%) as a second-delay barrier and staffing or medicine availability (26.7%) as a potential third-delay barrier. These categories were analytically mapped to delays; their frequencies should not be compared as though all respondents had been asked the same questions.

3.4 Reported Barriers Organised by Delay Stage

Figure 3 organises the reported barriers using the Three Delays framework. Husband or family permission was reported by 38/50 women (76.0%) and selected by 24/30

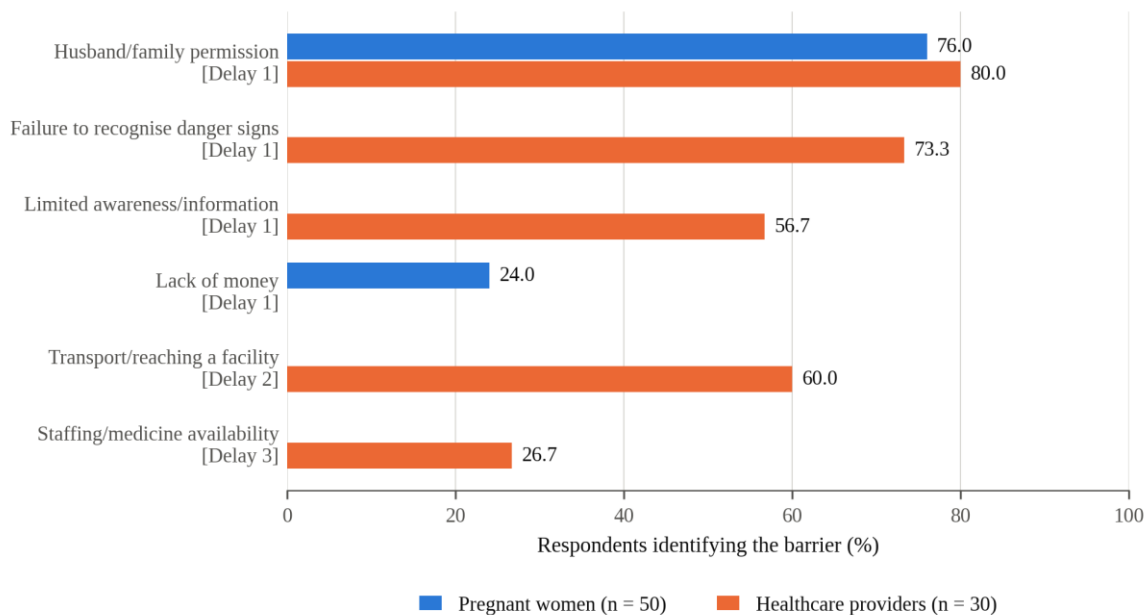


Figure 3: Reported barriers to timely care by respondent group and stage of delay

Description: Percentages use denominators of 50 pregnant women and 30 healthcare providers. An absent bar means that the barrier was not elicited from that respondent group, not that it was elicited and not reported.

3.5 Language, Format, Privacy and Cultural Considerations

Among women, 45/50 (90.0%) selected Hausa as their preferred language for health information; 39/50 (78.0%) selected audio-only messages and the remaining 11/50 (22.0%) selected audio combined with pictures. The aggregate analysis recorded privacy/confidentiality under the adoption-concern item for 50/50 women (100.0%). This is an item-level reported frequency and

should not be interpreted as evidence that all women independently raised privacy without prompting.

Providers converged on the same priorities from a different direction. Asked which factors would build trust in the application, 25 of 30 (83.3%) selected keeping health information private from others, 20 (66.7%) selected content in Hausa, Fulfulde or another local language, and 16 (53.3%) selected audio messages. Offline operation was selected by 10 (33.3%). On cultural considerations, 23 providers (76.7%) emphasised culturally appropriate wording and examples, 21 (70.0%) local-language communication, 18 (60.0%) culturally acceptable images, and 17 (56.7%) the involvement of husbands or male family members.

Table 2: Language, communication format, privacy and cultural considerations

Consideration	Women n (%)	Providers n (%)	Instrument item
Hausa as primary language	47 (94.0)	—	Women: profile
Prefers Hausa for health information	45 (90.0)	—	Women: D2
Local-language content builds trust	—	20 (66.7)	Providers: C5
Prefers audio-only information	39 (78.0)	—	Women: D2
Prefers audio with pictures	11 (22.0)	—	Women: D2
Audio messages build trust	—	16 (53.3)	Providers: C5
Privacy/confidentiality a concern or trust factor	50 (100.0)	25 (83.3)	Women: D3; Providers: C5
Offline access builds trust	—	10 (33.3)	Providers: C5
Culturally appropriate wording/examples	—	23 (76.7)	Providers: cultural
Culturally acceptable images	—	18 (60.0)	Providers: cultural
Husband/male family involvement	—	17 (56.7)	Providers: cultural

Description: Women's primary-language and preferred-format categories are presented as recorded; provider trust and cultural-consideration items could yield multiple selections. A dash (—) means that a question was not elicited from the indicated respondent group. Percentages use the denominator for each group.

3.6 Provider Feature Priorities

Figure 4 presents the reported weighted provider preferences. Picture- or audio-based danger-sign recognition had the highest score (105), followed by facility location and emergency contacts (86), appointment reminders (73), pregnancy information and weekly updates (67), nutrition guidance (51) and provider Q&A (39). These values are confirmed aggregate scores, not participant-level rank distributions;

their order is more informative for early design than their distances from one another.

The prominent position of danger-sign guidance and facility information is consistent with midwives' reported concerns about recognition of urgent symptoms and physical access to care. Feature rankings represent preferences only; they neither establish that an intervention would be feasible nor show that it would improve clinical outcomes.

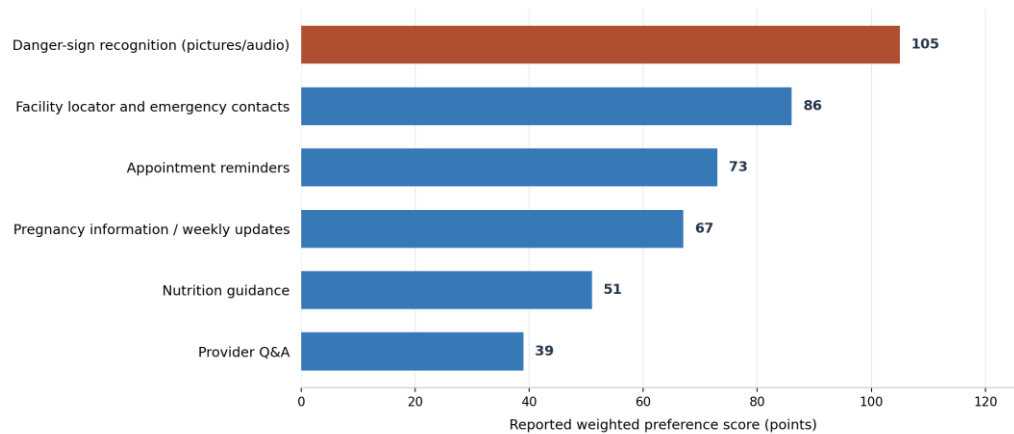


Figure 4: Weighted provider preferences for six proposed mHealth features (n = 30)

Description: Weights were 5, 4, 3, 2, 1 and 0 for ranks one to six, respectively. The theoretical maximum for one feature was 150. The reported scores sum to 421 rather than 450 for 30 fully completed six-position rankings; the aggregate data do not identify the pattern of rank completion. Values are therefore shown as reported point totals, without assuming that every participant supplied a complete ranking.

3.7 Provider Question-and-Answer Feasibility and Information Needs

Provider responses on the operation of a question-and-answer facility, and on priority information topics, are given in Table 3. Twenty-three of 30 providers (76.7%) considered a response within 24 hours feasible, but 20 (66.7%) indicated that mobile data, Wi-Fi or other internet support would be required and 12 (40.0%) raised workload or shift-flexibility concerns. Providers drew a clear boundary around the facility's clinical scope: 24 (80.0%) indicated that urgent cases should be

directed to a health facility rather than handled through the application, and 8 (26.7%) expressed concern that advice delivered through an application could reduce facility attendance.

On information priorities, postpartum danger signs were selected by 25 providers (83.3%) and newborn danger signs by 20 (66.7%), ahead of birth preparedness at 12 (40.0%) and nutrition at 9 (30.0%). The two leading topics both fall after delivery, a period outside the scope of many pregnancy-focused applications.

Table 3: Provider Q&A considerations and priority information topics (n = 30)

Indicator	n	%	Category
Response within 24 hours considered feasible	23	76.7	Operational
Mobile data/Wi-Fi/internet support needed	20	66.7	Operational
Urgent cases should be directed to a facility	24	80.0	Clinical boundary
Workload/shift flexibility concern	12	40.0	Operational
Concern app advice could reduce facility attendance	8	26.7	Clinical boundary
Postpartum danger signs	25	83.3	Information topic
Newborn danger signs	20	66.7	Information topic
Birth preparedness	12	40.0	Information topic
Nutrition	9	30.0	Information topic

Description: Items permitted multiple responses, so percentages do not sum to 100.

4.0 DISCUSSION

4.1 Interpretation of the Dual Perspectives

The central finding is the contrast between high correct-response rates on structured maternal-health questions and midwives' perception that recognition of danger signs is often inadequate in clinical practice. The datasets address different constructs: prompted knowledge among clinic attendees versus general impressions of care-seeking among midwives. This contrast is informative for formative design, but it is not evidence that

knowledgeable individual women failed to recognise the same symptoms when they occurred.

At least three interpretations are plausible. Prompted questions may make a familiar danger sign easier to identify than an unexpected symptom at home. Context-dependent recognition and assessment of severity may differ from recall of a textbook label. Finally, recognition may occur without prompt care-seeking because transport, resources or household approval are unavailable. The present descriptive data cannot distinguish these explanations. The Three Delays



framework is useful for locating them conceptually, rather than proving their relative effects (Thaddeus & Maine, 1994).

The most consistent cross-group observation concerns household permission: 76.0% of women and 80.0% of midwives selected it as a barrier. Because this was the same broad category in both instruments, it offers more direct convergence than the danger-sign comparison. Even here, the responses do not measure severity, timing or causal effects.

Interviewer prompts and facility-based recruitment may inflate apparently strong knowledge. Okoror and Omuemu (2023), using a different instrument and sample in southern Nigeria, reported much lower knowledge of obstetric danger signs. Differences in settings and measurement prevent direct comparison. Nevertheless, the permission finding and the reported late timing of first ANC attendance warrant attention independent of the mean knowledge score.

4.2 Beyond Information Alone: Knowledge and Care-Seeking

Forty-eight women (96.0%) reported attending their first ANC visit after 12 weeks, while 44 (88.0%) answered correctly a separate item concerning recommended pregnancy check-ups. The assessment did not establish that the latter item specifically measured knowledge of first-trimester booking. Thus, these results cannot demonstrate a knowledge-behaviour gap for the timing of ANC initiation, and they cannot identify the reasons for late booking. Both findings are nevertheless relevant when designing and testing appointment information and reminders.

The findings support adding accessible symptom-oriented guidance and clear referral information to routine pregnancy education, with optional, user-controlled materials that can be shared with household decision-makers. These are proposals for usability testing, not demonstrated solutions. The midwives gave picture- or audio-based danger-sign guidance the highest recorded feature score (105), ahead of weekly pregnancy information (67). The weighted scores indicate a preferred ordering in the reported aggregate results; they

do not establish complete rankings from all 30 participants.

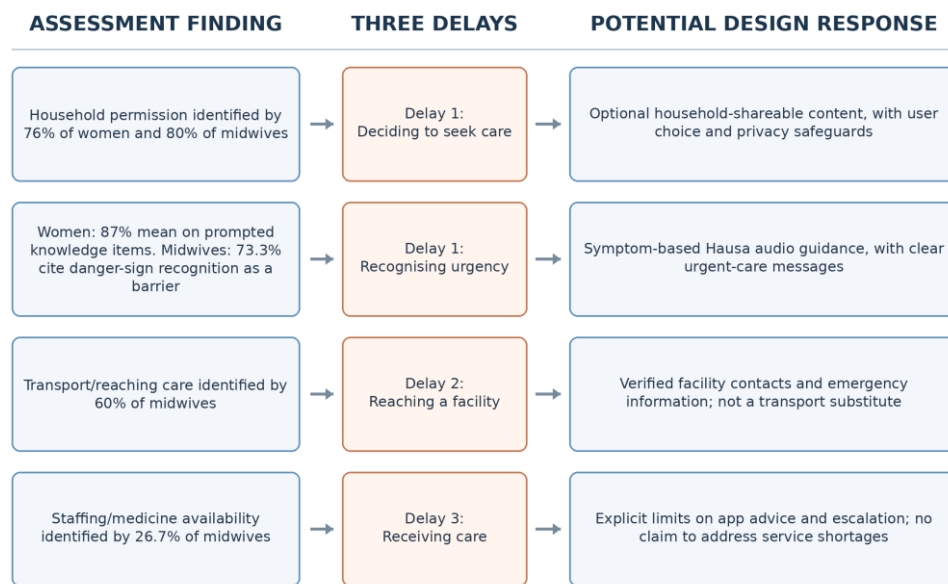
Dasuki and Zamani (2019) demonstrated that having a phone and using it for health are distinct capabilities. Studies of Nigerian maternal care also highlight the relevance of women's autonomy, male involvement and household decision-making (Adetutu *et al.*, 2024; Odusina & Oladele, 2023; Sinai *et al.*, 2024). These studies provide contextual support for exploring household-sensitive design, without establishing that family permission alone explains the responses in the present sample.

4.3 From Descriptive Findings to Proposed Requirements

Figure 5 links key findings to the Three Delays framework and corresponding design hypotheses, while Table 4 sets out eight requirements for later co-design and usability testing. These are proposed design responses, not evidence that an application has been implemented, tested or shown to improve maternal outcomes.

First, danger-sign information should be accessible through a symptom-oriented Hausa audio interface, without requiring users to diagnose the underlying condition. Second, optional family-shareable materials may help users discuss urgency and birth preparedness with relatives. This responds to the prominence of household permission in both groups and to the 17/30 midwives (56.7%) identifying husband or male-family involvement as relevant. However, privacy, user autonomy and safe access to urgent healthcare must take precedence over any design requiring permission to use the application.

Facility information and emergency contacts should be accessible from any danger-sign message, and content must clearly direct women with urgent symptoms to prompt in-person care. The provider Q&A function, if pursued, would need a defined non-emergency scope, response-time expectations, clinical oversight and escalation procedures. Neither a facility locator nor a Q&A facility can remedy transport shortages, staffing gaps or medicine availability; these remain health-system responsibilities.



Proposed responses are hypotheses for user-centred testing, not evidence of improved clinical outcomes.

Figure 5: Translating assessment findings into proposed maternal mHealth design responses

Description: The mappings connect descriptive findings to hypothesised design responses. Each proposed response requires usability, clinical-safety and implementation testing; none is evidence of a demonstrated health effect.

Table 4: Proposed mHealth design requirements and their supporting evidence

Requirement	Statement	Supporting evidence	Delay addressed
R1. Symptom-entry danger-sign recognition	Guidance reachable by describing a symptom in Hausa audio, not by navigating a topic menu	Top reported feature score (105); midwives identify commonly missed signs; women mean 87.0% on prompted checklist	Delay 1
R2. Household-facing content surface	Shareable danger-sign and birth-preparedness content addressed to husbands and senior family members	Permission barrier: women 76.0%, providers 80.0%; 56.7% cite male involvement	Delay 1
R3. Hausa audio as the primary delivery format	Audio-first delivery with concise text and culturally acceptable illustration as support	90.0% prefer Hausa; 78.0% prefer audio only; no woman preferred text alone	Cross-cutting
R4. Emergency and facility information adjacent to danger signs	Facility locator and emergency contacts reachable directly from danger-sign guidance	18/30 midwives (60.0%) identify transport/reaching care; facility locator scored 86	Delay 2
R5. Discreet-by-default presentation	Notifications and personal health information not visible to a casual observer of the handset	Concern coded in 50/50 women; confidentiality selected as trust factor by 25/30 midwives (83.3%)	Cross-cutting
R6. Postpartum and newborn content continuity	Content continues after delivery rather than terminating at birth	Postpartum danger signs 83.3%; newborn danger signs 66.7%	Delay 1
R7. Bounded provider question-and-answer	Routine questions only, with explicit routing of urgent symptoms to a facility and defined response responsibilities	24/30 midwives (80.0%) direct urgent cases to a facility; 20/30 (66.7%) report data/connectivity support needs	Cross-cutting; not a remedy for Delay 3 shortages
R8. Tolerance of intermittent connectivity	Core danger-sign and emergency content available without a live connection	Offline access selected by 33.3% of providers as a trust factor	Cross-cutting

Description: Requirements are derived from the findings reported in Section 3. Evidence percentages use denominators of 50 pregnant women and 30 healthcare providers.



4.4 Language, Literacy and Delivery Format

Hausa was the primary language of 47/50 women (94.0%) and the preferred mobile-health language for 45/50 (90.0%). Although 44/50 (88.0%) reported that they could read a short Hausa message, 39/50 (78.0%) preferred audio only and 11/50 (22.0%) preferred audio with pictures. Format preference cannot therefore be inferred solely from self-reported ability to read. Hausa audio and short on-screen text are appropriate options to prototype, alongside user testing of privacy when messages are played aloud. Voice-based health communication has been studied in other contexts (Ouedraogo *et al.*, 2025).

4.5 Privacy As A Design Constraint

Privacy/confidentiality appeared in the aggregate analysis for all 50 pregnant women, while 25/30 midwives (83.3%) identified protecting health information as a contributor to trust. The universal frequency is a recorded response to an instrument item, rather than evidence that every woman spontaneously volunteered the concern; individual response options and nonresponses cannot be reassessed from aggregate tables. It nevertheless supports testing discreet notifications, user-controlled audio playback, minimal collection of personal information and proportionate data-security safeguards (Alfawzan *et al.*, 2022; Alhammad *et al.*, 2024).

4.6 Relation To Existing Work

The results complement Nigerian work showing that mobile access does not guarantee meaningful health use (Dasuki & Zamani, 2019), reminder-based interventions may improve postnatal-care attendance (Olajubu *et al.*, 2020), and digital maternal tools can support risk assessment or education (Bola *et al.*, 2022; Babatunde *et al.*, 2025). Unlike intervention trials, this study measures preferences and reported barriers rather than changes in uptake or health outcomes. Its contribution is a local, dual-perspective set of hypotheses for app design, with explicit limits on how the two datasets can be compared.

4.7 Limitations

This was a small formative assessment of 50 pregnant women and 30 midwives in two hospitals, using non-probability sampling. Findings are not population estimates for Sokoto State. The female sample had relatively high reported secondary education (80.0%) and smartphone use (88.0%), and antenatal-clinic recruitment excluded women who never reached the participating facilities. All provider respondents were midwives; perspectives from physicians, community health workers and traditional birth attendants were not assessed. Recruitment through antenatal clinics necessarily excludes women who do not reach those clinics, including some facing substantial barriers to care. This selection mechanism may help explain the comparatively high knowledge and phone-access figures. The study measured neither actual delays nor the effects of a deployed application.

Only one woman reported Fulfulde as her primary language. This low count does not establish the language needs of Sokoto State overall; a subsequent pilot should purposively include rural and Fulfulde-speaking populations when relevant. Provider recommendations for local-language support should not be treated as representative user preferences.

The 12-item knowledge checklist was not formally psychometrically validated. Only aggregate tabulations were available for the manuscript analysis, so respondent-level score variability, associations with ANC timing and cross-group agreement could not be estimated. For provider feature rankings, the six tabulated point totals did not account for all 450 points expected from complete rankings; because respondent-level rank records were unavailable in the analysis file, the reasons for the unallocated points remain undetermined. Written-response themes were available as coded counts only, without verifiable verbatim quotations.

Finally, most findings rely on self-reported or prompted responses. Midwives' views of symptoms being missed are not observed incidence rates, and women's knowledge was not assessed during a real emergency. Formative results identify priorities for subsequent usability and safety testing, rather than evidence of clinical effectiveness.

4.8 Further Work

Future work should test symptom vignettes and observed navigation tasks to distinguish recognition from prompted recall; directly involve women and, where appropriate and voluntary, family decision-makers; and assess safety, accessibility and privacy in prototype usability studies. Further recruitment should reach people who are not currently attending antenatal clinics and those with lower smartphone access. Any clinical decision-support functionality requires qualified review and careful validation before deployment.

5.0 CONCLUSION

This formative assessment compared responses from 50 pregnant women and 30 midwives in Sokoto State. Women performed well on a 12-item prompted maternal-health checklist (10.44/12, 87.0%), while many midwives perceived danger-sign recognition as a care-seeking barrier. Both groups frequently identified husband or family permission as a barrier (76.0% and 80.0%, respectively). Hausa-language information, audio delivery, privacy and practical links to healthcare facilities also emerged as prominent design considerations.

These data do not show that knowledge is irrelevant or that it causes delayed care. They indicate that an information-only application could overlook questions about symptom interpretation, household decision-making and timely referral. Reported weighted provider-feature scores are useful for prioritising prototype features, but the aggregate ranking data do not permit



claims about the completeness of every respondent's feature ordering.

The proposed next step is to co-design and test an audio-first, Hausa-language application with symptom-oriented information, clear routes to urgent care, discreet communication and optional household-shareable resources. Prototype testing should assess comprehension, accessibility, safety and acceptability before claims are made about improved attendance, reduced delays or lower maternal mortality. These findings document formative project progress, not an evaluated clinical intervention.

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