

Developing Targeted Client Communication Messages to Women in Bangladesh: A Qualitative Approach Based on Women's and Family Members' Perceptions and Knowledge of Antenatal Care

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Abstract

Background: Timely and appropriate evidence-based practices during antenatal care improve maternal and neonatal health. There is a lack of information on how pregnant women and families perceive antenatal care in Bangladesh. This study explores their perceptions towards developing targeted client communication via text messages for increasing antenatal care utilization, as part of an implementation of an electronic registry for maternal and child health.

Methods: We conducted this qualitative study between May and June 2017 in two sub-districts of Chandpur district, Bangladesh. We selected study participants by purposive sampling. A total of 24 in-depth interviews were conducted with pregnant women (n=10), lactating women (n=5), husbands (n=5), and mothers-in-law (n=4). The health belief model was used to guide data collection and analysis. Thematic analysis was carried out manually. We used behavior change techniques to inform the development of targeted client communications based on the thematic results.

Results: Almost no respondents mentioned antenatal care as a preventive form of care, and only perceived it as necessary if any complications developed during pregnancy. Knowledge of the content of antenatal care and pregnancy complications was low. Women reported a variety of reasons for not attending ANC, including the lack of information on the timing of ANC; lack of decision-making power; long-distance to access care; being busy with household chores and not being satisfied with the treatment by health care providers. Study participants recommended phone calls as their preferred communication strategy when asked to choose between the phone call and text message, but saw text messages as a feasible option. We developed a library of 43 automatically customizable text messages to increase ANC utilization.

Conclusions: Pregnant women and family members had limited knowledge about antenatal care and pregnancy complications. Effective health information through text messages could increase awareness of antenatal care among study participants. This study presents an example of designing targeted client communication to increase antenatal care utilization within formal scientific frameworks, including a taxonomy of behavior change techniques.

Background:

Antenatal care (ANC) provided by skilled health professionals includes risk identification, prevention and management of pregnancy-related or concurrent diseases, health education, and health promotion [1]. Implementation of timely and appropriate evidence-based practices during ANC improves health as well as saves the lives of mothers and newborns [2]. In addition, ANC is a window of opportunity for social, cultural, physiological, and emotional support to pregnant women, through effective communication to increase health care utilization[3, 4]. ANC also provides an opportunity to prevent and manage concurrent diseases through integrated service delivery [5, 6].

Sixty-five percent of pregnant women attend a minimum of four ANC visits worldwide, suggesting context-specific interventions are needed to address ANC utilization [4, 7]. In Bangladesh, forty-seven percent of pregnant women attend four ANC visits [8]. Only 26% of women in Bangladesh receive their first ANC before 16 weeks of gestation[9]. This low coverage of ANC is suggested to be influenced by socio-cultural beliefs, demographic characteristics, and the performance of the health system [4]. Although physical access has not been reported as a significant problem, utilization is low despite multiple efforts, including demand-side financing projects [10]. Women's perceptions of care is a key issue limiting service utilization [11]. Women's negative perceptions of the quality of ANC and the expectation that pregnancy complications are rare may prevent adequate ANC utilization. Therefore health education about the benefits of ANC is essential prior to, and during, the early stages of pregnancy, as it provides an opportunity for dialogue between pregnant women and care providers to promote ANC service utilization, birth preparedness, and increase awareness of complications [2].

Maternal knowledge of complications is an essential precondition for routine ANC attendance for identification of early pregnancy-related complications, especially because most of these complications have no symptoms before severe illness develops. Studies from low- and middle-income countries, including Bangladesh, have reported that knowledge about pregnancy complications is low [12–15]. Complications, such as anemia[16], gestational diabetes mellitus (GDM) and hypertensive disorders in pregnancy [9] are common in South East Asia including Bangladesh [17–19]. Therefore, screening for these three conditions during pregnancy is essential, especially given that there are few symptoms at the early stages of these illnesses. Timely ANC attendance is critical for early screening for and identification of anemia, GDM, and gestational hypertension, thereby preventing later complications.

The use of digital health interventions in healthcare is increasingly prioritized to strengthen healthcare systems, with many low- and middle-income countries implementing digital health technologies to specifically address challenges in maternal and child health. Digital health interventions have the potential to improve ANC attendance through behavior change messages and targeted client communication (TCC)[20]. TCC is defined as the transmission of targeted health content to a specified population or an individual within a predefined health or demographic group [21]. In low-income countries, digital health interventions have shown promise as an effective way for TCC to influence behavior and encourage women to access preventive services including ANC [22]. Mobile phone features such as text messaging via Short Message Service (SMS), voice calls, Multimedia Message Service (MMS), or interactive voice recording have been found to be effective in increasing the uptake of different health care services [23–25]. While in some low resource settings, mobile phone text messaging has been shown to increase ANC attendance [26], others have found that telephone call reminders, compared to text messaging reminders, were more effective in increasing ANC attendance [27]. To guide policy-making, more information is needed on which methods can effectively increase ANC utilization in Bangladesh.

The objective of this study was to understand health-seeking behaviors, knowledge about pregnancy complications, women's and families' perceptions of self-care practices during pregnancy, mechanisms

might support the implementation of TCC to increase attendance, and subsequently develop TCC messages guided by these findings. This study is one of the formative components of the eRegMat (electronic registry Matlab) trial, a large cluster randomized controlled trial to implement and evaluate the effectiveness of an eRegistry on health care services delivered to pregnant women and newborn babies in rural Bangladesh (trial registration No: ISRCTN69491836). In this eRegMat trial, we are comparing an interactive eRegistry (longitudinal client records with health worker decision support and TCC via text messages), developed within the District Health Information System 2 (DHIS2 platform) to a 'silent registry' (with longitudinal client records only) on improvements in the quality of care during the antenatal, childbirth, and postnatal periods.

Methods

Design

A qualitative research design, guided by the Health Belief Model (HBM), was used to explore perceptions of ANC and pregnancy complications [28].

Study site and population

The study was conducted in Matlab South and Matlab North sub-districts in Chandpur District, Bangladesh. The study site mostly consists of rural and riverine delta areas of Bangladesh and is located 80–85 km southeast of Dhaka, the capital of Bangladesh. In Bangladesh, two wings of the health system provide maternal health care services. Domiciliary community health workers from both wings provide health education on maternal and child health at the village level [29, 30]. At the primary care level, maternal health services are provided at both Community Clinics (CC) and Union Health and Family Welfare Centres (UHFWC) [15]. The UHFWC cover a population of about 25,000, while CCs cover an average of 6,000 [29, 30]. The study population was pregnant and postpartum women, husbands, and mothers-in-law of pregnant women.

Sampling

We used purposive sampling to select study participants from the pregnancy register of domiciliary community health workers, based on parity and presence or absence of complications. Among 103 pregnancy registers, we randomly selected five from each sub-district. We selected husbands and mothers-in-law using the same register; these participants had no familial link with the pregnant or postpartum women interviewed.

Data collection

The HBM was used to develop a semi-structured interview guideline for performing in-depth interviews (Additional file 1). Our guideline covered the following constructs from the HBM: perceived susceptibility and severity of complications; perceived benefits of care, self-efficacy; and barriers and cues to action to attend care. In-depth interviews were conducted from May to June 2017. The research team, including

investigators with experience in qualitative research, conducted all in-depth interviews. We conducted the interviews in the interviewees' homes or other locations based on their choice, with the exception of husbands' interviews, which were done at their workplaces. All participants gave informed oral consent prior to the interviews and were assigned anonymous study participation numbers before the analysis phase. In addition to the in-depth interviews, a short questionnaire was used to collect background information (Additional file 2). Each interview took approximately 1 hour and was recorded with a digital recorder for transcription.

Data Analysis:

We prepared an outline of the purpose and plan for data analysis. Throughout the data collection process, we listened to the tape-recorded in-depth interviews; and read through all the transcribed interviews to identify themes that were discussed in the interviews, identified new emergent themes, strengths and weaknesses of interview techniques, and any missed opportunities for further exploration. All interviews were conducted in the Bengali language, transcribed, and then translated to English. Data were coded and analyzed according to the components of the HBM. Data were indexed, coded manually, and organized into a matrix. Emerging themes and sub-themes were analyzed. Data were compared between and within different types of respondents to strengthen the appropriateness of the findings. Two researchers in the team with qualitative background individually coded the data and finalized the code list by checking for similarities and dissimilarities during data interpretation. Discrepancies were discussed by the researchers, together with a third researcher, until consensus was reached. We analyzed the data to understand the views of the different target audiences on the underlying factors that influence their ANC utilization.

Message development and revision

Using the results from the in-depth interviews, we drafted TCC text messages in English that specifically addressed the knowledge gaps and perceptions that contributed to the low uptake of ANC. We tailored these draft messages to be aligned with specific pregnancy conditions, and the timing of screening for these conditions during ANC to increase client acceptance and enhance the impact on service utilization [31].

We applied established theory and behavior change techniques to the development of draft messages to strengthen the potential of achieving specific behavior change [32, 33]. According to Abraham and Michie's taxonomy, we used six behavior change techniques out of 26, underpinned by five theories [34]. We matched each component of given draft message to a specific behavior change technique. We used positively framed messages as opposed to negatively framed messages to engage in healthy behavior [35]. To nudge the study participants' decisions towards healthy behavior, messages were personalized by using their name [36, 37]. To address the knowledge gaps identified through the HBM constructs, we included information on common pregnancy complications of anemia, hypertension, and diabetes, their

consequences, and the benefits of ANC attendance. The content of these draft text messages was translated into Bengali.

Two focus group discussions were conducted with pregnant women to get their feedback on the draft messages to ensure that they were easily understandable and acceptable for pregnant women. Specifically, participants were shown the content of the messages and asked to comment on 1) their understanding of the message and 2) how to improve the specific text and language. Women were selected from community health workers registers. The results from the focus group discussions were evaluated by the team and text messages were modified based on the results.

Ethical Considerations

This study was approved by the ethics and research committees at the International Center for Diarrheal Disease Research, Bangladesh (protocol number: 16054), and exempt from review by the Regional Ethical Committee in Norway, Southeast region (2017/1018/REK sør-øst C). Individual informed consent was obtained for all participants.

Results:

Characteristics of the study participants

Of a total of 24 in-depth interviewees (Table 1), ten were pregnant women, five were postpartum women, four were mothers-in-law, and five were husbands. All pregnant women were housewives from 18 to 26 years of age. At the time of the interview, the mean gestational age was 23 weeks and four days (8–36 weeks). Among the ten pregnant women, four were pregnant for the first time. Seven pregnant women had less than 10 years of education, and the rest had more than 10 years. All the postpartum women were housewives, and 22–32 years old. Three postpartum women had completed less than 10 years of education and two women, more than 10 years. The five husbands ranged from 25 to 41 years of age; four had less than 5 years of formal education, and one up to 10 years.

Table 1
Characteristics of study participants

Participants	Mean age in years (range)	Education level (years)	Household type	Parity
Pregnant women	22 (18–26)	Secondary (6–10): 7	Single family:3	Nullipara:4
		Higher secondary (> 10):3	Extended family:7	Multiparous:6
Postpartum women	25 (18–32)	Secondary (6–10): 3	Single family:2	Parity = 1:1
		Higher secondary (> 10):2	Extended family:3	Parity > 1:4
Mothers-in-law	55 (50–60)	Primary (0–5):3		
		Secondary (6–10):1		
Husbands	35 (28–41)	Primary (0–5):4		
		Secondary (6–10): 1		
Perceived susceptibility and severity of pregnancy complications				

Knowledge of pregnancy-related complications

High blood pressure as a pregnancy complication was spontaneously mentioned by half of the postpartum women, but few pregnant women reported high blood pressure. Convulsions were mentioned as a common consequence of hypertension by most postpartum women spontaneously, but only one pregnant woman reported this. Anemia was rarely mentioned as a pregnancy-related complication by the pregnant and postpartum women without probing. Other complications reported by pregnant and postpartum women from their personal and family experiences included excess vomiting, less fetal movement, tetanus, breech presentation, white discharge, and fever. Women with children mentioned more complications compared to women who had never given birth. One pregnant woman said, *“I have heard many women have problems. Some suffer a lot during delivery, a girl from the neighborhood delivered at eight months. This girl also had pressure. For pressure, she went to the doctor one week or two weeks ago.”* (Pregnant woman, age 20, para 0)

Another pregnant woman stated, *“Different types of complications could arise; there would be a pain in the lower abdomen if a pregnant woman does heavy work. Then if the pregnant woman doesn't take the proper amount of water, the baby doesn't move properly, or less, that is also a problem.”* (Pregnant woman, age 25, para 2)

Most of the mothers-in-law mentioned common pregnancy complications such as headache, abdominal pain, vaginal bleeding, anemia, convulsion, high blood pressure as well as other diseases that could complicate the pregnancy like jaundice, tuberculosis, and pneumonia. The majority of the husbands mentioned very few complications such as anemia, vomiting, reduced food intake, abdominal cramp or

pain, weakness, and edema. Two husbands could not mention any complications related to pregnancy. When we asked about pregnancy complications, one husband stated that *"we do not understand the feminine problem."* (Husband, age 40, CNG driver)

Perceived susceptibility to, and severity of, anemia, hypertension, and gestational diabetes

Women were prompted to discuss three specific pregnancy-related complications: anemia, hypertension, and diabetes. Spontaneous knowledge of anemia and diabetes was minimal among all respondents and, in particular, its association with pregnancy. Only one pregnant woman spontaneously reported that anemia was a pregnancy-related complication, but she was unaware of the consequences. One postpartum woman mentioned anemia from her personal experience. Another pregnant woman stated after prompting, *"I have heard that anemia could happen. I have no idea. I can't say what could happen to the mother and baby."* (Pregnant woman, age 22, para 1)

Few husbands knew about anemia and its consequences. Concerning diabetes, only one pregnant woman stated, after probing, *"I have heard about diabetes. I know that it happens to people, but I also heard it might happen during pregnancy."* (Pregnant woman, age 22, para 1)

Knowledge of hypertension was quite different between pregnant and postpartum women, in that most postpartum women knew about hypertension in pregnancy and its consequences. Still, very few pregnant women, husbands, or mothers-in-law had the same level of knowledge. Only one pregnant woman could spontaneously mention hypertension since one of her relatives had suffered from it and developed convulsions later on.

"If the pressure rises, that could create problems. If it's high, some may have convulsions during pregnancy. I saw someone who had convulsions due to pressure. Then again, low pressure is also bad." (Postpartum woman, age 27, para 4)

Another pregnant woman stated *"I know that pressure increases. Increased pressure could create problems. But I don't know what would be the problem or what harm could happen."* (Pregnant woman, age 18, para 0)

Misconceptions about anemia in pregnancy and gestational diabetes were common among pregnant and postpartum women. Some pregnant and postpartum women linked anemia only to blood loss during delivery. They thought that women were less likely to develop anemia during the first pregnancy, and that women with previous births could develop anemia due to blood loss at delivery. One pregnant woman stated *"This is my first pregnancy; I should have plenty of blood in my body."* (Pregnant woman, age 18, para 0)

Women has no clear concept of gestational diabetes; one of them stated: *"Many pregnant women develop diabetes after delivery...my elder brother's wife didn't have any disease previously, but after delivery of her last child, diabetes was diagnosed."* (Postpartum woman, age 28, para 2)

Care for complications:

When we asked participants what they would do for pregnancy-related complications, all stated that they would visit a qualified doctor. One postpartum woman stated that pregnant women with anemia should take iron tablets and nutritious food. Another postpartum woman said that *"If any problem arises, I will not understand whether I have any complication or not. I need to visit a doctor and take advice."* (Postpartum woman, age 28, para 2)

Antenatal care practices

The perceived benefit of ANC attendance

Almost all pregnant and postpartum women mentioned that ANC is necessary to know the status of the baby and mother but could not mention the importance of timely ANC for appropriate screening and management as preventive care. ANC was mostly viewed as necessary during pregnancy only if complications developed. In addition women also thought that the health care provider needs to inform pregnant women about ANC utilization.

One pregnant woman with two children and in her fifth month of pregnancy stated *"I am well now, it isn't necessary to go to the healthcare provider now, and they haven't even called me yet... if any healthcare provider calls me for ANC, I will go for an ANC visit, but if she doesn't come to me I will not go for it. It is her duty, not mine."* (Pregnant woman, age 24, para 2)

Another postpartum woman stated *"The benefits of check-ups are that I could get to know whether the baby is in the upper or lower abdomen or healthy. It is also possible to know the status of the baby as well."* (Postpartum woman, age 28, para 2)

Mothers-in-law also stated that ANC is needed to know the status of the baby and the mother but could not mention the importance of timely ANC for appropriate screening and management as preventive care. Similar knowledge was found among husbands, although one of them stated that ANC is important to see the growth of the baby, and to identify problems. One husband stated that there is no need for ANC during pregnancy: *"I don't think that ANC is important, as my wife did not suffer from any problem, I didn't give any importance to ANC. If she suffered from any complication, I would have gone to the doctor with my wife and ask about the problem"* (Husband, age 28, cook)

First ANC attendance

Only half of the pregnant women had received their first ANC prior to the interview. Those that had not received ANC were less than five months of gestation. Their perceived need to attend ANC within five months was low. They believed that the chance of miscarriage within five months to be high, and they did not perceive that ANC played any role in preventing miscarriages.

One pregnant woman at four months of gestational age said: "*within five to six months, I have a plan to visit the facility for antenatal care.*" (Pregnant woman, age 18, para 0)

Another pregnant woman at the same gestational age said: "*No, I don't need to visit yet.*" (Pregnant woman, age 18, para 1)

On the other hand, most of the postpartum women had received ANC, and the majority had attended ANC following complications during their pregnancy or due to previous pregnancy complications. Other pregnant and postpartum women who had not experienced problems earlier received their first ANC after five months of gestation. Most women felt that if any health problem arises during pregnancy, then they need to visit a doctor. One woman stated that "*if I suffer from any problem, I should visit a doctor and follow doctor's advice.*" (Pregnant woman, age 25, para 2)

When we interviewed husbands, they reported that their wives did attend ANC. Among the five, three visited a facility within four months. One husband mentioned "*I have a child, if I didn't have a child, I would not have known about the check-ups. After three months and up to delivery, we need to go monthly for check-ups. As we have the government hospital and don't need to pay, we go for check-ups monthly.*" (Husband, age 40, CNG driver) Follow-up ANC visits

Health care providers shared information about follow-up visits with about half of the pregnant women who had ever attended ANC but did not provide specific dates for follow-up visits. Most of the women who received information on the timing of follow-up ANC visits actually attended those follow-up ANC visits, while the inverse was true for those who did not receive detailed information. More than half of the pregnant women and most of the postpartum women received at least one follow-up ANC, but it was not aligned with the recommended schedule of ANC visits. The women reported attending follow-up visits when they faced complications, and in this regard, one pregnant woman said, "*I visited a doctor for vomiting, and she prescribed medicine. But the condition is the same, although I am taking medicine. I am at six months. Still, I am vomiting. During the first visit, I was told that it would subside gradually. If it happens more frequently, then I plan to visit a doctor. I vomited once, and then it stopped; therefore, I didn't visit.*" (Pregnant woman, age 24, para 2)

Perceived barriers to ANC attendance:

Pregnant women who did not attend care reported a wide range of reasons including lack of decision making power, distance to the facility, being too busy, not being satisfied with the treatment by health care providers, non-cooperation by their husband, and unavailability of any family member to help in the household. One woman mentioned "*I did not panic. I cried a lot yesterday. I know a little bit about what I should do this time. But I am unable to do anything. If I can't go to the doctor now, what I know, what I am worried about is that, if I lost blood like this, it would be harmful to my baby. My baby would only be healthy if I have enough blood. Now, if I lost blood this way, this would be harmful to me. But I cannot do anything.*" (Pregnant woman, age 25, para 2)

Self-care and family support

We further explored women's general attitudes to taking care of their pregnancy through self-care and their families' supportiveness of her pregnancy and care. The majority of women practiced healthy behaviors such as eating adequate nutritious diets, avoiding heavy work, and resting. Most of the mothers-in-law and husbands knew that pregnant women need to eat nutritious food, take proper rest, and avoid lifting heavy things. Only very few pregnant women, pregnant for the first time, mentioned dietary restrictions such as selected fishes and green coconut during pregnancy.

Most of the women living with extended families received household support from their family members, especially from mothers-in-law. *"My mother-in-law brings me some water, or sweeps the room, and helps to cut the vegetables. I do all the cooking and other work. My husband doesn't stay at home; he goes for work in the early morning and comes back at 10 or 11 at night. Within that time, I usually finish all household chores."* (Pregnant woman, age 25, para 2)

In a few cases, husbands helped their wives with household work. *"I have my mother-in-law, but she can't work due to her excess weight and old age. She can't help me; she is more disabled. My husband helps me a lot. Like if there are a lot of heavy clothes to wash, bed covers, or curtains, he washes those for me. And we also have cows; he looks after those, I don't do any work related to cow ranching. He also fetches water for me if I need more water. I have to do the rest as I am the only one in this home."* (Pregnant woman, age 20, para 1)

Women living in single-family households generally did not get support for their household work.

One pregnant woman living in a single-family household (i.e., without extended family) reported most components of appropriate self-care as defined in the national ANC guidelines, but could not avoid doing heavy household work and mentioned *"I am the only female in the household. I have two small children. While cooking, I may need to do some heavy work, need to bring water, and wash clothes."* (Pregnant woman, age 26, para 2)

One postpartum woman stated *"In this pregnancy, I did a lot of work. In addition to my household works, I had to take care of 4 cattle and need to collect grass from the field to feed them. On the last day, my pain started, just after finishing grass cutting."* (Postpartum woman, age 27, para 4)

Decision making for maternal and child care service utilization

When the pregnant and postpartum women were asked about the decision-maker regarding their healthcare service utilization, most of them mentioned that their husbands were the main decision-makers in the family. But nulliparous women reported that their mothers-in-law played a vital role in the decision making along with their husbands. *"I became pregnant for the first time. I don't know much about pregnancy. So, most of the decisions are taken by my mother-in-law and husband."* (Pregnant woman, age 18, para 1)

All mothers-in-law with currently pregnant daughters-in-law mentioned that she and her son jointly made critical decisions about the pregnancy-related care in the family. Most husbands said that he was the main decision-maker in the family. One husband cited, "*I will have to make the decision. I can't depend on anybody. Now I am here; I will make the decision.*" (Husband, age 35, migrant worker)

Targeted client communication strategy

Modes of contact and reminders

Pregnant women were asked about communication strategies that could increase ANC attendance. Almost everyone preferred direct communication to remind them of ANC dates and give them health information. One woman stated "*Through a phone call, I would be able to talk directly. In the case of messages, I would have to read the message to understand... I read, sometimes not, if I am doing any work. That's why phone calls would be good.*" (Pregnant woman, age 20, primipara)

One woman stated "*If there is an emergency and the phone rings, I would pick it up and listen to that. After that, the phone remains somewhere idle; the message would only make a small sound, nothing after that.*" (Postpartum woman, age 32, para 3) They also mentioned that text messages could work as a reminder. However, they didn't know anything about voice messages as an option.

Contact person and time for communication

Given that husbands and mothers-in-law were the decision-makers, we asked to whom and when to send the text messages related to ANC attendance and pregnancy complications. Most suggested that it was preferred to communicate directly with the pregnant woman. Although some said the information could be sent at any time, a similar number suggested that evenings would be better.

Development of SMS messages for TCC:

The most important findings from our study guided the development of SMS messages for TCC. First, women and families only perceive the need for early ANC when women are sick. Perceived susceptibility to common pregnancy complications, and the knowledge that they may occur without symptoms, was low among study participants. Second, women did not recognize that common pregnancy complications could necessitate care during pregnancy. Third, they didn't know that attending ANC could result in fewer complications or earlier detection of complications. Fourth, they were unaware of the appropriate number and timing of ANC visits. Finally, most of the women who received detailed information on when and where to attend follow-up ANC during their first ANC visit did attend those follow-up visits, suggesting that lack of information is a key factor leading to inadequate utilization of ANC and that basic information served as cues-to-action. The evidence did not suggest any specific modifiable factor which could address a majority of women's self-efficacy and ability to attend ANC.

Given this evidence, and the planned integration of automated data-driven SMS messages into a health information system (the eRegistry), we designed a series of text messages for women to act as cues-to-

action and target women’s knowledge about ANC, specifically on 1) the benefits of attending ANC; 2) women’s susceptibility to complications; and 3) the severity of complications. The messages were designed to match the timing of critical screenings for common conditions including for anemia, hypertension, and gestational diabetes. We used clinical data from the eRegistry to further tailor these messages, based on women’s gestational age and common risk factors for the medical conditions targeted (Table 2), in order to make the text messages more individualized and provide added value to the individual woman.

Table 2
Common Risk Factors for Anemia, Hypertension, and GDM

Risk factors for anemia	Risk factors for hypertension	Risk factors for GDM
Age < 20	Age ≥ 35 [38]	Age > 25 [39]
Low Body Mass Index [40, 41]	High body weight/high Body Mass Index[38]	High Body Mass Index [39, 42]
Grand multiparity [43, 44]	Nulliparity [45, 46]	Grand multiparity [47]
Multiple pregnancies [44]	Previous hypertension [46]	Multiple pregnancies [39]
	Previous Small for Gestational Age[48, 49]	Previous hypertension [39]
	Previous prenatal mortality [50, 51]	Previous GDM [39]
	Family history of hypertension[38, 46]	Previous perinatal mortality [50]
		Family history of DM[39]
GDM = Gestational Diabetes Mellitus; DM = Diabetes Mellitus		

The Bangladeshi government recommends a schedule of four antenatal care visits for low-risk pregnant women. Reminder messages were designed to be sent both one week and one day prior to the scheduled ANC date, and we selected one topic to be highlighted in each of the reminder messages (Table 3). In addition, we created a welcome message to be sent upon enrolment, referral facilitation messages, and facility delivery reminders. The referral facilitation messages were reminders to women that their provider had recorded danger signs or created a referral in the eRegistry.

Table 3
National ANC schedule and linked health topic for messages

ANC schedule	Health topic for Messages	Recommended by
Within 16 wks	Anemia	National guideline [5, 52, 53]
24–28 wks	Gestational Diabetes	[54, 55]
32 wks	Gestational Hypertension	National guideline
36 wks	Malpresentation	National guideline

Given that the messages would be automatically generated within the eRegistry, we were able to additionally tailor each message based on clinical characteristics. Specifically, if data were entered into the eRegistry indicating anemia, hypertension, or gestational diabetes, an algorithm was developed which would take that into consideration and appropriately modify the messages. And, if the risk factors for these conditions were documented in the eRegistry (as shown in Table 2), the text messages would be tailored further.

Once the general topic for each message was agreed by the research team, the format of that message was designed based upon our review of effective behavior change techniques (BCT) recommended by Abraham and Michie [34]. The messages covered five theoretical frameworks and six BCTs. Behavior change techniques included the provision of general information about behavioral risk, information on benefits and consequences of action or inaction of the behavior, encouraging the person to decide to perform, rewarding the effort toward achieving the behavior change, how to perform the desired health behavior, and planning the desired health behavior with a planned outline to perform (Table 4). The theories linked with the techniques used are the information-motivation-behavioral skills model (IMB), a theory of reasoned action (TRA), theory of planned behavior (TPB), social-cognitive theory (SCogT) and control theory (CT).

Table 4

Behavior change techniques and HBM used to create TCC messages for ANC utilization

Behavior change technique	Description	HBM domain	Example text message phrase
[34]			
Provide information about behavior health link (IMB)	General information about health outcomes concerning behavior	Perceived benefit	Come to our health center, and we will check you and your baby (ies')'s health throughout your pregnancy.
Provide information on consequences (TRA, TPB, IMB, SCogT)	Information about the advantages and disadvantages of action	Perceived susceptibility and severity	High blood pressure may develop during this time and lead to a serious problem for the mother. The baby might be born early or very small.
Prompt intention formation (IMB, SCogT)	Encourage the person to decide to act	Other	Come to our health center, and we will check your and your baby's health throughout your pregnancy.
Provide general encouragement (SCogT)	Outcome of performance	Perceived benefits	Anemia will be treated accordingly, and you will be better prepared for delivery.
Prompt specific goal setting (CT)	Involves detailed planning of ANC visits	Cues to action	Please remember to attend your ANC visit next week. Excess blood pressure in pregnancy may cause serious problems for the mother and the baby. Come to the health centre, and we will reassess your blood pressure.
Provide instruction (SCogT)	Tell the person how to perform the desired behavior and how to prepare for it.	Cues to action	Please remember to attend your ANC visit next week. Come to our health center.
Personalization (nudge theory)	Insertion of the recipient's name and signing with the name of the clinic as a "trusted source"	Other	Salam (name) apa. Name of health facility
Note: IMB = Information-motivation-behavioural skills model; TRA = Theory of reasoned action; TPA = Theory of planned behaviour; SCogT = Social – cognitive theory; CT = Control Theory			

Table 4: Behavior change techniques and HBM used to create TCC messages for ANC utilization (Page 36–37)

The initial draft of the TCC messages, based on the HBM and the ANC schedule and tailored with the behavior change techniques, were translated into Bengali from English and shared with pregnant women in focus group discussions (data not shown). Participants reported that the content of messages was adequate, but some modifications of terminology were needed for ease of understanding. We then reviewed each message and finalized the wording of the TCC messages. Each message was then adapted to the typical SMS character limits (knowing that for some messages up to three SMS could be sent). In the end, a library of a total of 43 TCC messages was developed based on the individual woman's presence or absence of anemia, hypertension, GDM, and associated risk factors in the eRegistry. Examples of the messages are included in Table 5.

Table 5
Selected examples of the final targeted TCC messages

Message type	Message Timing	Message Content
Welcome message	same day as pregnancy identification/enrolment	Welcome [xxx] apa. We will provide four routine ANC visits. Come to our health centre and we will check you and your baby (ies)'s health throughout your pregnancy. [yyy]
Visit 1	1 week prior to the first scheduled ANC visit	Salam [xxx] apa. Please remember to attend your ANC visit next week. 1 in 3 women is anaemic in pregnancy. Anemia can cause dizziness and weakness. Come to our health centre and we will check for your anemia and will treat accordingly so that you will be better prepared for delivery. [yyy]
Visit 2 reminder - for women with no risk	1 week prior to second scheduled ANC visit	Salam [xxx] apa. Please remember to attend your ANC visit next week. We will check for sugar in blood or urine for signs of diabetes. Diabetes in pregnancy has to be followed-up carefully throughout pregnancy to ensure that both mother and baby stay healthy. [yyy]
Visit 2 reminder – for women with mild or moderate anemia	1 week prior to second scheduled ANC visit	Salam [xxx] apa. Please remember to attend your ANC visit next week. Anaemia in pregnancy may cause problems for the mother and the baby, if not treated. Come to the health centre and we will reassess for anemia and check for diabetes. [yyy]
Visit 3 reminder - for women with no risk	1 week prior to third scheduled ANC visit	Salam [xxx] apa. Please remember to come to ANC this week as agreed. High blood pressure may develop during this time and lead to serious problems for the mother. The baby might be born early or very small. Come to ANC and we will measure your blood pressure and manage it appropriately. [yyy]
Visit 3 reminder - for women with severe hypertension	1 week prior to third scheduled ANC visit	Salam [xxx] apa. Please remember to attend your ANC visit next week. Excess blood pressure in pregnancy may cause serious problems for the mother and the baby. Come to the health centre, and we will reassess your blood pressure. [yyy]
Visit 4 reminder - for women with no risk	1 week prior to fourth scheduled ANC visit	Salam [xxx] apa. Please remember to attend you ANC visit this week. Knowing your baby's presentation at this time can help you plan a safe delivery. Come to the health centre and we will check your baby's position. [yyy]
Visit 4 reminder - for women with anemia and GDM	1 week prior to fourth scheduled ANC visit	Salam [xxx] apa. Please remember to attend your ANC visit next week. Knowing the baby's current position helps you to plan for safe delivery. Come to the health centre, and we will check your baby's position and reassess your diabetes and anemia. [yyy]

[xxx]: woman's name; [yyy]: name of health facility; GDM: gestational diabetes

Message type	Message Timing	Message Content
1-day reminder	1 day before each routinely scheduled ANC visit	Salam [xxx] apa. Remember to attend your ANC visit tomorrow. It is very important to know your present health status. [yyy]
Facility Delivery	1 wk after last 36-week message	Salam [xxx] apa. Your health history puts you at greater risk of problems. You are advised to give birth in a facility for a safer delivery. [yyy]
Danger Sign	1 day after being diagnosed	Salam [xxx] apa. You were referred to a higher level facility for improved care yesterday. Please attend care immediately if you have not already done so. [yyy]
[xxx]: woman's name; [yyy]: name of health facility; GDM: gestational diabetes		

Table 5: Selected examples of the final targeted TCC messages (Page 38–39)

Discussion:

The study found that most of the participants could not describe ANC as a preventive form of care; it was viewed as necessary during pregnancy only if complications developed, while WHO recommends preventive ANC visits for early identification of complications [4]. We found that most women would only attend ANC after five months of pregnancy due to concerns about miscarriages. They would seek care regardless of their gestational age if complications arise. In general, the population had limited knowledge of ANC, pregnancy complications, and their consequences on both mother and their neonates. Limited ANC attendance has been shown to result in poor pregnancy outcomes [56–58]. The utilization of ANC was low, and women did not receive ANC services at the recommended time. Similar to other reports from Bangladesh, only a small proportion of women in our study received their first ANC visit within 16 weeks of gestation [9]. Most pregnant and postpartum women mentioned that ANC is required only to know the wellbeing of baby and mother. Women also reported not having adequate information on the timing and numbers of ANC visits needed in our study. A cross-sectional study found similar results and observed low levels of awareness about ANC among pregnant women in a rural area, and recommended development and strengthening of behavior change communication [59].

Poor understanding of complications, combined with the lack of contextual health education, might lead to less timely attendance at ANC. Similar to our findings, another study in Matlab, Bangladesh, reported that only 26% of women had good knowledge of pregnancy complications [15]. Several studies have showed that ANC utilization is associated with women's knowledge about pregnancy complications [15, 60, 61]. Women with poor knowledge of pregnancy complications are likely to also be unfamiliar with the consequences of the conditions. Awareness of the benefits of ANC is positively associated with positive maternal and neonatal outcomes [62].

Lack of decision-making power of women for using maternal and child health care may also contribute to low ANC utilization in Bangladesh. Women need to be empowered with adequate health information,

availability, and use of services to make their own decisions regarding healthcare through different strategies [63, 64]. Although husbands and mothers-in-law are the primary decision-makers in the household and make the majority of decisions about health service utilization during pregnancy and delivery, their knowledge of pregnancy complications was limited. Creating awareness among husbands and mothers-in-law using simple languages for health education can potentially improve maternal and neonatal service utilization [65].

The prevalence of mild to moderate anemia during pregnancy is about 50% in rural Bangladesh, and early diagnosis and management can prevent serious consequences on the health of the mother and the baby [66]. The inadequate knowledge of anemia demonstrated by the participants in our study needs to be addressed in this context. Our finding of poor knowledge of GDM is aligned with studies conducted in Bangladesh and other low-and-middle-income countries [17, 67]. Compared to diabetes and anemia, knowledge of hypertension was better, especially among postpartum women, presumably because some had developed hypertension during their pregnancy. A study conducted in Bangladesh assessing community awareness, beliefs, and experiences around hypertension found a lack of knowledge of hypertension [68]. This low level of knowledge about anemia, hypertension and diabetes implies that effective health education could improve adequate knowledge, thereby increasing ANC utilization among pregnant women.

Direct communication with health care providers was preferred by most of the respondents as a means of improving ANC utilization. However, women knew nothing about voice messages, even though they mentioned text messages as an effective communication strategy. At the time of the interviews, technical limitations of the eRegistry prevented us from setting up a two-way communication system, although this has been found to be more effective than one-way communication in other settings; as a result, this option was not discussed with women [69]. Given that women were positive to the idea of context-specific automated text messages containing ANC related information, and considering the affordability of sending automated text messages, we incorporated such text messages into the eRegistry, as previously mentioned. TCC through text messages has the potential to affordably achieve universal coverage of timely ANC services, and the TCC messages are currently being evaluated in a cluster-randomized controlled trial of the eRegistry in Matlab, Bangladesh.

To our knowledge, this is the first qualitative study in Bangladesh describing the knowledge, gaps, and perceptions of pregnant and postpartum women, mothers-in-law, and husbands on pregnancy-related care and pregnancy complications. The study shows the critical need to evaluate the local beliefs and belief structures for developing any form of client communication, especially when it will be delivered through an intermediary, such as a digital device. Key strengths of the study design and the development of TCC include having the researchers involved in all steps towards the final cluster-randomized trial of the comprehensive eRegistry, to ensure that the messages are well-integrated within the larger health systems platform. To enhance the appropriateness of the data analysis, we checked transcripts against audio recordings, and performed triangulation among codes and themes by consensus. We placed special emphasis on confidentiality, particularly important in this context where we were linking clinical

records with text messages that could be read by anyone that has access to the phone. As an example, recipients' specific risk factors were excluded from the text messages, considering that a woman might share her mobile phone with other family members. With due consideration to the cultural context, we decided to send the TCC messages one week prior to scheduled visits and a second reminder message 24 hours before the visit to empower the women for future planning and to react quickly if necessary. The output of this study is a critical component to the ongoing eRegMat trial, which is, in part, aimed at assessing the effectiveness of these automated TCC messages to increase ANC utilization. This study's findings are relevant for implementations of digital health interventions to increase ANC coverage, and serves as a model for a theoretically informed approach to TCC.

Conclusion

This study presents an example of TCC message development based on established theory and behavior change techniques with the purpose of increasing ANC utilization. Improving knowledge of pregnancy complications, and the importance of timely ANC is essential, and providing health information through text messages has the potential to increase awareness among pregnant women. The effectiveness of TCC messages are being evaluated in an ongoing cluster-randomized controlled eRegMat trial (trial registration no: ISRCTN69491836).

Abbreviations

ANC

Antenatal care; **GDM**:Gestational diabetes mellitus; **TCC**:Targeted client communication; **SMS**:Short Message Service; **MMS**:Multimedia Message Service; **eRegMat**:electronic registry Matlab; **DHIS2**:District Health Information System 2; **HBM**:Health Belief Model; **CC**:Community Clinic; **UHFWC**:Union Health and Family Welfare Centres; **DM**:Diabetes Mellitus; **BCT**:Behavior change technique; **IMB**:Information-motivation-behavioral skills model; **TRA**:Theory of reasoned action; **TPB**:Theory of planned behavior; **SCogT**:Social-cognitive theory; **CT**:Control theory..

Declarations

Ethics approval and consent to participate

The study was approved by the Research and Ethical Review Committees of the International Centre for Diarrhoeal Disease Research, Bangladesh, and the Regional Ethical Committee in Norway, Southeast region. All participants received an explanation of the purpose of the study and gave written informed consent for participation in the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets and materials used in the study are available from the corresponding author on reasonable request.

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Authors' contributions

JFF, IKF, and AR contributed to the study concept and design. IKF and JP supervised the implementation of the study. JP, UTN, AMQ, BKS, involved in data collection and JP, UTN, BKS, FK, JFF, IKF contributed to data analyses. JP and IKF drafted the initial draft of the manuscript. JP, IKF, JFF, AR, UTN, AMQ, BKS, MV, FK reviewed and approved the final version of the manuscript.

Competing interests

The authors declare that they have no competing interests.

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73. Additional. file 1. In-depth interview guides.
74. Additional file 2. Questionnaire for background information.

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