Original Paper

Mobile Health for Postpartum Contraception Knowledge in India (mMitra): Realist Evaluation Using Moderation Analysis and Structural Equation Models

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Abstract

Background: Indian National Family Health Survey data from 2021 suggest that 9.4% of women of reproductive age had an unmet need for spacing or limiting future pregnancies. Randomized controlled trials evaluating mobile health interventions (programs delivered via mobile phones) provide evidence of their potential benefit in addressing the determinants of misconceptions and lack of knowledge regarding postpartum family planning (PPFP) methods. The mMitra program has been implemented since 2014 and uses automated voice-messaging to deliver pregnancy and postpartum care information to socioeconomically vulnerable women in the Mumbai metropolitan area. However, the mMitra program has not been adequately evaluated to understand its impact on PPFP knowledge and outcomes.

Objective: This study aims to assess whether, how, why, for whom, and in what contexts the mMitra program affects PPFP awareness by analyzing cohort follow-up survey data, call duration, and attendance to measure the impact of listenership and by refining context-mechanism-outcome configurations (CMOCs) by testing for effect modification in logistic regression and structural equation models (SEMs).

Methods: This study presents the quantitative findings from the realist evaluation of the mMitra program. Moderator analysis (through testing for effect modification in a logistic regression model) and SEMs were used to test CMOCs from an accompanying realist review.

Results: After adjusting for religion as a potential confounder and including phone access as an effect modifier in the logistic regression model, mMitra call duration, a proxy measure for program engagement, had a modest effect on knowledge of one or more highly effective contraceptive methods (odds ratio 1.012, 95% CI 1.002-1.021; *P*=.02). In addition, 77% of women measured at baseline did not complete the endline survey at 6 months, potentially due to cultural expectations surrounding women returning to natal homes during their final months of pregnancy. SEMs show some evidence of an association between shared phone ownership and mMitra program engagement, potentially via the mechanism of women's ability to negotiate phone access.

Conclusions: This study adds to the growing body of evidence on the usefulness of SEM for testing CMOCs in realist evaluations. Issues with data collection and management, and the absence of survey data from locations outside Mumbai, limit the generalizability of the conclusions from this study.

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Keywords: mHealth; postpartum; family planning; realist evaluation; structural equation modeling; multivariable regression

Introduction

Background

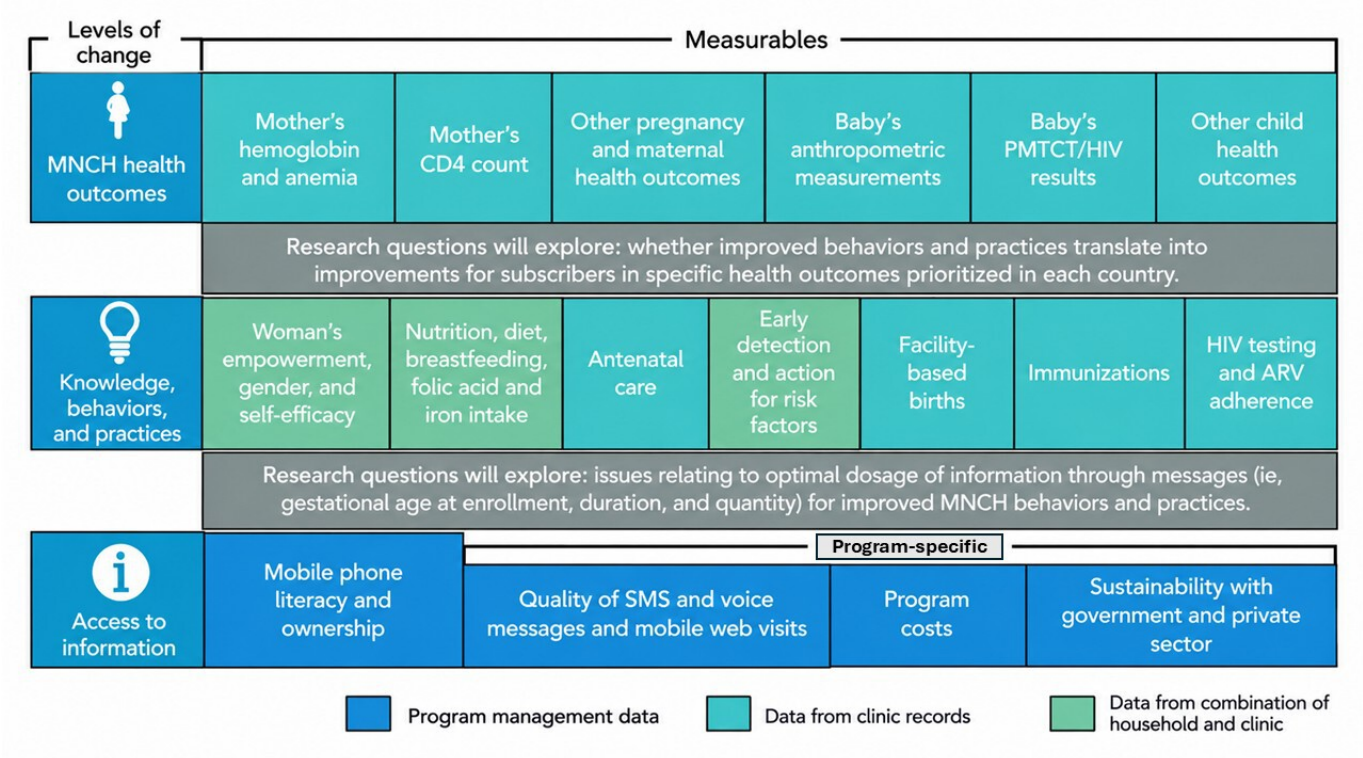
Approximately 218 million women of reproductive age (15-49 years) in low- and middle-income countries (LMICs) have an unmet need for family planning (FP) [1-4]. Indian National Family Health Survey Data from 2021 suggest that 9.4% of women of reproductive age had an unmet need for spacing or limiting future pregnancies [1]. The total unmet need for FP in India also significantly varies according to demographic determinants, such as educational attainment, the number of antenatal care visits, and place of residence [5,6]. Poor knowledge on the availability of FP services and the diversity of FP methods influence contraceptive nonuse [7]. Misconceptions regarding the effectiveness and potential side-effects associated with modern contraceptives also contribute to contraceptive nonuse among rural Indian women [8]. A descriptive study of Indian District Level Household Survey Data from 2007 and 2008 confirms this finding; women continue to use traditional, less effective methods of FP due to lack of information dissemination on modern methods by local health services [9].

Globally, mobile phone ownership has grown exponentially over the last decade [10], becoming an avenue for many individuals from LMICs to access crucial health information and services [10]. Mobile health (mHealth) includes any health program supported by or delivered through mobile technologies such as cellular phones, personal monitoring devices, and other wireless devices [11]. mHealth interventions have been used to bridge the knowledge gap on FP methods across population subsets [12]. One example is the mobile for reproductive health program piloted in Kenya and Tanzania, which was successful in improving participants' knowledge of FP services [13]. Findings from the randomized controlled trial of the Kilkari intervention in Madhya Pradesh, India, suggest that women in the intervention group were more likely to ask health care providers about FP methods compared to women in the control groups (risk ratio 1.04, 95% CI 1.01-1.07; $P<.001$) [14].

The "mMitra" program, initially piloted in Mumbai and currently being implemented in 9 Indian states, provides pregnancy and postpartum care information to participants through 141 automated voice messages [2,15]. mMitra has reached approximately 3.6 million women across India and is underpinned by the assumption that access to easily understandable and engaging information aligning with women's antenatal and postnatal stages will encourage them to perform necessary self-care measures and "seek needed health services" [16]. mMitra is modeled after the Mobile Alliance for Maternal Action intervention from South Africa, which uses the same theory of change, and proposes that sending messages tailored to women's gestational stage would motivate women to change pregnancy and postpartum self-care behaviors, which would subsequently improve maternal and child health outcomes [17]. The mMitra program messages were developed by BabyCenter, using guidelines on pregnancy self-care and infant development produced by the World Health Organization (WHO) and the Indian Health Mission [18]. For mMitra subscribers in the Mumbai Metropolitan Region, messages are delivered in Hindi or Marathi and range between 1 and 2.5 minutes in duration. mMitra messages are delivered in the chosen language and timeslot of every enrolled woman. The automated voice-message delivery system makes 9 attempts to reach every woman for each of the 141 messages. An incoming missed call system and mMitra call center service are also available to offer technical support to enrolled women.

Women are enrolled either at government health facilities by trained health workers or in communities by trained outreach workers, enabling coverage of socioeconomically vulnerable populations. By using widely available mobile phones, the program aims to address gaps in counseling and health communication within routine maternal and child health services. The program theory of change for the mMitra program proposes that delivering timely and comprehensive health information increases the knowledge of recommended practices, including adequate birth spacing between consecutive pregnancies. Increased knowledge can enhance women's motivations and perceived feelings of self-efficacy to adopt recommended practices such as postpartum family planning (PPFP). The theory of change underpinning the Mobile Alliance for Maternal Action series of interventions emphasizes the causal pathway between obtaining knowledge, subsequent motivation, and the adoption of self-care practices to improve maternal, reproductive, and child health behaviors (Figure 1).

Figure 1. Mobile Alliance for Maternal Action (MAMA) theory of change and priority outcomes applied to the development of the mMitra program (reproduced with permission from Mechael et al [16]). ARV: antiretroviral; CD4: cluster of differentiation 4; MNCH: maternal, newborn, and child health outcomes; PMTCT: prevention of mother-to-child transmission.



There is a gap in the existing evidence on the effectiveness of the mMitra program. Murthy et al [2,3] evaluated the program's impact on subscribers' postpartum health behaviors. Subscribers were no more likely (odds ratio [OR] 0.82, 95% CI 0.64-1.04) to discuss adopting an FP method or report having used an FP method compared to controls [2]. Although mMitra has scaled up across Indian geographies and contexts since the pseudorandomized trial reported above, there is a need for updated evidence on the reach and effectiveness of the program [15]. In order to understand how complex social interventions change outcomes, evaluations should explore both how various contexts can alter the intervention's functions and also how these contextual features alter the ways individuals interact with mHealth interventions [19]. To do this, mMitra listenership, engagement, and knowledge were evaluated through a cohort study (Appendix A in Multimedia Appendix 1).

We conducted a realist evaluation of mMitra [20,21] to assess the program's influence on PPFP awareness, given the substantial impact of contextual factors, such as age, income, ability to access adequate health services, individual empowerment, and interpersonal relationships [22,23]. The realist approach employs the generative model of causality that emphasizes the role of contexts and conditions in which mechanisms are activated to produce program outcomes, thus aligning with the evidence gap on the mMitra program [3,21,24]. This realist evaluation builds upon the findings of an accompanying realist review by testing and further refining the context-mechanism-outcome configurations (CMOCs) concerning whether, how, for whom, and in what contexts the mMitra program influences PPFP knowledge. The realist review identified contextual factors influencing participant engagement with mHealth interventions, such as women's access to mobile phones, household power dynamics, and social support. This realist evaluation involved a secondary analysis of quantitative data from the aforementioned cohort study. While there is ongoing debate about the usefulness of quantitative methods to test and refine CMOCs in realist evaluations [24-26], we propose that quantitative methods are useful for testing theorized causal pathways regarding how and for whom program resources change outcomes, and for assessing the strength of the association between theoretical components leading to program outcomes [21,27-29]. We propose that moderator analysis, through testing for effect modification in logistic regression models, and structural equation models (SEMs) allow for testing and refining CMOCs from the accompanying realist review and contextualize these findings within the mMitra program.

Aims and Objectives

Aim

The aim of this study is to quantitatively explore how, for whom, and in what contexts the mMitra program influences PPFP knowledge.

Objectives

The objectives of this study are

1. to analyze mMitra cohort study follow-up survey data, call durations, and attendance to evaluate the effect of mMitra listenership on PPFP awareness.

2. to refine CMOCs identified in the accompanying realist review of how, whether, and for whom the mMitra program works through testing for effect modification in logistic regression models and structural equation modeling.

Methods

Study Design

We propose that moderator analysis, through testing for effect modification in logistic regression models, and structural equation modeling allow for testing and refining CMOCs from the accompanying realist review and contextualize these findings within the mMitra program. Findings have been reported in accordance with RAMESES II (Realist and Meta-Narrative Evidence Syntheses: Evolving Standards II) reporting standards for realist evaluations [30].

Data Collection

We performed a secondary analysis of cohort study follow-up survey data and system data on call attendance and duration collected from mMitra subscribers. The original cohort study comprised data collection at baseline and 4 follow-up points administered at 3-month intervals. Routinely collected system data on call attendance and duration were extracted only for the time period corresponding to enrollment and participation in the cohort study. The second follow-up survey, approximately 6 months after enrollment, was the end line of this study because it included questions on PPFP knowledge.

Ethical Considerations

Ethical approval for the mMitra cohort study was provided by ARMMAN's Institutional Review Board (Appendix B in Multimedia Appendix 1). Ethical approval for the secondary analysis of cohort study survey data was provided by the Observational/Interventions Research Ethics Committee at The London School of Hygiene & Tropical Medicine and ARMMAN's Institutional Review Board (Appendix C in Multimedia Appendix 1).

Exposure Variables

Engagement with the mMitra program was measured in 2 ways, resulting in the following two exposure variables:

1. Total mMitra call duration—total duration in minutes of mMitra calls listened to by each subscriber.
2. Call duration of mMitra calls only on FP—duration in minutes of mMitra calls only on the topic of FP listened to by each subscriber.

Outcome Variable

PPFP awareness, the outcome variable, was defined as subscribers' awareness of one or more highly effective contraceptive (HEC) methods and was measured as a binary variable.

Contextual Variables and Mechanisms

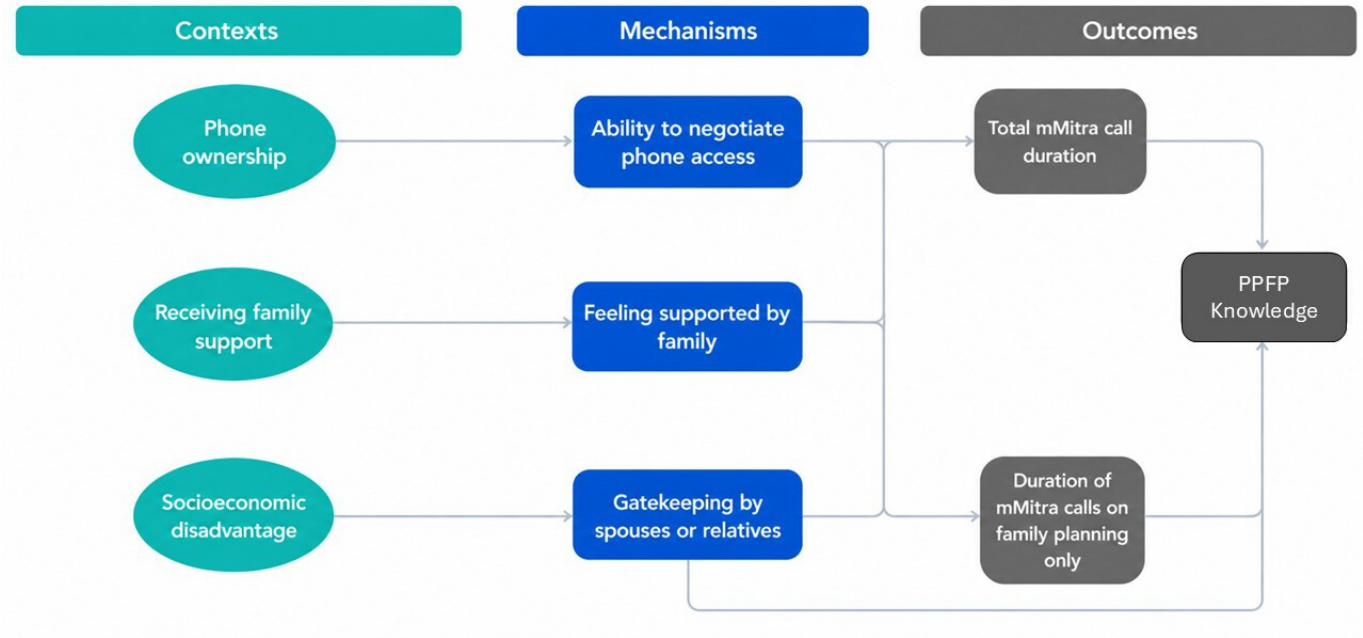
Variables representing potential realist contexts included demographic characteristics, education, religion, and indicators of phone access and household dynamics measured in the baseline survey. Age (continuous, 18-43 years), caste (open or general/other backward caste/scheduled caste, scheduled tribe, or nomadic tribe), religion (Hindu/Muslim/Buddhist/Other), and educational attainment (less than secondary education/secondary education or higher) were considered potential confounders of the association between mMitra call duration and PPFP awareness and were measured in the baseline survey. Age was considered a potential confounder because older women are more likely to have greater knowledge of PPFP needs [31-33], as well as a greater understanding of adverse pregnancy outcomes [31-33]. This means that they may be more willing to learn about pregnancy-related self-care measures, leading to greater engagement with the mMitra program. Women who have greater educational attainment may be more inclined to learn about pregnancy and postpartum care and thus engage more with the mMitra program. Women who have greater educational attainment may also have greater preexisting knowledge of PPFP methods [34-37]. Phone access was constructed as a composite binary variable by combining binary indicator variables that answered the questions outlined in Appendix D in Multimedia Appendix 1.

Women who responded with all the high-access responses for the binary indicator variables (outlined in Appendix D in Multimedia Appendix 1) were categorized as having "High access" to mobile phones. For the purposes of constructing this access variable, women who did not provide "high-access responses" for all the indicator variables were considered to have "low access" to mobile phones. Women with missing data for any of the variables were coded as missing data in this composite "Access" variable.

Latent variables, representing mechanisms identified in the realist review, were constructed using combinations of observed variables and used to test mechanisms using SEMs. These mechanisms and their potential to generate PPFP awareness improvement through greater engagement with mHealth programs are rooted in evidence from the accompanying realist review. We started by identifying variables in the dataset that could theoretically reflect the latent mechanisms to be tested based on evidence from the realist review (Appendix G in Multimedia Appendix 1). We tested Cronbach α values for each combination of observed variables that could make up the latent mechanism variables to test for construct validity and internal consistency. The combination of observed variables with the highest Cronbach α value was selected. The following CMOCs were tested using structural equation modeling (Figure 2). Different combinations of the measured variables were used to construct the mobile phone access variable used in the logistic regression model and the latent variables used in the SEMs. This is to reflect the overarching realist logic underpinning this study. These variables (Appendix D in Multimedia Appendix 1) reflect women's access to

mobile phones and consider household dynamics that could influence these concepts, which can be explored through logistic regression models. However, certain elements of phone access (eg, whose phone is registered with the mMitra program) may influence other elements of phone access such as a women's confidence to ask to use shared mobile phones from other family members, which is better explored through constructing SEMs.

Figure 2. Context-mechanism-outcome configurations (CMOCs) from accompanying realist review tested through structural equation models (SEMs). PPFP: postpartum family planning.



Data Analysis

We conducted univariate analysis of the exposure, outcome, potential confounders, and potential effect modifiers to describe the demographic characteristics of the study sample. The results are presented as frequencies and percentages for categorical or binary variables and as means and SDs for continuous variables.

We summarized call durations by sociodemographic characteristics and compared them using z-tests. Bivariate analysis was conducted between the exposure and outcome variables to calculate a crude OR. Mantel-Haenszel OR estimates were used to assess potential confounding or effect modification of the association between mMitra call duration and PPFP awareness. Potential confounders not on the causal pathway were considered for inclusion in the logistic regression model if there was evidence of an association ($P \leq .05$) between the confounder and both the exposure and outcome variables.

In the multivariable analysis, 2 logistic regression models were built: one for each of the 2 exposure variables. Confounders and effect modifiers (Table S1 in Multimedia Appendix 2) were added sequentially based on bivariate analysis findings and rationalized by evidence from the literature. A threshold of $P \leq .05$ was used to determine the statistical significance of estimates. Crude ORs, adjusted ORs, and their associated 95% CIs are reported to 2 or 3 decimal places to ensure that the small differences in effect estimates are reflected in the results.

We built 3 SEMs to represent causal pathways (mechanisms) identified in CMOCs from the accompanying realist review (Figure 2). These included (1) receiving and feeling supported by family, (2) ability to negotiate phone access, and (3) gatekeeping of mMitra phone access by spouses and relatives. Principal component analysis and confirmatory factor analysis were used to assess the structure and reliability of covariance among observed variables forming each latent construct. We used a conservative Cronbach α threshold of ~.60 to account for inconsistencies and error in the reporting and measurement of observed variables [38-40]. SEMs were built using Stata 18 (StataCorp LLC) [41] and statistical significance was defined as $P \leq .05$. As alpha values informed latent variable construction, goodness-of-fit estimates were not used to assess model fit. The decision to treat "Receiving family support" (ie, do family members encourage you to listen to mMitra calls?) as a contextual factor distinct from the mechanism of "feeling supported by family" was based on realist review findings: emotional support and confidence to engage with mHealth were enabled by practical access to a phone [42]. PPFP awareness and mMitra engagement were modeled as outcomes in the CMOCs, reflecting the realist review's identification of mHealth engagement as an outcome produced by mechanisms operating within specific contexts. Given the exploratory and theory-testing nature of this analysis, we interpreted findings cautiously and emphasized patterns consistent with hypothesized CMOCs.

Results

Study Population Characteristics

Baseline data were collected from 884 mMitra subscribers; a large percentage of these subscribers were lost to follow-up and were not captured at end line (the second follow-up survey data were collected approximately 6 months after baseline). There were negligible differences in demographic characteristics of mMitra subscribers between those who completed the second follow-up survey and those who were lost to follow-up.

Out of 884 individuals who were captured at baseline, 683 (77.3%) women were lost to follow-up and 201 women completed follow-up survey 2. There were no significant differences in demographics or access among women lost to follow-up and those captured at end line (Table S1 in Multimedia Appendix 2). Table 1 describes the number of minutes the 201 women in the end line survey had spent listening to mMitra calls and to the call segments containing FP messages. Table S2 in Multimedia Appendix 3 presents the proportion of the end line respondents who were aware of one or more highly effective methods of contraception. There were small variations by sociodemographic characteristics in both the total duration of calls listened to and the duration of FP calls, but *z*-test results (not shown) indicated that these were all likely to be chance variations (Table 2). Awareness of at least one highly effective method of contraception did not differ by age, education, or gestational age at enrollment. It was highest among women of open or general caste, Muslim women, and those with low access to a mobile phone at baseline (Table S2 in Multimedia Appendix 3).

Table 1. Awareness of modern methods of contraception among respondents to follow-up survey, by sociodemographic characteristics.

Characteristic	Number of respondents, n	Traditional methods only, n (%)	Modern HEC[a] methods, n (%)
Total	171	84 (49.12)	87 (50.88)
Age (y)			
<20	2	1 (50.00)	1 (50.00)
20-30	142	70 (49.30)	72 (50.70)
≥31	27	13 (48.15)	14 (51.85)
Highest completed education			
Less than secondary education	32	19 (59.38)	13 (40.62)
Secondary education or higher	139	65 (46.76)	74 (53.24)
Gestational age at enrollment (mo)			
<6	126	61 (48.41)	65 (51.59)
≥6	45	23 (51.11)	22 (48.89)
Caste			
Open or general	101	40 (39.60)	61 (60.40)
OBC[b]	16	13 (81.25)	3 (18.75)
SC[c]/ST[d]/NT[e]	31	18 (58.06)	13 (41.94)
Religion			
Hindu	77	45 (58.44)	32 (41.56)
Muslim	78	25 (32.05)	53 (67.95)
Buddhist	12	10 (83.33)	2 (16.67)
Other	1	1 (100)	0 (0.00)
Access			
Low access	63	28 (44.44)	35 (55.56)
High access	58	32 (55.17)	26 (44.83)

[a]HEC: highly effective contraceptive.
[b]OBC: other backward caste.
[c]SC: scheduled caste.
[d]ST: scheduled tribe.
[e]NT: nomadic tribe.

Table 2. Demographic characteristics of mMitra cohort study population.

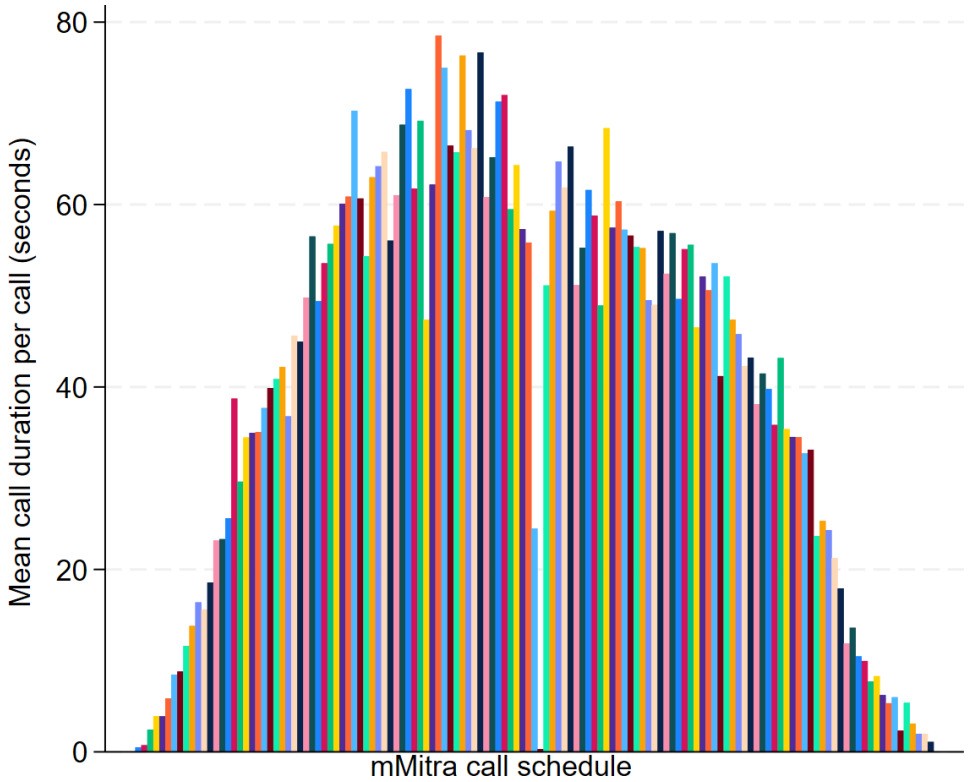
Characteristic	Lost to follow-up (n=683)	Followed up in survey 2 (n=201)	Total (N=884)
Age at enrollment (y), mean (SD)	25.39 (4.00)	26.28 (4.00)	25.61 (4.01)
Total call duration (min), mean (SD)	73.93 (67.01)	118.44 (68.58)	84.05 (69.87)
FP[a]-only call duration (min), mean (SD)	5.75 (4.62)	8.24 (4.60)	6.39 (4.74)

Characteristic	Lost to follow-up (n=683)	Followed up in survey 2 (n=201)	Total (N=884)
Highest completed education, n (%)			
Less than secondary education	125 (19.8)	37 (18.4)	162 (19.4)
Secondary education or higher	507 (80.2)	164 (81.6)	671 (80.6)
Gestational age, n (%)			
Less than 6 months	438 (64.1)	144 (71.6)	582 (65.8)
6 months or more	245 (35.9)	57 (28.4)	302 (34.2)
Caste, n (%)			
Open or general	346 (73.0)	120 (69.4)	466 (72.00)
Other backward caste (OBC)	45 (9.5)	17 (9.8)	62 (9.6)
Scheduled caste/scheduled tribe/nomadic tribe	83 (17.5)	36 (20.8)	119 (18.4)
Religion, n (%)			
Hindu	308 (49.6)	95 (48.0)	403 (49.2)
Muslim	281 (45.2)	90 (45.5)	371 (45.3)
Buddhist	28 (4.5)	12 (6.1)	40 (4.9)
Other	4 (0.6)	1 (0.5)	5 (0.6)
Access, n (%)			
Low access	218 (52.5)	72 (52.2)	290 (52.4)
High access	197 (47.5)	66 (47.8)	263 (47.6)
Total, n (%)	683 (77.3)	201 (22.7)	884 (100)

[a]FP: family planning.

Mean call duration per call was highest during the mMitra calls scheduled for later in pregnancy (Figure 3). Mean call duration per call also tapers off during the final calls of the mMitra schedule. The second message delivered during week 39 had the lowest call duration (mean 0.31, SD 6.12 seconds) and most women in the dataset did not attend this call (n=750).

Figure 3. Mean call duration per call of the mMitra call schedule.



On average, women who were more aware (knew one or more HEC methods in the follow-up survey) had listened to 123.38 minutes of the mMitra program, whereas women who were less aware (only knew traditional FP methods) listened to a mean total mMitra call duration of 120.37 (SD 71.37) minutes. Women who were more aware had a mean duration

of FP-only calls of 8.05 (SD 4.47) minutes, whereas women who were less aware had a mean duration of FP-only calls of 8.83 (SD 4.71) minutes.

Crude Association Between Call Durations and PPFP Knowledge

There was no evidence of an association between total mMitra call duration per participant and PPFP awareness (OR 1.00, 95% CI 0.997-1.004; *P*=.83). There was some evidence of an association between religion and total mMitra call duration (OR 0.61, 95% CI 0.40-0.92; *P*=.02) as well as between religion and PPFP awareness (OR 2.15, 95% CI 1.16-3.99; *P*=.02; Multimedia Appendix 4). Therefore, religion was adjusted for as a confounder in the logistic regression model of the effect of total mMitra call duration on PPFP awareness. No variables fulfilled the criteria for confounding in the logistic regression model of the association between the duration of FP-only calls and PPFP awareness. There was no evidence of an association between the duration of FP-only calls and PPFP awareness (OR 0.97, 95% CI 0.91-1.03; *P*=.32).

Multivariable Analysis—Logistic Regression

Main Findings

There was some evidence of an association between total mMitra call duration and PPFP awareness after including an interaction term reflecting phone access as an effect modifier and religion as a confounder (OR 1.012, *P*=.02). Of the 3 CMOCs tested via SEM (feeling supported by family, ability to negotiate phone access, and gatekeeping by spouses or family), there was some evidence of an indirect association between context (phone ownership) and outcomes (mMitra program engagement) via the mediating mechanism of women's ability to negotiate phone access.

Association Between Total mMitra Call Duration and PPFP Awareness

After including an interaction term reflecting phone access as an effect modifier and religion as a confounder, there was some evidence of an association between total mMitra call duration and PPFP awareness. Women with low access to mobile phones (effect modifier) were the reference group for this regression model. For every 1-minute increase in total mMitra call duration, mMitra subscribers with low access to mobile phones had 1.012 times greater odds of identifying one or more HEC methods (OR 1.012, 95% CI 1.002-1.021; *P*=.02). There was no evidence of an association between total mMitra call duration and PPFP awareness among women with high access to mobile phones (OR 0.997, 95% CI 0.989-1.005; *P*=.48). Likelihood-ratio test estimates (*P*=.02) provide evidence that the logistic regression model is a better fit with the addition of the interaction term between phone access and total mMitra call duration. Religion was associated with the outcome as a confounder.

Association Between the Duration of mMitra Calls on FP Only and PPFP Awareness

We did not conduct a multivariable regression analysis with the duration of FP-only calls as the exposure variable because no significant confounders or effect modifiers were identified in the bivariate analysis.

SEMs

SEMs were built to test 3 CMOCs. These CMOCs were chosen because latent variables could plausibly be constructed using the measured variables in the mMitra cohort study dataset. We measured the direct association between context and outcome and the indirect association between context and outcome via a mediating mechanism (indirect association).

Feeling Supported by Family

Cronbach α for this SEM indicated good reliability (0.65). There was no evidence of a direct context-outcome or indirect context-mechanism-outcome association in this SEM (Table 3).

Table 3. Direct (context to outcome) and indirect (context to outcome via mechanism) effects of family support context-mechanism-outcome configurations (CMOCs) detailing the mechanism of feeling supported by family tested via structural equation modeling (context: receives family support).

Outcome	Direct effect (context to outcome)		Indirect effect (context to outcome via mechanism)	
	β or OR[a] (95% CI)	*P* value	β or OR (95% CI)	*P* value
Total mMitra call duration	1.89[b] (–48.62 to 52.41)	.94	10.78[b] (–37.82 to 59.38)	.66
Duration of calls on FP[c] only	.70[b] (–2.99 to 4.38)	.71	–.04[b] (–3.59 to 3.50)	.98
PPFP[d] awareness	0.77[e] (0.38 to 1.46)	.47	1.32[e] (0.68 to 2.58)	.41

[a]OR: odds ratio.
[b]Denotes β values.
[c]FP: family planning.
[d]PPFP: postpartum family planning.
[e]Denotes OR values.

Ability to Negotiate Phone Access

Cronbach α for this SEM indicated moderate reliability (0.59). There was some evidence of an indirect association between phone ownership (context) and total mMitra call duration (outcome) via the mechanism of women's ability to negotiate phone access (β=−16.54, 95% CI −31.61 to −1.47; *P*=.03). This means women who shared mobile phones with husbands or relatives listened to 16.54 fewer minutes of the mMitra program because they were unable to negotiate phone access compared to women who used their own mobile phones to engage with the mMitra program. There was also some evidence of an association between phone ownership (context) and the duration of mMitra calls for FP only (outcome) via the mechanism of women's ability to negotiate phone access (β=−1.41, 95% CI −2.52 to −0.29; *P*=.01; Table 4).

Table 4. Direct (context to outcome) and indirect (context to outcome via mechanism) effects of context-mechanism-outcome configurations (CMOCs) detailing the mechanism of women's ability to negotiate phone access tested via structural equation modeling (context: phone registered with mMitra [own phone or shared phone with spouse/relatives]).

Outcome	Direct effect (context to outcome)		Indirect effect (context to outcome via mechanism)	
	β or OR[a] (95% CI)	*P* value	β or OR (95% CI)	*P* value
Total mMitra call duration	.93[b] (–23.08 to 24.94)	.94	–16.54[b] (–31.61 to –1.47)	.03[c]
Duration of FP[d]-only calls	–.32[b] (–2.09 to –1.41)	.72	–1.41[b] (–2.52 to –0.29)	.01[c]
PPFP[e] awareness	1.33[f] (0.83 to 2.14)	.24	0.87[f] (0.63 to 1.20)	.40

[a]OR: odds ratio.
[b]Denotes β values.
[c]*P*≤.05 was considered statistically significant.
[d]FP: family planning.
[e]PPFP: postpartum family planning.
[f]Denotes OR values.

Gatekeeping by Spouses or Relatives

Cronbach α for this SEM indicated moderate reliability (0.61). There was some evidence of a direct association between socioeconomic disadvantage (context) and PPFP awareness (outcome; OR 0.57, 95% CI 0.33-1.01; *P*=.054; Table 5).

Table 5. Direct (context to outcome) and indirect (context to outcome via mechanism) effects of context-mechanism-outcome configurations (CMOCs) detailing gatekeeping by spouses and relatives tested via structural equation modeling (context: socioeconomic disadvantage).

Outcome	Direct effect (context to outcome)		Indirect effect (context to outcome via mechanism)	
	β or OR[a] (95% CI)	*P* value	β or OR (95% CI)	*P* value
Total mMitra call duration	–14.57[b] (–40.21 to 11.07)	.27	1.27[b] (–5.57 to 8.11)	.72
Duration of FP[c]-only calls	–1.76[b] (–3.64 to 0.11)	.07	.09[b] (–0.38 to 0.56)	.72
PPFP[d] awareness	0.57[e] (0.33 to 1.01)	.054[f]	1.00[e] (0.99 to 1.01)	.95

[a]OR: odds ratio.
[b]Denotes β values.
[c]FP: family planning.
[d]PPFP: postpartum family planning.
[e]Denotes OR values.
[f]*P*≤.05 was considered statistically significant.

Discussion

Main Findings

This analysis found some evidence for a modest association between total mMitra call duration and PPFP awareness. Although the effect size per additional minute of listening to the mMitra program was small, women, on average, listened to approximately 118 (SD 68.58) minutes of the mMitra program. Thus, the effect of this program could compound over time to lead to a substantial increase in awareness. Shared ownership of mobile phones (context) lowered women's ability to access the program (mechanism), which led to slightly poorer engagement (outcome). Building on the logistic regression models, an examination of specific domains of phone access through the SEM suggests that access can influence engagement with the program contingent on context. Although women with low-access to mobile phones were most likely to benefit from the mMitra program, the program was not designed intentionally to increase phone access, and therefore engagement, in this group. There was also some evidence that women who experienced gatekeeping by spouses and relatives of a shared mobile phone (context) were less likely to identify HEC methods (outcome). There was a 77% loss to follow-up by 6 months. It is important to note that this study aimed to unpick the associations between many co-occurring complex concepts using all available data,

and the findings of this study were interpreted by acknowledging these limitations.

Interpretation

There was evidence of a significant difference in the effect of listening to the mMitra program between women who had low access to a mobile phone and those who had high access to a mobile phone. It is possible that women with high access to mobile phones may have had less knowledge to gain from listening to the mMitra program. At end line, the proportion of women aware of a highly effective method of contraception was at 55%, higher in the low access group than in the high access group (44%); there may have been a larger increase in awareness among the low access group if they started from a lower baseline level of knowledge. Awareness of PPFP was conducted during the second follow-up survey, administered 6 months after enrollment in the mMitra program, which means we are not able to test this. This limits our ability to conclusively determine the salience of the identified mechanisms and their ability to generate program engagement and PPFP awareness outcomes.

The difference in the association of mMitra listenership with PPFP awareness between women with low access to a mobile phone and those with high access may be explained by differences in the relevance of the other program content. FP messages make up less than 10% of the overall mMitra program content, and the messages are spread over the course of several months. If the other program content was less useful for women with high access to a mobile phone, perhaps due to existing high levels of knowledge, they may have "switched off" and been less receptive to the FP messages, even though they listened to the same amount as women with low access.

It is possible that the mMitra program potentially activates women's interest in self-care during pregnancy and the postpartum period, and that the full dose of content is not required to elicit changes in PPFP awareness. mMitra subscribers may then choose to access contraceptive information through alternative sources such as health care providers. mMitra subscribers do not exist in isolation, and there are several information sources they can access to improve their health literacy during pregnancy and the postpartum period that may lead to a drop in their active engagement with the mMitra program. We do not know what caused women to disengage. A greater understanding of how to tailor the mode of delivery, and how much of the mMitra program women are willing to receive may help build on the theories of tailored and personalized messaging to activate motivation for health behavior change, which reflects a key CMOC developed and refined through the findings of the accompanying realist review.

We assessed exposure to the intervention as a continuous variable; however, there may not be a linear relationship between listening to the program and increase in knowledge. There may be a threshold at which increased exposure to the mMitra program does not affect PPFP awareness, or, conversely, a minimum level of exposure below which no effect is observed. A dose-response relationship may still exist on either side of a threshold in mMitra call duration. We had no reason to suspect a threshold effect, as each message delivered content on different topics. Messages were "drip-fed" to participants, and listening to complete messages was necessary to receive all planned information. Future research on patterns of engagement with the mMitra program could provide better insight into the dose of program content required to fully engage women and yield improvements in PPFP awareness and outcomes.

The analysis used two proxy variables for mMitra program engagement: (1) total mMitra call duration and (2) duration of mMitra calls on FP. However, neither of these variables captured participants' active listening to the call content. The measurement of participants' completion of each message and whether "dropped" calls were reinitiated by participants could have added to the depth of analysis on participants' true engagement with the program. The mMitra program's delivery system, using one-way automated voice-messaging, may contribute to our inability to assess the accuracy of the theorized CMOCs when applied to real-time data. For instance, incorporating more advanced conversational or bidirectional messaging channels in the mMitra program may aid in assessing women's interactions with the program content, as seen in recent interventions [43]. For instance, the PROMPTS SMS platform designed and delivered by Jacaranda Health in 2023 used AI capabilities to enable a conversational experience between participants and the interventions. This allowed for triaging of concerns and offering personalized solutions in real time. While the mMitra program offers a similar telephone help desk and reminds subscribers of the availability of this service at the end of each message, this service can only be accessed by subscribers who feel motivated to call the number and converse with someone regarding their concerns. Measuring these elements and assessing their associations with program engagement outcomes could strengthen the methodological approach of SEM within realist evaluation.

A large percentage of women (~71%) who were enrolled at baseline did not complete the second follow-up survey, which reduced the statistical power for the analysis. Call duration information is available for the nonrespondents and shows that this loss to follow-up occurred across the 6-month period. There were no significant differences between those who responded to the second survey and nonrespondents with respect to age, educational attainment, caste, or religion. Women who did not complete the second survey had listened to fewer minutes of calls and may have lost interest in the mMitra program (only 128 out of 683 women who did not respond to the end line survey listened to the last scheduled mMitra call). Women who enrolled in the program at a later gestational age were less likely to have responded to the follow-up survey, perhaps because they were occupied with newborn care duties. Among those who responded to the follow-up survey, there was no difference in engagement by gestational age at enrollment. Those lost to follow-up may have differed from those who were retained in factors associated with accessing mobile phones (such as household income, cellular network infrastructure, and digital literacy)

and FP knowledge, if these were not correlated with the demographic characteristics outlined in Table S1 in Multimedia Appendix 2. This might have biased the results if women who felt they had gained from the program were the most likely to take part in the follow-up survey. However, there are other, more neutral, explanations for the poor response in the follow-up survey. It is common for women to temporarily move to their natal home during late pregnancy leading up to delivery, and this may have led to nonresponse.

SEM provided evidence supporting the CMOC pertaining to gatekeeping of phone access and PPFP awareness as well as associations between phone ownership (context) and mMitra program engagement (outcome). Since the data used to build the SEMs were observational, we cannot conclusively determine a causal link between the tested intervention mechanisms and their potential to generate outcomes related to improvements in PPFP awareness or mMitra program engagement.

The loss to follow-up within 6 months of enrollment may be indicative of systemic issues with program engagement. Since there was no difference in demographics between the groups lost to follow-up and those who were retained, it is difficult to predict why women were less likely to continue engaging with the program even while residing in their natal homes. The loss to follow-up may also reflect women's lack of interest in engaging with the program. A gradual decrease in call duration per call during the final messages of the mMitra program may indicate waning interest or motivation to continue listening to the calls as women may perceive their or their child's risk of adverse health outcomes to be lower than during the pregnancy or initial postpartum period.

Comparison to Existing Literature and Implications for Future Research

Evidence from the literature suggests that repetitive information delivered through automated calls may lead to subscriber disinterest and disengagement from the program; call dropout rates steadily decreased in a sexual and reproductive health mHealth intervention for adolescents in Sierra Leone [44]. Alshurafa et al [45] also suggest that there is a disconnect between metrics used to measure doses received by participants of mHealth programs and the true "engagement" required to activate health behavior changes. The commentary by Alshurafa et al [45] on the connection between intervention engagement and health behavior change further suggests that there is still no consensus in the literature regarding the optimal dose of mHealth programs required to elicit health behavior change. Findings from the accompanying realist review theorized the importance of gestational stage-based messaging and tailored content to activate motivation to engage with an mHealth program and potentially improve PPFP awareness or awareness [42]. Future research could build on this study's findings by aiming to appropriately measure and identify a dose-response relationship between mMitra engagement and PPFP behaviors.

Lower mean call durations at the end of the mMitra call schedule potentially align with the results of the accompanying realist review, which suggests that the motivation of women who were lost to follow-up may have been activated if their enrollment in the program occurred earlier in their pregnancy to capitalize on their inherent high intrinsic motivation to seek health information [46-54]. Women may have enrolled in the program due to social pressure and expectations from trusted health professionals rather than intrinsic motivation or interest. This may have impacted the low mean call durations in the initial calls of the mMitra program. Longer call durations picking up later in pregnancy may correlate with increased anxieties in women regarding the health of their babies. Previous studies of nonuse attrition in an mHealth program targeting adolescent health behaviors suggest that participants' perceptions of the benefits of the program were a key determinant of continued engagement [55]. An evaluation conducted by Mauriello et al [56] of an mHealth program providing prenatal and postpartum care to women with low socioeconomic status in Rhode Island suggested that continued efforts to engage with participants through community outreach at health care centers could be an effective strategy to reduce dropout rates [56]. The mMitra program theoretically employs a similar "tech + touch" approach to encourage behavior change [15]. Perhaps, more frequent opportunities for interaction between mMitra subscribers and stakeholders could yield greater engagement with the program and potential behavior change. It would be helpful for future research on the mMitra program to also address the contexts in which the mechanism of subscriber disinterest is activated to yield the outcome of poor program engagement.

While this study tests CMOCs that are rooted in empirical evidence from the accompanying realist review, the findings could be strengthened if the realist evaluation approach were embedded within the cohort study design and data collection procedures. This type of data collection and analysis would also align with current debates on the use of quantitative indicators to estimate associations within CMOCs.

These findings contribute to the growing body of literature exploring the usefulness of structural equation modeling as a method to test and refine CMOCs in realist evaluations. Ford et al [57] used SEM to test CMOCs representing access to primary care facilities by socioeconomically disadvantaged older people living in rural communities. Although they concluded that SEM is a feasible and appropriate method for quantitative analysis in realist evaluations, they state that this analysis should form part of a mixed methods approach to realist evaluations of complex social phenomena. Abildgaard et al [58] used structural equation modeling to analyze data from a cluster randomized trial aimed at understanding the interactions between organizational contexts and intervention mechanisms in yielding improvements to the psychosocial work environment. They used qualitative interview data to complement their SEMs, thus concurring with the Ford et al [57] approach to using SEM in realist evaluations. As far as we know, there have not been any studies using structural equation modeling to investigate the mediating effects of mechanisms on mHealth interventions and their influence on PPFP outcomes. Based on the findings from this study, it is

evident that SEM can be used to test predefined CMOCs that are built through primarily qualitative data or qualitatively analyzed empirical evidence from the literature. Collecting primary quantitative data that explicitly represent CMOC components would positively build on the strengths of SEM used in this study.

Strengths and Limitations

This analysis of cohort study survey data contributes to the growing body of evidence, supporting the inclusion of quantitative data to test and refine emerging program theories. A key strength of this evaluation is that it was informed by and empirically tested the validity of CMOCs from an accompanying realist review through evidence from an mHealth program implemented in an LMIC setting [42]. However, this study is not without its limitations. Overreliance on categorical data also limited model fit in many instances because these variables could not capture the variability in the data. Furthermore, insufficient availability of data from mMitra subscribers from locations other than Mumbai limited the ability to generalize conclusions on the effectiveness of the program. The duration of the study follow-up period, and the duration of the mMitra program by extension, may have contributed to the high loss to follow-up. The assessment of knowledge outcomes at a single time point is a notable limitation. In addition, it is important to note that engagement in the program was a proxy measurement, and it is unclear whether the call-duration measure captured participants' attention to, and comprehension of, the delivered messages.

Conclusions

To our knowledge, this is the first realist evaluation to be directly informed by a realist review of mHealth program implementation in LMICs, addressing FP knowledge and awareness. Findings from the quantitative study suggest a modest impact but highlight the importance of phone access as a contextual factor influencing mMitra's effectiveness. Future research on the mMitra program should focus on testing additional CMOCs from the literature to assess their relevance and impact, especially when scaling across diverse cultural and geographic contexts.

Generative AI Use

The authors declare that generative AI (GenAI) tools (Microsoft CoPilot and GPT-6) were used in the research and writing process. According to the GAIDeT taxonomy (2026), the following tasks were delegated to GenAI tools under full human supervision: proofreading and editing. Responsibility for the final manuscript lies entirely with the authors. GenAI tools are not listed as authors and do not bear responsibility for the final outcomes.

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Data Availability

The datasets generated or analyzed during this study are not publicly available currently as they are being processed for storage in a data repository. Data are available from the corresponding author upon reasonable request.

Authors' Contributions

Conceptualization: AC
Data curation: AC
Formal analysis: AC
Funding acquisition: AC
Investigation: AC
Methodology: AC
Project administration: AC
Resources: NM
Software: AC
Supervision: ES, JF, NM, EW, CF
Validation: ES, JF, NM, EW, CF
Visualization: AC
Writing – original draft: AC
Writing – review & editing: AC, ES, JF, NM, EW, CF

Conflicts of Interest

None declared.

Multimedia Appendix 1

Data and variables used to create a composite "mobile phone access" variable.
[DOCX File (Microsoft Word File), 583 KB-Multimedia Appendix 1]

Multimedia Appendix 2

Construction of composite mobile phone access variable.
[DOCX File (Microsoft Word File), 16 KB-Multimedia Appendix 2]

Multimedia Appendix 3

Time follow-up survey respondents spent listening to mMitra calls and sections of calls containing family planning messages, by sociodemographic characteristics.
[DOCX File (Microsoft Word File), 19 KB-Multimedia Appendix 3]

Multimedia Appendix 4

Adjusted odds ratios for the association between total mMitra call duration and postpartum family planning awareness.
[DOCX File (Microsoft Word File), 15 KB-Multimedia Appendix 4]

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Abbreviations

CMOC: context-mechanism-outcome configuration
FP: family planning
HEC: highly effective contraceptive
LMIC: low- and middle-income country
mHealth: mobile health
OR: odds ratio
PPFP: postpartum family planning
RAMESES II: Realist and Meta-Narrative Evidence Syntheses: Evolving Standards II
SEM: structural equation model
WHO: World Health Organization

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