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How a Multi-Component Mobile Health Strategy Improved Uptake of India's Janani Suraksha Yojana Cash Transfer Program Among Rural Pregnant Women in Wardha District

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Abstract: Background: Wardha district in rural Maharashtra continues to struggle with maternal health issues, recording a maternal mortality ratio of 62.5 per 100,000 live births. Although India's Janani Suraksha Yojana (JSY) program offers cash incentives for institutional deliveries, uptake among eligible rural women remains disappointingly low. Common barriers include poor awareness of the scheme, practical difficulties in accessing services, and deep-rooted cultural factors that discourage hospital births. **Objectives:** We set out to determine whether a mobile phone-based health intervention could meaningfully improve how pregnant women in rural Wardha learn about, sign up for, and actually use JSY benefits. **Material and methods:** We conducted a pair-matched cluster quasi-experimental study involving 420 pregnant women across 24 villages, with randomized allocation within matched pairs assigning 12 villages each to intervention and control arms. The 15-month intervention combined text messages, automated voice calls featuring stories from other mothers, and WhatsApp support groups facilitated by local health workers. We analysed data using mixed-effects models with wild cluster bootstrap for small-sample inference, complemented by modified Poisson regression for relative risk estimation. **Results:** Women in the intervention group delivered at health facilities at a rate of 92.4%, compared with 74.3% in the control group (adjusted RR=1.23, 95% CI: 1.11-1.36, p<0.001). JSY registration increased from 67.6% to 87.6% among intervention participants, while control villages saw minimal change (difference-in-differences: +18.1 percentage points, p<0.001). Knowledge scores improved by 87% in the intervention arm versus 14% in controls. Subgroup analyses, adjusted for multiple comparisons using Benjamini-Hochberg correction, confirmed greater effects among illiterate women (interaction p=0.003) and below-poverty-line families (interaction p=0.008). Estimated cost was USD 4.82 per participant. **Conclusions:** A relatively simple mobile health intervention can substantially boost awareness and use of government maternal health programs. The fact that benefits were greatest among the most disadvantaged women suggests this approach could help address longstanding inequities in healthcare access.**Funding sources.**Doctoral research; no external funding received.

Keywords: mobile health; maternal health services; conditional cash transfer; institutional delivery; health education; India; mHealth; pregnancy; rural health

INTRODUCTION

India has made remarkable strides in reducing maternal deaths over the past twenty years, yet the problem is far from solved. In rural Maharashtra, women still die at rates of 36-38 per 100,000 live births according to the latest Sample Registration System figures (1). The situation in Wardha district is even more concerning, with maternal mortality running at 62.5 per 100,000—a stark reminder that progress has been uneven (2).

Back in 2005, the Indian government launched an ambitious program called Janani Suraksha Yojana, or JSY for short. The idea was straightforward: pay women cash if they deliver their babies in proper health facilities rather than at home (3). On paper, it seemed like an elegant solution—financial incentives to overcome the poverty barrier that keeps so many women from seeking professional care during childbirth. And indeed, JSY has contributed to increased institutional delivery rates nationally. But here's the catch: many women who qualify for the program never actually use it (4). They either don't know it exists, can't figure out how to enroll, or face other obstacles that nobody anticipated when the scheme was designed.

This is where mobile phones enter the picture. Over the past decade, researchers working in low- and middle-income countries have found that simple interventions delivered through mobile devices—text messages, voice calls, smartphone apps—can genuinely move the needle on maternal and child health (5,6). India itself has seen several large-scale maternal mHealth programs, most notably Kilkari and ARMMAN's mMitra, which have reached millions of women with voice-based health information (7,8). These programs have demonstrated modest but meaningful improvements in health behaviours, though their effects on conditional cash transfer uptake specifically have not been the primary focus. Systematic reviews have documented how mHealth approaches can boost antenatal visit rates, encourage facility-based deliveries, and improve postnatal care uptake (9). What's been missing, though, is solid evidence on whether mHealth can specifically enhance the reach and effectiveness of cash transfer programs like JSY—a gap we aimed to address.

We designed this study to test whether a mobile health intervention could increase institutional delivery rates by improving how women engage with JSY. Beyond that, we wanted to understand whether such an intervention might change women's knowledge and attitudes about the program, whether it would actually get more women enrolled, and whether certain groups might benefit more than others.

METHODS

Study design and setting

We carried out a pair-matched cluster quasi-experimental study in rural Wardha district, Maharashtra, between March 2024 and May 2025. We identified 24 villages and matched them into 12 pairs based on population size (within 15%), distance to nearest primary health centre (within 3 km), and historical institutional delivery rates from district health records for 2022-23 (within 10 percentage points). Within each matched pair, we used computer-generated random numbers to allocate one village to the intervention arm and one to control. This randomization within pairs was performed by a statistician not involved in participant recruitment, using sealed opaque envelopes opened after pair matching was complete.

Contamination prevention

We took several steps to minimize the risk of information spilling over between study arms. Paired villages were required to be at least 8 kilometres apart with no shared ASHA workers or common markets. Each ASHA worker served only one study village, and we provided explicit instructions not to share intervention materials with colleagues. WhatsApp groups were set to admin-only posting to prevent content forwarding, and we removed metadata from shared images. During monthly supervision visits, we asked control village ASHAs whether they had heard about our messaging program—only 3 of 48 (6.3%) reported any awareness, and none had received specific content.

Participants

We recruited pregnant women living in these villages who met two key criteria: they had to be eligible for JSY (meaning they belonged to scheduled castes, scheduled tribes, or families classified as below the poverty line) and they had to be early enough in their pregnancy—20 weeks or less—to benefit from the full intervention. We excluded women who lived outside our study villages, those who didn't qualify for JSY, and anyone unable to give informed consent.

Sample size calculation

Before starting, we calculated how many participants we would need to detect a meaningful difference. Working from a baseline institutional delivery rate of around 40% (based on district records for our study villages in 2022-23), we aimed to detect a 15 percentage point improvement. With 80% statistical power and a 5% significance threshold, and after accounting for the clustered nature of our data (intraclass correlation coefficient of 0.08 based on pilot data, giving a design effect of 2.28) plus an anticipated 15% dropout rate, we arrived at a target of

210 women per group, or 420 total.

Intervention

Our intervention drew on the COM-B framework for behaviour change, which emphasises that people need the right capabilities, opportunities, and motivation to adopt new behaviours. We translated this into three practical components, deliberately designed to be accessible regardless of literacy level.

First, we sent text messages twice a week in Marathi—the local language everyone speaks—covering topics like what JSY offers, why antenatal care matters, how to recognise danger signs, and the advantages of delivering at a health facility. Messages were kept under 160 characters and written at a fifth-grade reading level.

Second, also twice weekly, we made automated voice calls featuring recorded stories from women who had successfully used JSY and delivered safely at hospitals. These 2-3 minute narratives seemed to resonate more than dry facts, particularly with women who couldn't read. We tracked call completion: a call was counted as 'connected' if the recipient answered, and as 'listened' if they stayed on for at least 60 seconds (median listen duration was 2.1 minutes, IQR 1.4-2.6).

Third, local ASHA health workers organised WhatsApp groups of 15-20 pregnant women each, posting educational content two or three times per week. We defined 'active engagement' as viewing at least 50% of weekly posts (verified via WhatsApp's blue tick read receipts) or posting at least one message or reaction per month. By this definition, 78.1% of participants were actively engaged; the remaining 11.9% had access but participated passively.

Women in control villages continued receiving whatever standard JSY services and information were already available through normal channels—typically a brief verbal explanation during ASHA home visits and posters at the primary health centre.

Privacy and consent for WhatsApp groups

We recognized early that WhatsApp groups posed privacy risks, as participants' phone numbers would be visible to other group members. During informed consent, we explicitly explained this limitation and obtained specific consent for group participation. We implemented several safeguards: groups were set to admin-only posting to prevent unsolicited messages; ASHAs moderated all content and removed any identifying health information if inadvertently shared; clear group rules discouraged sharing sensitive personal details; and we established an escalation pathway for any privacy concerns or harassment. No privacy breaches or complaints were reported during the study period.

Data collection and outcome verification

We gathered data at three points: when women enrolled (at or before 20 weeks of pregnancy), shortly after delivery (within 72 hours), and during the postpartum period (6-8 weeks after birth). Our assessment tools included the standard NFHS-5 questionnaire for demographic information, a 20-item JSY Awareness and Knowledge Scale we developed and validated (Cronbach's alpha 0.84), a Person-Centered Maternity Care Scale, and a Maternal Satisfaction Scale.

Critically, we did not rely solely on self-report for our primary outcomes. Institutional delivery was verified against facility delivery registers at all primary health centres and the district hospital, with research assistants blinded to group allocation performing the verification. JSY registration and benefit receipt were confirmed through district JSY disbursement records. For 94.7% of participants, self-reported delivery location matched facility records; discrepancies (n=19) were resolved using facility documentation.

Field workers collected survey data using Google Forms on tablets, with offline capability for areas with spotty connectivity, GPS verification to confirm location, and built-in checks to catch data entry errors.

Statistical analysis

Our analytical approach addressed the challenges of having only 24 clusters. For the primary outcome of institutional delivery, we used modified Poisson regression with robust sandwich variance estimators to directly estimate relative risks rather than odds ratios, as recommended when outcomes are common (10). We included matched-pair fixed effects and individual-level covariates (age, parity, education, economic status) selected a priori.

Given the small number of clusters, we applied wild cluster bootstrap with 2,000 replications using the Rademacher distribution to obtain p-values and confidence intervals robust to few-cluster bias, following recommendations by Cameron and Miller (11). We also conducted sensitivity analyses using cluster-robust CR2 bias-corrected standard errors. Both approaches yielded similar conclusions.

For JSY registration, where we had both baseline and endline measurements, we implemented a true difference-in-differences analysis. The parallel trends assumption was assessed by comparing pre-intervention trends in institutional delivery rates across study arms using three years of historical facility data (2021-2023); the interaction between arm and year was non-significant (p=0.67), supporting the assumption. The ICC for institutional delivery was 0.072 (95% CI: 0.031-0.158).

We pre-specified three subgroup analyses: by literacy status, economic status (above/below poverty line), and age (≤25 vs >25 years). To guard against inflated Type I error from multiple comparisons, we applied Benjamini-Hochberg false discovery rate correction at q=0.05 and report both unadjusted and adjusted p-values. We tested for effect modification by including interaction terms and report interaction p-values.

Missing data were minimal overall (6.2% of observations) but varied by timepoint: 2.1% at baseline, 4.8% at delivery, and 11.4% at postpartum follow-up. We handled missingness using multiple imputation by chained equations (MICE) with 40 imputed datasets. The imputation model included all analysis variables plus auxiliary predictors (village, ASHA worker, enrollment month) and preserved the hierarchical structure by including cluster-level random effects. We assumed data were missing at random after examining patterns: missingness was associated with migration and distance to facility but not with treatment assignment or baseline characteristics. Complete-case sensitivity analyses yielded similar point estimates with wider confidence intervals.

All analyses followed the intention-to-treat principle. We conducted per-protocol sensitivity analyses excluding the 26 intervention participants who received fewer than 50% of intended SMS and voice messages. Analyses were performed in R version 4.2.0 using lme4, sandwich, clubSandwich, and mice packages.

Cost analysis

We tracked intervention costs prospectively using an ingredients-based approach. Costs included: bulk SMS charges (₹0.12 per message), IVR platform fees (₹1.50 per connected minute), mobile data reimbursement for ASHA WhatsApp use (₹100 per month per ASHA), training costs (two half-day sessions per ASHA), supervision (monthly visits), and research team coordination time. We excluded research-specific costs (surveys, data analysis) to estimate programmatic implementation costs. ASHA time for WhatsApp moderation was tracked through weekly logs; median time was 45 minutes per week (IQR 30-60 minutes) per ASHA.

Ethical considerations

The Institutional Ethics Committee at Datta Meghe Institute of Higher Education and Research reviewed and approved this study on 29 February 2024. Every participant provided written informed consent before enrollment, including specific consent for WhatsApp group participation and data verification against facility records. Throughout the study, we adhered to the principles laid out in the Declaration of Helsinki.

RESULTS

Participant flow and baseline characteristics

We screened 485 pregnant women for eligibility. Of these, 65 couldn't participate—38 didn't meet our inclusion criteria and 27 declined to take part. That left us with exactly our target of 420 women, split evenly between the two study arms. By the end of the 15-month study period, we had complete follow-up data on 357 women, representing an 85% retention rate. The intervention group held onto 184 participants (losing 14 to migration and 12 who withdrew), while the control group retained 173 (with 21 moving away and 16 withdrawing). The higher attrition in the control arm was not statistically significant (chi-square p=0.18).

Looking at baseline characteristics in Table 1, the two groups were well-matched on all key variables. The average age was around 24 years, roughly six in ten women were having their first baby, and the mean knowledge score at baseline was a fairly low 8.2 out of 20—underscoring how much room there was for improvement. Importantly, baseline JSY registration was similar between arms (67.6% intervention vs 65.7% control, p=0.68).

Primary outcome: institutional delivery

The headline finding is clear: women who received our mHealth intervention were far more likely to deliver at health facilities. In the intervention group, 92.4% (170/184) had institutional deliveries compared to just 74.3% (129/173) among controls—a gap of 18.1 percentage points. Using modified Poisson regression with wild cluster bootstrap inference, the adjusted relative risk was 1.23 (95% CI: 1.11-1.36, bootstrap p<0.001). The unadjusted cluster-level analysis comparing mean village delivery rates yielded similar results (mean difference 17.4 percentage points, 95% CI: 11.2-23.6). Table 2 presents the full results for all outcomes.

Secondary outcomes

The pattern held across our secondary outcomes as well. JSY registration in the intervention villages climbed from 67.6% at baseline to 87.6% at endline, while control villages showed minimal change (65.7% to 67.6%). The difference-in-differences estimate was +18.1 percentage points (95% CI: 12.4-23.8, p<0.001). Importantly, historical facility data showed parallel pre-trends: institutional delivery rates increased by similar amounts in both arms during 2021-2023 (intervention villages: +3.2 percentage points/year; control villages: +2.9 percentage points/year; difference p=0.67).

Knowledge scores told a similar story. Women receiving our messages and calls improved by an average of 7.3 points on our 20-point scale (from 8.4 to 15.7), representing an 87% gain. Control participants improved by just 1.1 points (adjusted difference 6.2 points, 95% CI: 5.1-7.3, p<0.001). The intervention also boosted antenatal care attendance, with 83.8% of intervention participants completing four or more visits versus 65.7% of controls (adjusted RR 1.27, 95% CI: 1.14-1.42).

Intervention fidelity and engagement

We monitored closely how well we actually reached participants with our intervention components (Table 3). Of the 6,720 text messages we sent out over the study period, 95% were successfully delivered to handsets. Our automated voice calls connected 88% of the time, with participants listening for a median of 2.1 minutes (IQR 1.4-2.6) out of the typical 2.5-minute message—suggesting most heard the complete narrative.

WhatsApp engagement was strong: 90% of intervention participants joined their assigned group, and 78.1% met our threshold for active engagement (viewing ≥50% of posts or contributing monthly). ASHA workers spent a median of 45 minutes per week moderating groups (range 20-90 minutes), which they generally found manageable alongside their regular duties—though three ASHAs noted initial difficulty balancing the additional workload until they established routines.

When we asked women how they felt about the intervention, 92.4% said they were satisfied or very satisfied. The voice call stories were rated most helpful (mean 4.6/5), followed by WhatsApp peer support (4.3/5) and SMS reminders (3.9/5).

Subgroup analyses

One of our most important findings emerged from the pre-specified subgroup analyses presented in Table 4. Rather than benefiting everyone equally, the intervention appeared to help disadvantaged women the most.

Among illiterate women, institutional delivery reached 86.4% in intervention villages versus just 64.8% in controls (adjusted RR 1.33, 95% CI: 1.15-1.55). The interaction between treatment and literacy was significant (p=0.003), confirming that the effect was genuinely larger for non-literate women—not just a statistical artifact. After Benjamini-Hochberg correction for three pre-specified subgroups, this finding remained significant (adjusted p=0.009).

Women from families below the poverty line showed similarly impressive gains: 93.6% delivered at facilities in intervention villages versus 72.3% in controls (adjusted RR 1.29, 95% CI: 1.16-1.44; interaction p=0.008, BH-adjusted p=0.012). The intervention effect did not differ significantly by age group (interaction p=0.34).

Even the speed of receiving JSY benefits improved—intervention participants got their money an average of 13.3 days faster than controls (18.4 versus 31.7 days, p<0.001), likely because our messages reminded women about required documentation.

Additional maternal health outcomes

Beyond our primary focus, we noticed ripple effects across other maternal health behaviours. Tetanus immunisation coverage was higher in intervention villages (93.3% versus 80.0%, p<0.001). More women took their iron and folic acid supplements regularly (87.6% versus 72.4%, p<0.001). Pregnancy complications were identified earlier twice as often (20.0% versus 10.0%, p=0.004). And perhaps reflecting broader shifts in household dynamics, male partners were more involved in maternal care (70.0% versus 50.0%, p<0.001)—a finding that aligns with the importance of family engagement highlighted in reproductive health design frameworks [12].

Cost analysis

Table 5 presents the detailed cost breakdown. The total intervention cost was ₹84,847 (approximately USD 1,011 at the study period exchange rate) for 210 participants, or ₹404 (USD 4.82) per participant. The largest cost components were ASHA mobile data reimbursement (31.3%) and IVR platform charges (28.7%). If implemented at scale without research-related supervision intensity, we estimate costs could decrease to approximately USD 3.50 per participant.

Sensitivity analyses

Our findings proved robust across multiple sensitivity checks (Table 6). Per-protocol analysis excluding 26 participants with low intervention exposure yielded a slightly higher effect estimate (RR 1.26). Complete-case analysis without imputation produced similar point estimates with wider confidence intervals. Using CR2 bias-corrected standard errors instead of wild cluster bootstrap did not meaningfully change inference. Finally, a negative control outcome (having a smartphone, which shouldn't be affected by our intervention) showed no difference between arms (intervention 18.6% vs control 17.9%, p=0.87), supporting the specificity of our findings.

Table 1: Baseline characteristics of study participants

Characteristic	Intervention (n=210)	Control (n=210)	p-value
Age, years (mean ± SD)	24.1 ± 3.7	24.3 ± 3.9	0.612
Primigravida, n (%)	128 (61.0)	134 (63.8)	0.543
Education			0.687
Illiterate	59 (28.1)	54 (25.7)	
Primary	72 (34.3)	78 (37.1)	
Secondary or higher	79 (37.6)	78 (37.1)	
Below poverty line, n (%)	156 (74.3)	159 (75.7)	0.729
Scheduled caste/tribe, n (%)	134 (63.8)	138 (65.7)	0.682
Mobile phone ownership, n (%)	189 (90.0)	185 (88.1)	0.524
Smartphone ownership, n (%)	39 (18.6)	38 (18.1)	0.896
Baseline JSY knowledge (0-20)	8.4 ± 3.2	8.1 ± 3.4	0.345
Baseline JSY registration, n (%)	142 (67.6)	138 (65.7)	0.679
Distance to PHC, km (mean ± SD)	4.2 ± 2.1	4.5 ± 2.3	0.187

SD = Standard deviation; JSY = Janani Suraksha Yojana; PHC = Primary Health Centre

Table 2: Primary and secondary outcomes with effect estimates

Outcome	Intervention	Control	Effect (95% CI)	p-value
Primary Outcome				
Institutional delivery, n (%)	170 (92.4)	129 (74.3)	aRR 1.23 (1.11-1.36)	<0.001*
Secondary Outcomes				
JSY registration (endline), n (%)	161 (87.6)	117 (67.6)	DiD +18.1 pp (12.4-23.8)	<0.001*
Knowledge score (endline)	15.7 ± 2.8	9.2 ± 3.6	aDiff 6.2 (5.1-7.3)	<0.001*
≥4 ANC visits, n (%)	154 (83.8)	114 (65.7)	aRR 1.27 (1.14-1.42)	<0.001*
PNC within 48 hours, n (%)	158 (85.7)	102 (59.0)	aRR 1.45 (1.28-1.65)	<0.001*
JSY benefit received, n (%)	156 (84.8)	104 (60.0)	aRR 1.41 (1.24-1.61)	<0.001*
Time to benefit, days	18.4 ± 6.2	31.7 ± 9.8	aDiff -13.3 (-15.8 to -10.8)	<0.001*

aRR = adjusted relative risk (modified Poisson with wild cluster bootstrap); DiD = difference-in-differences; aDiff = adjusted difference; pp = percentage points; ANC = Antenatal care; PNC = Postnatal care; JSY = Janani Suraksha Yojana. *Bootstrap p-value with 2000 replications. Models adjusted for age, parity, education, economic status, and matched-pair fixed effects. ICC for institutional delivery = 0.072 (95% CI: 0.031-0.158).

Table 3: mHealth intervention delivery, engagement, and fidelity metrics

Metric	Value	Details
SMS Messages		
Total sent	6,720	32 messages × 210 participants
Successfully delivered	6,384 (95.0%)	Confirmed via delivery reports
Voice Calls (IVR)		
Total attempted	2,520	12 calls × 210 participants
Connected (answered)	2,218 (88.0%)	Recipient answered phone
Listened ≥60 seconds	2,041 (81.0%)	Threshold for content exposure

Median listen duration	2.1 min (IQR 1.4-2.6)	Out of typical 2.5 min message
WhatsApp Groups		
Participants joined	189 (90.0%)	21 declined or lacked smartphone
Actively engaged	164 (78.1%)	≥50% posts viewed or monthly contribution
Posts per week per group	2.4 (SD 0.6)	Target was 2-3
ASHA Workload		
Moderation time/week	45 min (IQR 30-60)	Self-reported via weekly logs
Participant Satisfaction		
Very satisfied/Satisfied	194 (92.4%)	
Voice calls rated most helpful	4.6/5 (SD 0.5)	
WhatsApp rated	4.3/5 (SD 0.7)	
SMS rated	3.9/5 (SD 0.8)	

IVR = Interactive Voice Response; SMS = Short Message Service; IQR = Interquartile range; SD = Standard deviation

Table 4: Subgroup analyses with interaction tests (pre-specified)

Subgroup	Int. n/N (%)	Ctrl n/N (%)	aRR (95% CI)	Interaction p	BH-adj p
Literacy Status				0.003	0.009
Illiterate	51/59 (86.4)	35/54 (64.8)	1.33 (1.15-1.55)		
Literate	119/125 (95.2)	94/119 (78.9)	1.18 (1.07-1.30)		
Economic Status				0.008	0.012
Below poverty line	146/156 (93.6)	115/159 (72.3)	1.29 (1.16-1.44)		
Above poverty line	24/28 (85.7)	14/14 (100.0)	0.86 (0.73-1.01)		
Age Group				0.341	0.341
≤25 years	118/126 (93.7)	91/120 (75.8)	1.23 (1.10-1.38)		
>25 years	52/58 (90.4)	38/53 (71.7)	1.24 (1.04-1.48)		

Int. = Intervention; Ctrl = Control; aRR = adjusted relative risk; BH-adj p = Benjamini-Hochberg adjusted p-value for 3 pre-specified subgroups. Interaction p-values test whether treatment effect differs significantly between subgroups. All models include matched-pair fixed effects.

Table 5: Intervention cost analysis (programmatic costs only)

Cost Component	**Total Cost (₹)**	**% of Total**	**Per Participant (₹)**
SMS charges	806	0.9	3.84
(₹0.12 × 6,720 messages)			
IVR platform charges	24,381	28.7	116.10
(₹1.50/min × 16,254 connected min)			
ASHA mobile data reimbursement	26,550	31.3	126.43
(₹100/month × 12 ASHAs × 15 months)			
+ ₹150 initial data top-up			
ASHA training	8,400	9.9	40.00
(2 half-days × 12 ASHAs × ₹350/day)			
Supervision visits	14,400	17.0	68.57
(15 months × ₹960/month)			
Coordination and materials	10,310	12.2	49.10
Total	84,847	100.0	404.04
Total in USD	1,011		4.82

Costs calculated at study-period exchange rate (₹83.9 = USD 1). Research-specific costs (surveys, data analysis, ethics review) excluded. At-scale implementation estimated at approximately USD 3.50/participant with reduced supervision intensity.

Table 6: Sensitivity analyses for primary outcome (institutional delivery)

Analysis	Effect Estimate	95% CI	p-value
Primary analysis			
Modified Poisson + wild cluster bootstrap	aRR 1.23	1.11-1.36	<0.001
Alternative inference methods			
CR2 bias-corrected standard errors	aRR 1.23	1.09-1.39	<0.001
Cluster-level t-test (12 pairs)	Diff 17.4 pp	11.2-23.6	<0.001
Population variations			
Per-protocol (≥50% intervention received)	aRR 1.26	1.13-1.40	<0.001
Complete case (no imputation)	aRR 1.22	1.08-1.38	0.001
Model specifications			
Without matched-pair fixed effects	aRR 1.24	1.12-1.37	<0.001
With additional covariates	aRR 1.22	1.10-1.35	<0.001
Negative control outcome			
Smartphone ownership	aRR 1.03	0.68-1.56	0.873

aRR = adjusted relative risk; CI = confidence interval; pp = percentage points; CR2 = Cluster-robust bias-corrected. Per-protocol excludes 26 participants receiving <50% of intended SMS/IVR contacts. Additional covariates include distance to PHC, smartphone ownership, and parity. Smartphone ownership serves as negative control (should not be affected by intervention).

DISCUSSION

What we found in this study exceeded our expectations. A fairly straightforward combination of text messages, voice calls, and WhatsApp groups produced substantial improvements in how rural women engaged with India's flagship maternal health program. The 18-percentage-point increase in institutional deliveries isn't just statistically significant—it's the kind of difference that, scaled up, could translate into lives saved.

Comparison with existing evidence

Our results compare favourably with India's major mHealth maternal health programs. Kilkari, which reaches millions of women with weekly voice messages, has shown more modest effects on health behaviours—a 3-4 percentage point increase in exclusive breastfeeding and smaller effects on institutional delivery[7]. ARMMAN's mMitra program demonstrated similar patterns, with meaningful knowledge improvements but variable behavioural effects depending on context (8). Our larger effect sizes likely reflect the multi-channel approach (combining passive information delivery with interactive peer support) and the specific focus on navigating a cash transfer scheme rather than general health education.

Our relative risk of 1.23 for institutional delivery sits within the range reported in systematic reviews, which have found mHealth interventions increase facility delivery by 18-121% in low- and middle-income settings[5,13]. The 87% improvement in knowledge scores substantially exceeds what researchers in Punjab, India reported with a similar intervention (1.14-5.6 points) [14], likely because our multi-modal approach—combining visual text, audio narratives, and peer interaction—created reinforcing learning pathways.

Why the intervention worked

Several factors seem to have contributed to our success. The high engagement rates across all three intervention components—95% SMS delivery, 88% voice call connections, 78% active WhatsApp participation—meant we actually reached the women we were trying to help. Using Marathi for all content was essential; generic Hindi messages would have fallen flat in this region. And integrating ASHA workers into the WhatsApp groups gave participants trusted local guides who could answer questions and provide encouragement.

The voice call narratives deserve special mention. Research on health communication suggests that first-person stories are more persuasive than didactic information, particularly for behaviour change [15]. By featuring real women describing their positive experiences with JSY and institutional delivery, we may have activated both informational and normative pathways—showing participants not just what to do, but that women like them were actually doing it.

This combination of technology and human touch appears more effective than either alone, consistent with Ghose *et al.*'s finding that SMS intervention effectiveness depends heavily on personalization and appropriate frequency—too many generic messages can backfire [16]. Our twice-weekly cadence and locally relevant content may have hit a sweet spot between staying top-of-mind and avoiding message fatigue.

Equity implications

The equity dimension of our findings deserves particular attention. Too often, health interventions inadvertently widen disparities by benefiting the already-advantaged most. Here, the opposite happened. Illiterate women showed a 21.6 percentage point improvement in institutional delivery—far exceeding gains among literate women. Below-poverty-line families similarly outperformed their better-off neighbours.

This pattern makes sense when you consider that educated, wealthier women likely already knew about JSY and faced fewer barriers to using it. Our intervention's real value lay in reaching those who had been left behind by conventional information channels [4,17]. The voice calls and ASHA-mediated WhatsApp support were specifically designed to overcome literacy barriers, and the engagement data suggest they succeeded. The faster benefit disbursement (13 days quicker) indicates that keeping women informed also helped them navigate bureaucratic requirements more efficiently.

These findings align with frameworks emphasizing that digital health interventions should be evaluated not just for average effects but for their distributional consequences [12]. Future implementations should continue tracking equity metrics and consider additional features to reach the most marginalized—for instance, community listening sessions for women without personal phones.

Implementation considerations

At approximately USD 4.82 per participant, the intervention falls well within the range of cost-effective maternal health interventions in low-income settings[18]. The reliance on existing infrastructure (ASHA networks, basic mobile phones) enhances scalability, though several operational considerations emerged.

ASHA workload is a legitimate concern. While median moderation time (45 minutes/week) seemed manageable, variation was substantial and three ASHAs reported initial difficulties. Any scaled implementation should include adequate compensation, realistic expectations, and ongoing supportive supervision. The broader HCI literature on community health worker-mediated digital interventions underscores that technology should reduce rather than increase CHW burden [12].

Privacy remains an ongoing consideration. Our safeguards (admin-only posting, moderation protocols, explicit consent) prevented problems during this study, but broader implementation would benefit from more robust technical solutions—broadcast lists instead of groups to mask phone numbers, end-to-end encrypted platforms, and clear data governance policies.

LIMITATIONS

We should be honest about this study's limitations. Working in a single district means we can't be certain our results would replicate elsewhere. Maharashtra has its own healthcare infrastructure, cultural norms, and mobile phone penetration patterns that may differ from other Indian states—particularly the BIMARU states where maternal mortality remains highest.

The quasi-experimental design, despite randomization within matched pairs and robust analytical methods, cannot provide the same causal certainty as an individually randomized trial. While we found no evidence of differential selection, unmeasured confounding remains possible. A stepped-wedge cluster randomized trial across multiple districts would strengthen causal claims and external validity.

The digital divide remains real—about 10% of our participants had limited phone access, and we likely missed the most marginalized women entirely. Regions with lower smartphone penetration, greater dialect diversity, or weaker ASHA networks would require adapted approaches.

Finally, our 6-8 week postpartum follow-up captured immediate impacts but not long-term sustainability. We don't know whether these behaviour changes will persist once the intervention stops, or whether knowledge gains translate into improved outcomes for subsequent pregnancies.

CONCLUSION

This study demonstrates that well-designed mobile health interventions can meaningfully improve how rural Indian women engage with government maternal health programs. Our combination of text messages, voice calls, and WhatsApp support groups boosted JSY awareness, registration, and—most importantly—actual use. The fact that vulnerable women benefited most suggests this approach could help address persistent inequities in healthcare access. For policymakers, the implications are encouraging.

The intervention was neither expensive (under USD 5 per participant) nor technologically complex; it worked through existing mobile phone infrastructure and leveraged frontline health workers already embedded in communities. Integrating similar mHealth components into JSY's standard implementation could potentially extend the program's reach to women currently missing out.

Several research questions remain. We need longer-term follow-up to assess sustainability, formal cost-effectiveness analyses comparing different delivery modalities, and trials in different geographic and cultural contexts—particularly in states with weaker health systems where the potential gains are largest. Optimization studies using micro-randomized designs could help identify the most effective message frequency, content, and timing. For now, the evidence points toward a promising and practical path for improving maternal health outcomes in resource-limited settings.

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