Original Article

Effect of mHealth, Interactive Voice Response System (IVRS) on Maternal and Fetal Outcomes

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ABSTRACT

Introduction: Pregnancy and child birth are universally celebrated events. The factors affecting the fetal outcome mainly lie within the premises of the antenatal period. The emergence of mobile telephone technology and its universal reach has improved service delivery, and information transfer. Thus, this study was planned to attempt improvement in the ante-natal care of pregnant women using an interactive voice response system (IVRS) with the ultimate aim of improving the maternal and fetal outcome, mainly in the form of low birth weight (LBW) rates.

Methodology: The study was a community-based randomized intervention study. A total of 796 pregnant females of gestational age ≤16 weeks were recruited and followed up till delivery. The target population was from the urban slums of Jaipur. These areas are covered by Integrated Child Development Services (ICDS) scheme for the provision of basic child and maternal service.

Results: Out of 796 recruited pregnant females, 722 singleton deliveries were analysed. 98.5% of pregnancy outcomes were in the form of live births and the rest were stillbirths. Among live births, 23.9% were low birth weight (21.4% in the intervention v/s 26.7% in the control area). A difference of 5% was observed in low birth occurrence between the two groups. Institutional deliveries were higher and caesarean sections, abortion, still birth, and congenital malformation among delivered were found to be lower in the intervention group as compared to the control group. The intervention group had a higher number of ANC visits and the difference was statistically significant. The maternal health indicators were slightly better in the intervention group. The number of iron-folic acid (IFA) tablets consumed and the number of pregnant females consuming them was also higher in the intervention group and was statistically significant.

Conclusion: Intervention group as a result of intervention by mHealth and IVRS had better indicators of maternal and fetal outcomes as compared to the control group.

Keywords: Fetal outcomes, Interactive voice response system (IVRS), Maternal outcomes, mHealth .

INTRODUCTION

Pregnancy and childbirth are universally celebrated events. Over the last century, advances in pregnancy care have led to the general expectation of a viable outcome, particularly as gestation reaches its later months. The fetal outcome may be in the form of live or stillbirth. The outcomes like low birth weight (LBW), prematurity, macrosomia, congenital malformations etc. can have significant adverse implications in live births.

The factors affecting the fetal outcome mainly lie within the premises of the antenatal period. According to the Annual Health Survey (AHS) 2012-13, only about one-tenth (9.5%) of pregnant females in Rajasthan and only one-fifth (20%) in district Jaipur are getting full antenatal checkups (comprising at least three visits for ANC, at least one tetanus toxoid (TT) injection received, and iron-folic acid (IFA) consumption for 100 days or more). Only 12.7% of pregnant females were consuming tab IFA for 100 days or more in Rajasthan. The consequences of this poor ANC,

might be higher low birth weight (LBW) rates (36.3%) in the state as compared to the national average of 21% (NFHS-3).

Lots of successful interventions have been devised and implemented during the ante-natal and intra-natal periods to improve fetal outcomes. A further leap in this direction can be lunged with the help of new emerging technologies. The emergence of mobile telephone technology and its universal reach has improved service delivery, information transfer, businesses, banking, and changed the ways people communicate in the world. The mobile subscribers base has grown consistently on a year-to-year basis, the world's teledensity was 101.5% and reached 7,511 million in 2016.[1] India had 1167 million wireless subscriptions while the teledensity in Rajasthan was 85% in 2018 as per TRAI.[2] This technology has been cashed in a few sectors of health. Rural doctors in China can partner with specialists in urban areas and at the same time access client information and data through mobile software. To improve patient awareness, Bangladesh doctors launched a Mobiles-4-Health initiative that provides how to take care of expectant mothers during pregnancies, early warning signs of possible infant problems, the benefits of family planning, and breast-feeding best practices. An initiative "Text 4 Baby" for pregnant women in America has had a good impact by informing women how to handle pregnancy, and problems that may arise, the study noted that 92% of the clients in their study were satisfied with the program.[3] Zurovac et al[4] in their study, noted the significance of mobile telephone use by increasing communication between clients, and health workers in respect of treatment adherence and also disease surveillance, commodity monitoring, post-marketing adherence and, adherence to guidelines. There is a demographic transition happening in India as is evident from the census 2011 with an increase in urban population to 32% from 30% in the census 2001.[5] With increasing urbanization comes new challenges. As urban slum indicators are poorer than rural health indicators and improving these can have a drastic improvement in the overall national average. Thus, this study was planned to attempt improvement in the antenatal care of pregnant women using an interactive voice response system (IVRS) with the ultimate aim of improving the maternal and fetal outcome, mainly in the form of low birth weight (LBW) rates.

METHODS

The study was a community-based randomized intervention study. A total of 796 pregnant females of gestational age ≤ 16 weeks were recruited and followed up till delivery. The target population was from the urban slums of Jaipur. These areas are covered by Integrated Child Development Services (ICDS) scheme through 5 ICDS projects (Jaipur 1, Jaipur 2, Jaipur 3, Jaipur 4 and Sanganer-urban) for the provision of basic child and maternal service. Assuming intervention lowers the low-birth-weight rate by 6%, the sample size required per group (n) was calculated by n=[Z1-α√(2P(1-P))+Z1-β√(P1(1-P1)+P2(1-2)]2/(P1-P2)2 where P1 is the low birth weight before intervention (i.e., 36%, according to Annual Health Survey 2012-13 Rajasthan), P2 is assumed low birth weight rate after intervention (i.e. 30%), P=(P1+P2)/2, Z1-α=normal deviate at considered level of confidence (95%) =1.96, Z1, β=normal deviate at considered power (80%) of study=0.842. It came out to be 356 per group, an attrition rate of 10% was presumed and thus, 390 random pregnant females were enrolled per group with a total of 780 mothers constituting the desired sample size. The present study was originally planned to carry out in the Jaipur-2 ICDS project but we could not recruit enough from its five sectors and the Anganwadi of randomly selected two sectors out of four of the Jaipur-1 ICDS project were also included. The total number of Anganwadis included were 161 and out of this 72 were in the intervention group while 89 were in the control group. All Anganwadi centres were listed and given a unique number. Then with the help of a computer, random unique numbers were chosen and as per the random numbers, the Anganwadis were assigned to the control or intervention group. The pregnant females of respective Anganwadis using the inclusion and exclusion criteria for participation in the study were earmarked and were included in the control or intervention groups with the help of field workers (ASHA worker/Anganwadi worker or helper) till the required sample size of both groups was achieved. Written informed consent was taken from all the participants before enrolling them for the study. The study was approved by institutional ethics committee (DCG(1) Registration ECR/27/SP/Inst/Raj/2013, dated 02/06/2015) The sampled population is detailed in figure 1.

Intervention: In this study, information regarding various health-related topics like early registration, antenatal care, nutrition during pregnancy, iron and folic acid tablet importance, institutional delivery, postnatal care, breast-feeding, family planning, and scheduled visits for check-ups relevant to antenatal and intra-natal care were generated electronically first and then delivered to study
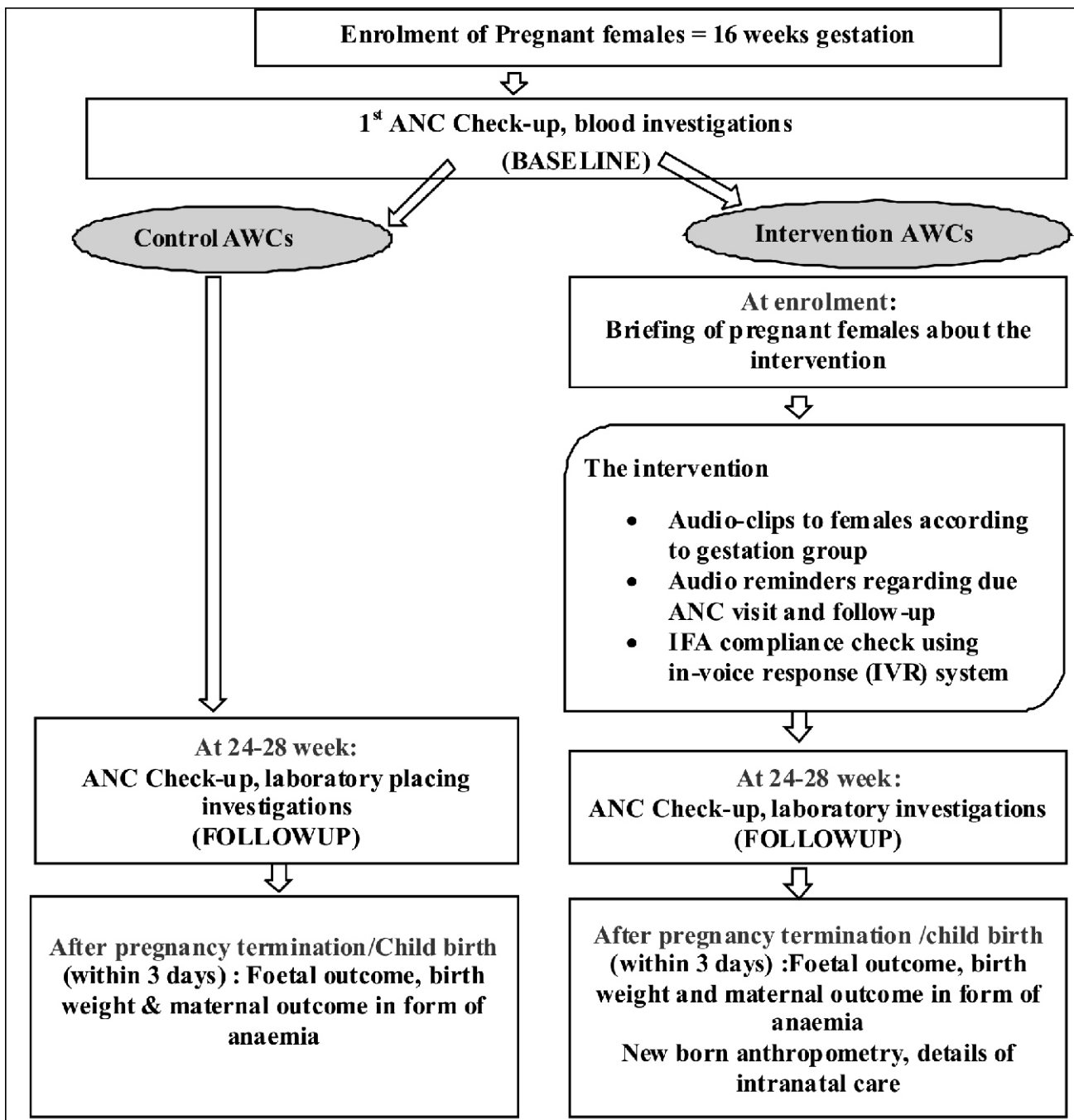
Enrolment of Pregnant females = 16 weeks gestation

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1st ANC Check-up, blood investigations (BASELINE)

Control AWCs ⟵   ⟶ **Intervention AWCs**

At enrolment:
Briefing of pregnant females about the intervention

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The intervention

- Audio-clips to females according to gestation group
- Audio reminders regarding due ANC visit and follow-up
- IFA compliance check using in-voice response (IVR) system

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At 24-28 week:
ANC Check-up, laboratory placing investigations
(FOLLOWUP)

At 24-28 week:
ANC Check-up, laboratory investigations
(FOLLOWUP)

⇩

After pregnancy termination/Child birth (within 3 days) : Foetal outcome, birth weight & maternal outcome in form of anaemia

After pregnancy termination /child birth (within 3 days) : Foetal outcome, birth weight and maternal outcome in form of anaemia
New born anthropometry, details of intranatal care

Figure 1: Methodology and data collection.

participants through interactive voice response system (IVRS) (Figure 2).

Audio calls to selected study participants were delivered daily.

- Morning 7 AM: Health information as per respective gestation period

- Evening 7 PM: IFA reminder

A web-based MIS reporting interface was developed with the help of telecom agencies. The ongoing status of audio calls could be visualized.

Intervention development: Firstly, the research literature was searched to generate a comprehensive list of factors affecting birth weight and barriers to iron and folic acid medication adherence. The focused group discussion sessions were conducted among pregnant women to add up to this list. The clinicians, including gynecologists and pediatricians, were requested to iteratively review this list, prioritizing barriers most relevant to the target population and those that could be addressed with audio messaging
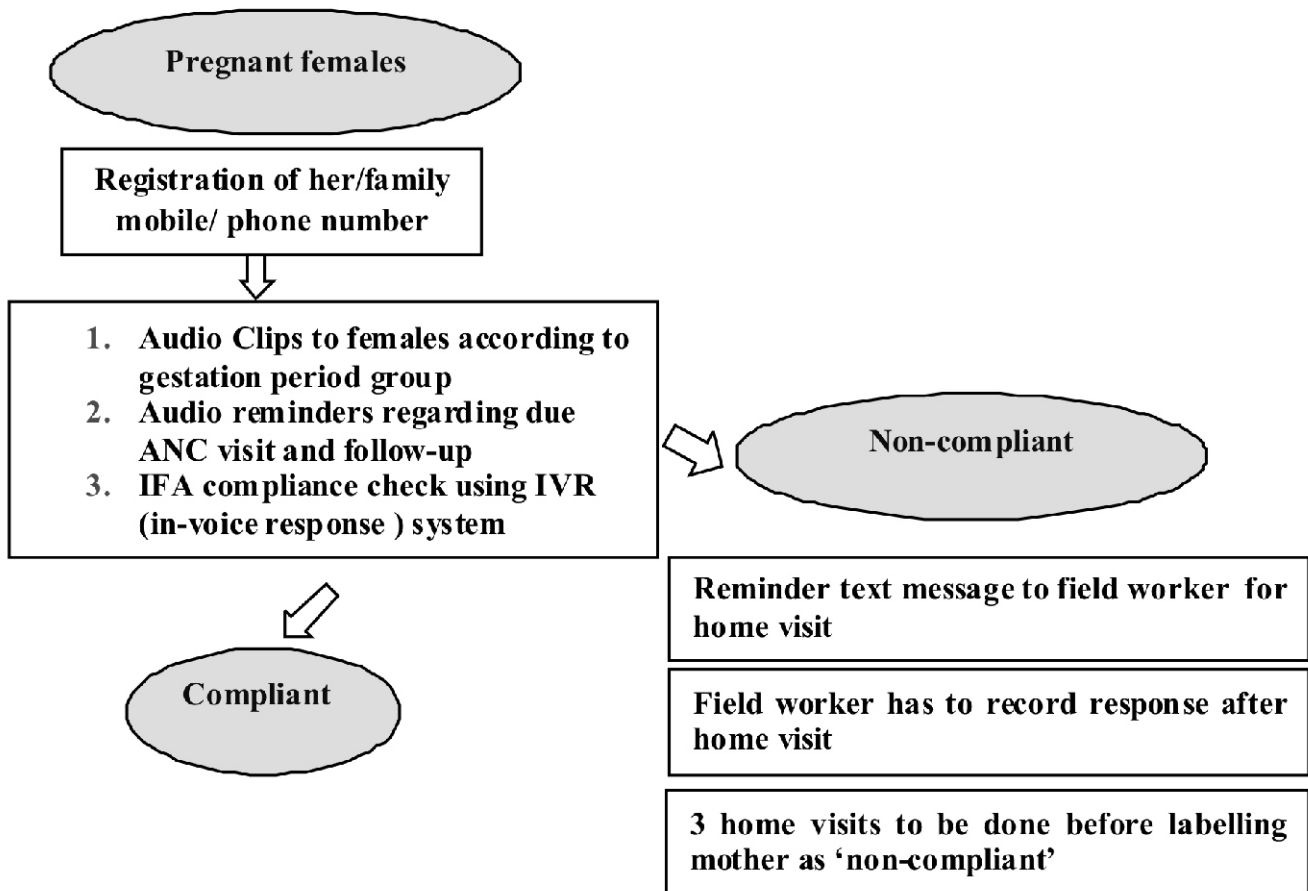
Figure 2: Intervention planned.

content. Finally, six broad areas of health education were identified and at least 8 messages per broad area (8-17) were developed with a total of 62 messages. A weekly schedule was developed such that at least one message related to all six broad areas was delivered in one week and out of this, one important/key message according to the gestation period was repeated to emphasize.

Data collected were entered in the MS Excel spreadsheet, coded appropriately, and later cleaned for any possible errors in Statistical Package for Social Studies (SPSS) for Windows version.22.0. Categorical data were presented as percentages (%). Pearson's chi-square test was used to evaluate differences between groups for categorical variables. Quantitative data were presented as mean and SD. Student t-test was used to compare differences for continuous variables. All tests were performed at a 5% level of significance.

RESULTS

In the present study, a total of 796 pregnant mothers of gestational age ≤16 weeks were recruited and followed up till delivery. The first follow-up could be done for 618 (77.6%) females and was comparable in both groups (80.5% in the intervention and 75.3% in the control group, p>0.05). 739 (92.8%) completed 2nd follow-up and was comparable in both groups (94.2% in the intervention and 91.3% in the control group (Figure 3).

The socio-demographic characteristics of study participants in both the control and intervention groups were comparable at baseline. Primigravida comprised less than one-third of the total study participants (29.0% in the intervention and 28.0% in the control group).

IVRS intervention: Audio calls were sent to study participants in the intervention group two times daily.

IVRS morning: A total of 175 audio messages were intended to be delivered to each study participant i.e., an average of 7 audio messages per week for 25 weeks. An average of 174.5 audio messages per pregnant female could be delivered in the intervention area. The average audio message received per pregnant female was 132.6. The overall response rate was 73.06 percent. The average call duration was 39.86 seconds.
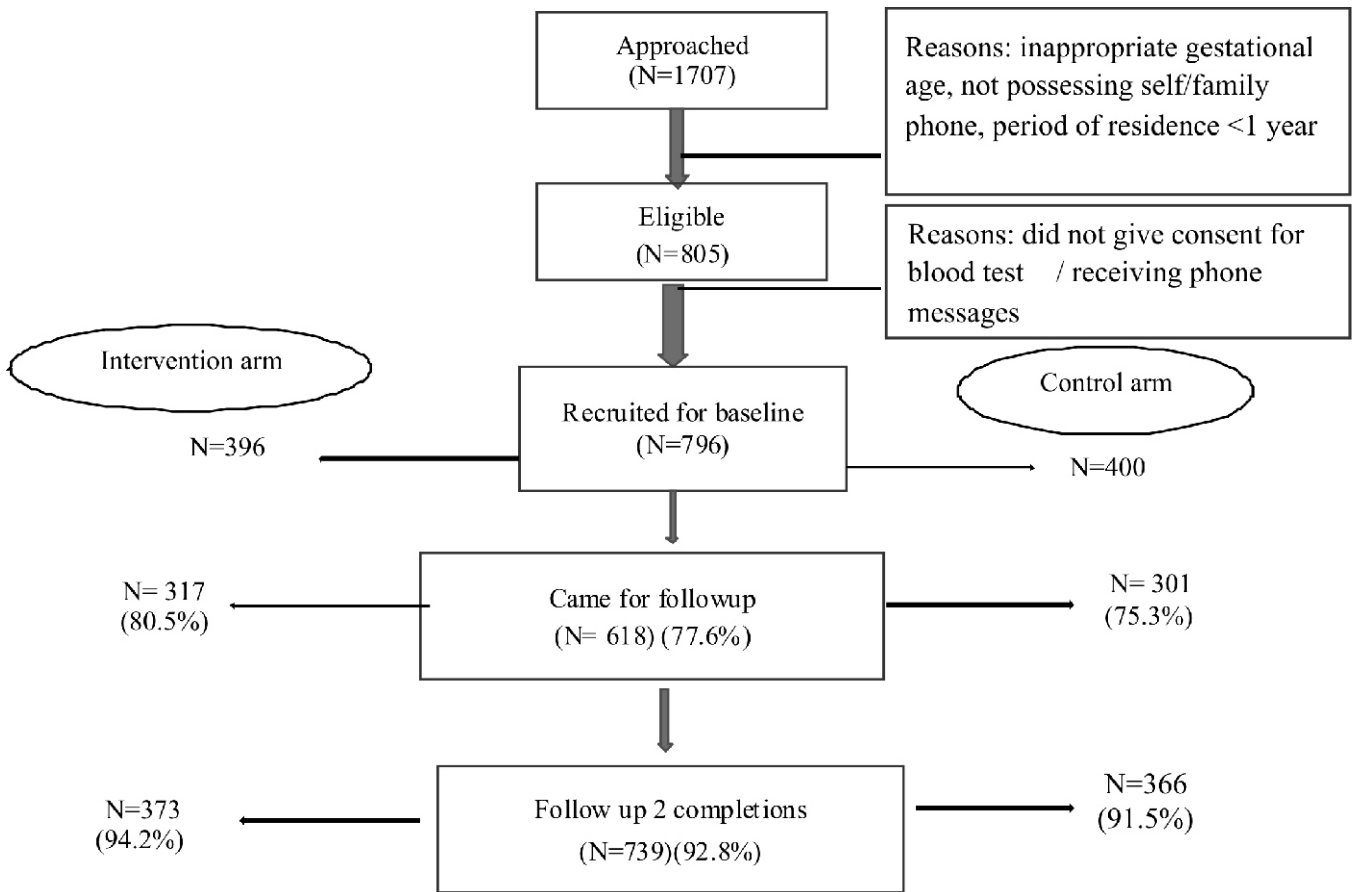
IVRS evening audio messages response rate was 66.93%.

Figure 3: Consort flow chart of study participants.

The average reminder response rate was 73.73% among responders. The average audio message duration was 10.93 seconds.

Maternal morbidities during pregnancy: Of the 796 participants, 227 (28.5%) were primi-gravidae while the rest 569 were multiparous (71.5%). Out of the total, 6.65% (53/796) pregnant females were teenagers and 1.1% (9/796) were elderly primigravida (≥35 years) at the time of registration. Pregnant females' weight ≤45 kg (35.8%, 285/796) and anaemia 59.9 % (477/796) were major risk factors. About one-third, 35.8% (285/796) of pregnant females were aware of Janani Suraksha Yojana and less than one-fourth, 22.1% (176/796) knew about referral transport service provision under it at the time of registration.

Fetal outcome: At the end of the follow-up, (739/796 completed 2nd follow-up) it was found that 12/739 (1.6%) pregnant females had abortions and 727 (98.4%) delivered. There were 4 twin deliveries and 1 triplet delivery which were excluded from the analysis. Hence, a total of 722 singleton deliveries was analysed. 98.5% (711/722) of

pregnancy outcome was in the form of live births and the rest 1.5% (11/722) were stillbirths. Males constituted more than half (53.3%, 379/711) of the live births.

Among live births, 23.9% were low birth weight (21.4% in the intervention v/s 26.7% in the control area) while 0.55 % were macrosomic (birth weight ≥4 kg). A difference of 5% was observed in low birth occurrence between the two groups. Abortion, stillbirth, and congenital malformation among delivered were found to be lower in the intervention group as compared to the control group (Table 1).

The intervention group had a higher number of ANC visits and the difference was statistically significant. The maternal health indicators were slightly better in the intervention group but were not significant statistically. Institutional deliveries were higher and caesarean sections were lower in the intervention group compared to the control group (Table 2).

The number of IFA tablets consumed and the number of pregnant females consuming them was also higher in the intervention group and statistically significant. The anaemia level dropped from 59.9% to 40.46%. About 36%

Table 1: Fetal outcome among study participants

Outcome	Intervention area	Control area	Total	p value
Abortion, (n%)	5/373 (1.3)	7/366 (1.9)	12/739 (1.6)	0.54
Total deliveries	368	359	727/739 (98.4)	
Multiple births	2 Twin	2 Twins, 1 Triplet	5	
Singleton births	366	356	722	
Stillbirth, (n%)	5/366 (1.4)	6/356 (1.7)	11/722 (1.5)	
Live birth, (n%)	361/366 (98.6)	350/356 (98.3)	711/722 (98.5)	0.12
Low birth weight, (n%)	78/361 (21.6)	95/356 (26.7)	173/722 (24.3)	0.11
Macrosomia, (n%)	2/361 (0.6)	2/356 (0.6)	4/722 (0.6)	0.98
Congenital anomaly, (n%)	5/361 (1.4)	9/356 (2.5)	14/722 (1.9)	0.27

$p < 0.05$: Significant

Table 2: Utilization of health services among study subjects

Variable	Intervention area (n=373)	Control area (n=366)	Total (n=739)	p value
Average ANC visit per female	4.5	3.8	4.3	0.01
Females with 4 or more ANC visits, (n%)	256/373 (68.6)	234/366 (63.9)	490/739 (66.3)	0.18
Place of delivery (n%)				
Institutional delivery	346/368 (94.02)	249/359 (92.7)	570/727 (93.5)	0.47
Home delivery	17/368 (4.6)	19/359 (5.2)	36/727 (4.9)	0.71
Delivery by C-section	105/368 (28.5)	105/359 (29.2)	210/727 (28.9)	0.8

$p < 0.05$: Significant

Table 3: Distribution of variables related to Iron-folic acid tablets among study participants

Variable	Intervention area (n=373)	Control area (n=366)	p value
Average number of IFA tablets consumed per female (n)	101.8	77.3	0.001
Females who consumed an appropriate number of IFA tablets n(%)	185 (49.6)	133 (36.3)	0.0003
Anemic pregnant females after intervention n(%)	134 (35.9)	165 (45.1)	0.01

$p < 0.05$: Significant; $p < 0.001$: Highly significant

of women in the intervention group had anaemia of variable severity, as against 45% in the control group and this difference was also statistically significant (Table 3).

DISCUSSION

In the present study, 796 pregnant females of gestation less than or equal to 16 weeks were recruited, and participants of the intervention group were given IVRS health messages and iron intake reminders. In the first follow up, 77.6% of pregnant females reported for an ante-natal checkup and in the second follow up field worker was able to contact 739 (92.8%) females. This might be because it

was an extra antenatal check-up for females in the first follow up and that's why it was less important from their perspective. The 2nd follow-up had better compliance as it was a home visit by a field worker and the female did not have to come to the Anganwadi centre.

In the present study, socio-demographic characteristics were comparable at baseline. The average age at marriage of study participants was 18.97±2.40 years and was comparable among both groups while as per the census 2011, the mean age at effective marriage for females in India was 21.2 years. There were 72.61% (578/796) literate

females in the study participants which is similar to NFHS-4 data of Rajasthan, 75.8% in urban areas. Almost all study participants were homemakers in both intervention and control groups, respectively (89.9%, 94.5%). This might be because the research team visited Anganwadis during the working time of the day. Audio calls were sent to study participants in the intervention group daily two times. The average call response rate of morning calls was 73.06% and evening calls were 66.93%. The reason for the lower response rate in the evening can be engaged in other assignments at home.

Our study reported an increase in healthcare utilization in the intervention group similar to various other studies.[6-9] The intervention group has a high IFA intake, 4 or more ANC visits, more institutional delivery, less home delivery, and caesarean section. Thirty-six percent of women in the intervention group had anemia of variable severity, as against forty-five percent in the control group, thus a significant difference in the prevalence of anemia was seen. The relative improvement in the number of IFA tablets consumed and a significant increase in the ANC visits by pregnant females in the intervention group can be ascribed to IVRS intervention. IFA coverage rate, IFA uptake rate, mean ANC visit and percentage of completed ANC visit rate are epidemiological indicators that only indicate the secular trend of directionality of change. For a vertical program manager, these indicators are valuable because it proves work is done and at best there is a hope of improvement if secular trends of indicators are favorable.

Obstetric risk factors were similar in the intervention and control groups. The study revealed that 12 (1.6%) females had abortions and 727(98.4%) delivered. There were four twin deliveries and one triplet delivery which were excluded from the analysis. Hence, a total of 733 singleton deliveries (370 in the intervention v/s 363 in the control area) were analysed. 98.5% (711/722) of total fetal outcome was in the form of live births and the rest 1.5% (11/722) were stillbirths. The number of abortions, still-births and caesarean sections was lower in the intervention group while more institutional deliveries and lesser home deliveries were in the intervention group, similar to the study by Lund et al[6] absolute values were better in our study indicating better healthcare service availability over the period.

Among live births, 23.9% were low birth weight (21.4% in the intervention v/s 26.7% in the control area. Bangal VB et al[7] reported in Maharashtra, India in an interventional study of short message service in 2017 that the rate of low-birth-

weight babies was 30% in women from the intervention group as against 35% in women from the control group. A 5% difference is comparable in both studies. The reason can be low birth weight has multifactorial causation. Therefore, targeting just one cause i.e., improved ANC and IFA supplementation cannot bring down the indicator substantially.

Limitation: The authors are unable to detect a significant relationship with child health which may be limited by the absence of exogenous variation in prenatal care and the short follow-up period in their study.

Conclusion: Intervention group as a result of intervention by mHealth and interactive voice response system (IVRS) had better indicators of maternal and fetal outcomes as compared to the control group.

Conflict of interest: None

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