Mobile Mira Channel: A Digital BCC Model for Improving the Uptake of Prenatal Care Services in Rural Nuh, India

Subhi Quraishi[1, *], Hilmi Quraishi[2], Ayushi Singh[1], Srikrishna Sulgodu Ramachandra[3], Ilmana Fasih[2], Hemlata Yadav[1], Mohd Arif[1], Akram Ahmad[1]

[1]ZMQ Development, New Delhi, India

[2]ZMQ Global, Montreal, Canada

[3]IKP Knowledge Park, Hyderabad, India

Email address:

subhi@zmq.in (Subhi Quraishi)

[*]Corresponding author

Abstract: Every year, 131.4 million babies are born worldwide. Out of these, 303,000 maternal fatalities and an estimated 2.7 million neonatal deaths and 2.6 million stillbirths are thought to occur annually over the world. ZMQ established an innovative BCC model called MIRA Channel which interacts with semi-literate and illiterate women using an innovative digital-Communication for Development (d-C4D) technique for bringing about change in behaviours & attitudes by bridging the knowledge gap and building new demand-seeking behaviours. For millions of semi-literate and illiterate rural women, MIRA Channel employs audio-visual based localised and contextualised messages that act as a "Talking Toolkit," assisting in faster processing and longer retention of knowledge for sustainable behaviour change. The model was tested in Nuh (Mewat) with 2,467 women and 25 MIRA and ASHAs in the intervention and the control group. The findings showed that the MIRA Channel, along with its weekly prenatal care communication packs and other SBCC tools, significantly influenced the overall outcome of all the key parameters like prenatal and postnatal KAPs, uptake of ANCs, uptake of tetanus vaccine, institutional deliveries, initiation of breastfeeting and other parameters. When compared to the control group, MIRA intervention showed significant increase in the uptake of all three ANCs in the intervention area. An important MCH indicator component, institutional delivery, showed improvement of over 67 percent. We discovered that women in the intervention region were more knowledgeable about obstetrics and the danger indicators of a new-born and were better equipped to respond to a situation, should one arise. Findings also showed, on an average 13-18 visits to pregnant women during the course of pregnancy comprising of information delivery and health tracking leads to improved knowledge and positive attitude towards health services. It is discovered that the innovative communication employing localised audio-visual information increased beneficiary service uptake and comprehension.

Keywords: Maternal and Child Health (MCH), Social and Behaviour Change Communication, (SBCC) Neonatal Deaths, Maternal Fatalities, Digital Communication

1. Introduction

Globally 131.4 million children are born each year. Out of these, an estimated 2.6 million are stillbirths, 2.5 million are neonatal deaths and 303,000 maternal deaths occur globally each year. [1-3] Maternal and Child mortality remains a big problem even though there is a substantial decline in global levels. Presently, the infant mortality rate (IMR) for India is 34 per 1,000 live births, and the neonatal mortality rate (NMR) is 28 per 1,000 live births. [4, 5] NMR contributes to 82% of the IMR, and any further reduction in IMR can only come from a decline in NMR. The infant mortality rate (IMR) of Nuh is 91/1,000 live births, Maternal Mortality Rates of Nuh are 360/100,000 live births. Institutional deliveries in

Nuh are a low 40.3% [6] as compared to the Haryana states being 77.6%. The overall female literacy rate of the district is barely 36.6% (Ministry of Minority Affairs), one of the lowest in any of the districts of India [7].

The key interventions needed for improving Maternal and Child Health indicators are well known. Some of them are the long-term sustained policy commitment and financial commitment; strengthening health system, building adequate and quality skilled health workers and establishing multi-level monitoring system; Maternal and Child health (MCH) welfare schemes, education, incentive based programs and last but not the least, approaches for increasing the demand for services.

Rural women are key agents of development. But limited knowledge & access to health pose constant challenge in their growth. Empowering them and saving their lives is essential for improving the development indicators which can be done by providing appropriate & context specific tools in the hands of women [8]. Also, in developing countries, the last mile health service is delivered by community health works and volunteers using a paper based approach. This approach has not been very successful because of inconsistency in communication, lack of transparency in service delivery leading to disconnect between the beneficiaries and the health service provisioning system.

To address the given challenges, ZMQ proposed an innovative tech linked platform called MIRA Channel. It is an innovation designed to bridge the gap between low MCH literacy among rural women and uptake of Basic Health services. MIRA a mobile-phone based last-mile integrated health system opens up new opportunity for rural women to get timely information on MCH, generate demand and build new service seeking behaviors.

MIRA Channel brings in three levels of innovation namely in Communication, Progress Tracking and Service Delivery.

1.1. Innovation in Communication

MIRA Channel uses an innovative digital- Social and Behavior Change Communication (d-SBCC) approach to interact with semi-literate and illiterate women thus bridging the gap in knowledge, and creating sustainable new demand seeking behaviors. The content and its icon based graphics were designed together with the communities by conducting workshops and focus group discussions. The key weekly messages were developed and delivered on various topics like diet, medication, immunization, ANCs, danger signs, dos, don'ts and around growth of the child in the womb.

Figure 1. Communication Design.

1.2. Innovation in Tracking Health

MIRA Channel has built-in progress tracking tools such as trackers, calculators and analyzers for managing MCH. Some of these tools are Pregnancy week-by-week tracker, ANC calculator & tracker, Immunization calculator & tracker, Postnatal & Newborn progress tracker, menstrual cycle calculator and High Risk Pregnancy indicator (Analyzer).

These built-in tracking tools help MIRAs (CHWs – Community Health Workers) and the women to remain updated with progress of each pregnancy, its due delivery date, due ANC date, immunization date and High-risk status of the woman. MIRA has on her finger-tips all the essential progress indicators/data of each registered woman for ensuring timely communication and delivery of services. These health calculators and progress trackers are integrated with audio-visual instructions and serve as reminder-recall alerts which are shared by MIRA with the woman during their weekly visits.

1.3. Service Delivery Innovation

MIRA Channel is also integrated with the last layer of public health service delivery system (Midwife) for timely delivery of health services like ANCs, Immunization, delivery of IFA tablets, High Risk Pregnancy Care,

Institutional delivery, Postnatal Care, Neonatal Care and other Emergency Services. MIRAs are connected with their Midwife (called ANM - Auxiliary Nurse Midwives), who are the last layer in the health service delivery system in India. Under the MIRA Channel, these Midwives are also provisioned a mobile toolkit called the ANM Toolkit. All the community health workers (MIRAs) under an ANM are linked with their respective ANMs through these two toolkits – MIRA Channel Toolkit and ANM Toolkit [9]. Using the ANM Toolkit, the Midwife can track the activities of each of the MIRA under her, and also monitor the progress of all the beneficiaries (women and newborn) under those MIRAs. The ANM toolkit helps in initiating timely service delivery for each woman. The ANM sends requests to MIRAs for ANC check-ups, Immunization request, various medical services/needs and institutional delivery initiation.
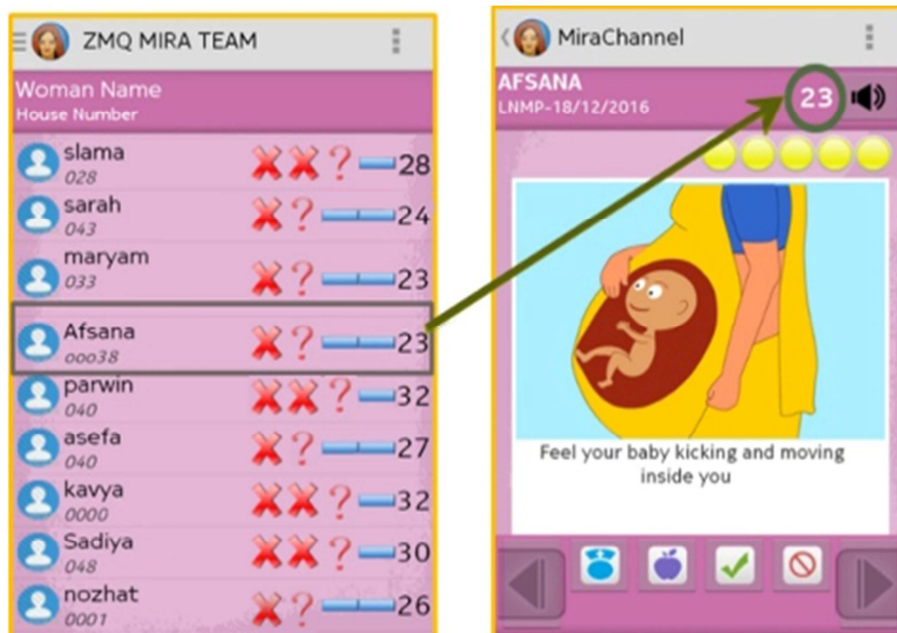

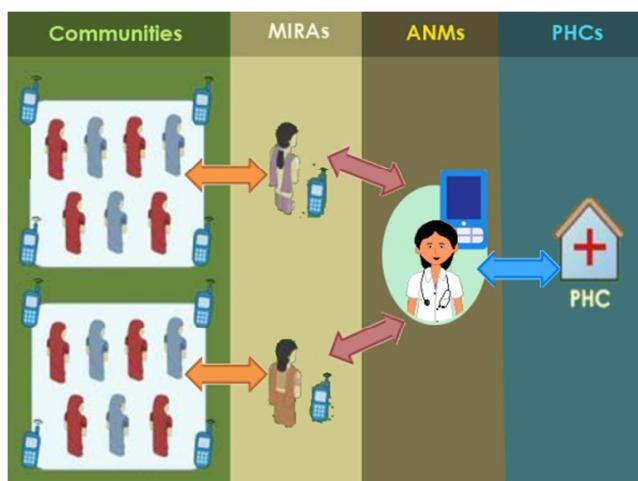**Figure 2.** *Antenatal Care Progress Tracker.*

Figure 3. *Last mile Service delivery model.*

Also, when the MIRA reports a high risk pregnancy using the symptomatic questions, the Midwives resolves the queries and emergencies) by taking immediate action, which is automatically indicated back to the MIRA.

Under the Service delivery component, MIRA Channel also has a multi-tier 'Real-time Activity' dashboard for all hierarchical levels in the public health system [10]. The dashboard provides live monitoring of stakeholders, their progress and activities. This model is also referred as the 'MIRA-PHC Connect' model.

Following are the key features of MIRA Channel:

1) MIRA is first of its kind holistic resource center for all the aspects of basic health services using the RMNCH+A approach (Reproductive Maternal, Neonatal, Child and Adolescent health), making it a complete family toolkit with a focus on MCH.

2) The MIRA Toolkit can be easily localized for any

geography and cultural context & is available both for feature phones and smart phones and has ability to work on a 100% off-line mode for communication and progress tracking.

3) MIRA Channel also has a Value Added Services (VAS) tools for capacity building of rural women. The VAS channels uses gamification and story-telling approach to build the capacities of communities.
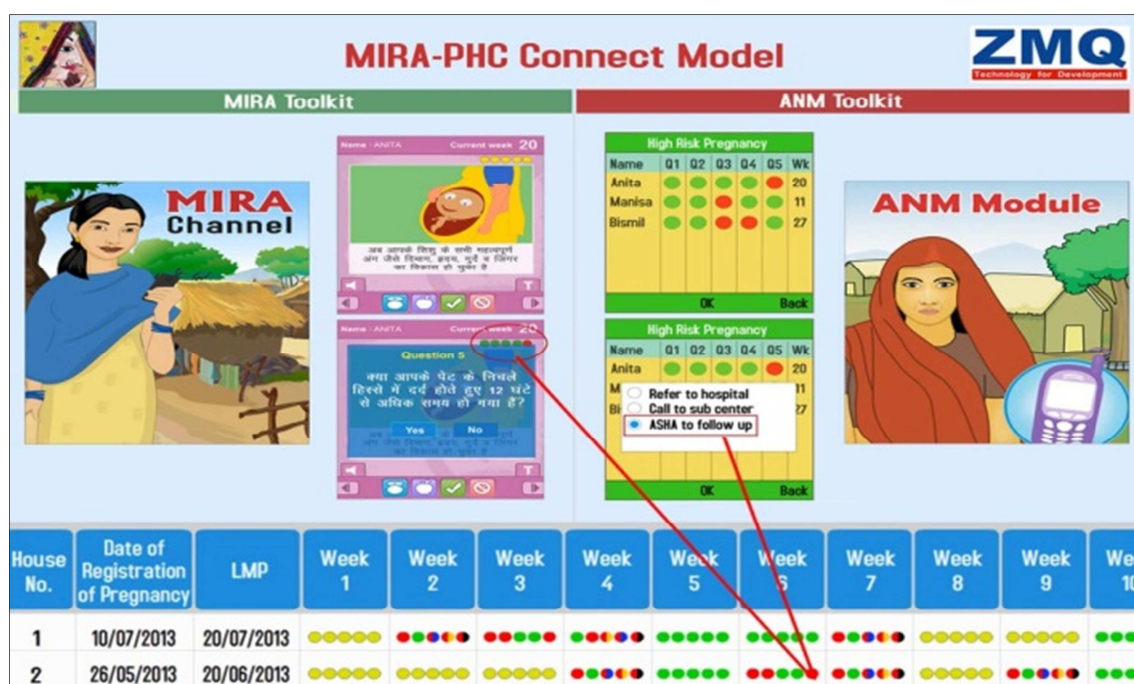

Figure 4. *MIRA PHC Connect Model.*

2. Methodology

MIRA is a holistic end-to-end solution which connects with the last mile communities for delivery of health communication; progress tracking & referrals; and service delivery. Above all, MIRA Channel covers multiple domains of basic health services like prenatal care, post-natal care, neonatal care, immunization coverage, family planning and adolescent health development. MIRA has multiple novel elements which can help in accelerating health impact.

MIRA was designed with the local women with a human centric approach to increase its acceptability & usability in the rural areas. The toolkit was designed for health workers to identify pregnant women & to do house to house communication to bring about change in the knowledge & increase the uptake of services.

For the proposed study, ZMQ selected district Nuh in the state of Haryana in India to study the impact of 'MIRA Channel's localized & contextualized Communication tools (MIRAs) in increasing the knowledge of the beneficiaries & thereby increase the demand and uptake of Prenatal Care and Postnatal Care services; and also to determine the average number of visits and communications required to bring about positive shift in the behaviour & attitudes of the beneficiaries towards maternal & child health.

MIRA Channel was piloted from December 2017 to April 2019 in Nuh. Although MIRA Channel is a comprehensive tool covering a whole gamut of communication & services, like Prenatal Care, Postnatal Care, Newborn Care, Adolescent Girl Health Communication (Menstrual Hygiene Management) and Family Planning advisories; but for the study, scope was limited to analyzing the impact of digital Behavior Change Communication (BCC) tools in MIRA Channel on uptake of Prenatal and Postnatal care services, by building KAP (Knowledge, Attitude and Practice). The study was based on Quasi-experimental case control design.

2.1. Study Area

For the study, 2 sets of 25 villages each were selected in 2 blocks of Nuh, namely Nagina and Tauru. One set of 25 villages were selected for full MIRA Channel model exposure and for control group, day to day activities of Community health workers (ASHAs) being conducted in traditional mode was studied. In the intervention area, 17 villages were selected in Nagina block and 8 in Tauru block; and in the Control group 19 villages were selected in Nagina Block and 6 in Tauru block. In order to avoid any overlap, 17 villages in the intervention area in Nagina block were under PHC Nagina whereas the 19 villages in control area were under PHC Marora. Similarly, 8 villages in Tauru block in the intervention area were under PHC Tauru and the 6 villages in the Control Group were under PHC Mohammadpur-Ahir. The detailed structure design is as below.
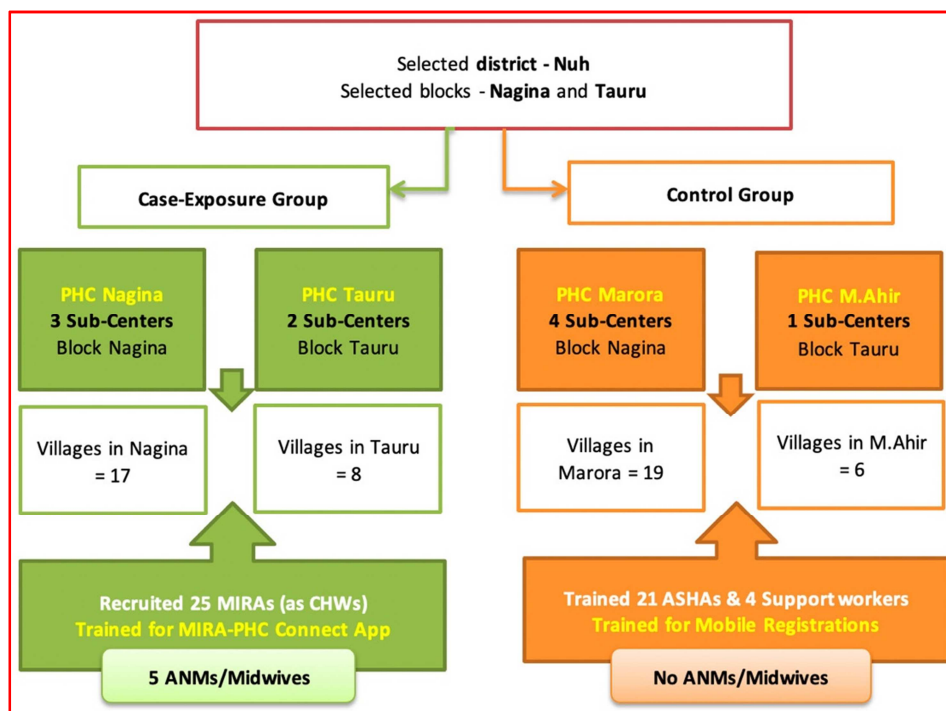
Figure 5. *Site structure of the MIRA Nuh Project.*

2.2. Sample Selection

We established a case-control model for the study. As we know, the institutional delivery indicator in Nuh, Haryana stands at 40.3%. Assuming the same, 40.3% of the women who opt for institutional deliveries in rural Nuh, this value was taken as the basis for calculating the proportion in the intervention and control groups. The expected proportion in the intervention group was calculated assuming the standard power of 80% ($Z_{1-\beta}=0.84$) and for a confidence interval of 95%, i.e. a significance level of 0.05 ($Z_{1-\alpha}=1.96$). We used the Lisa Sullivan's method to calculate the sample size for equal number of cases and controls (r=1) [11]. Using this approach, the resultant sample size calculated was 133.98 (≈134) for each group. Based on this, we designed the program and selected 268 cases; 134 case each in intervention and control areas.

2.3. Characteristics of Intervention and Comparison Group

For the implementation of the intervention component, 25 MIRAs were recruited and trained for all the MIRA Channels tool - Registration Services, Communication Delivery Services (through week-by-week visits) and Health Service Deliveries, including the Reporting of High-Risk Pregnancy (HRP) & Delivery of Emergency Services. Also, 5 ANMs, covering the 25 MIRA village units, were trained and provided with ANM tool kits to monitor progress of pregnant women. Using the toolkit, ANMs role to provide timely services to women like ANC check-ups, tetanus vaccinations, folic-acid tablets, HRP referrals, postnatal check-ups, routine immunization (to children under 5) and institutional delivery referrals to PHCs, CHCs and sub-centers, under their respective MIRAs. The ANMs were also responsible to take action on the pregnant women HRPs generated by MIRAs, during their weekly visits. All the data generated from both MIRA and ANM activities are securely pushed to cloud servers and collated.

In the Control group, 25 were selected. No communication tools were given to them nor any strategies designed for them to visit pregnant women. ASHAs continued to attend pregnant women as their usual routine business.

During the course of the project, in the intervention area a total of 2,467 pregnant women were registered during the period of December 2017 to April 2019. In the same period, in the control group a total of 2,713 pregnant women were recorded. The selection criteria for the study were based on the two parameters (constraints):

1) Women registered in the first trimester of pregnancy; and;
2) Women registered between the periods of December 2017 to April 2019. A random choice algorithm was run to select 134 pregnant women from each of the two groups.

2.4. Data Collection

A composite approach of data collection was done. In the intervention area, all the quantitative data like the LMC (Last Menstrual Cycle) or EDD (Expected date of delivery, date of registration of pregnant women on MIRA Channel, ANC Visits (with dates), ANC check-up results (through ANM toolkit), Number of weekly visits by MIRAs/to pregnant women, Number of Weekly communication packages delivered, number of training modules shared (in terms of time in minutes), receipt of IFA Tablets and consumed

(through survey), tetanus vaccination dates (MIRA Input) etc. were generated from the MIRA platform. Other qualitative and KAP based information was generated using paper based Questionnaire survey tools (standard for both the groups). Focus Group Discussions (FGDs) and Key Informant Interviews were conducted with the women and MIRAs and ANMs were also interviewed in the intervention area. Similarly, in the control group, Focus Group Discussions (FGDs) and Key Informant Interviews were conducted with the women; and ASHAs were also interviewed in the group. All the data was validated from the PHCs, sub-centre and ANM registers [12].

Human Subject protection: The exercise was done for internal quality control and all the ethical processes were followed. We briefed the participants about the study and gave them an information sheet and took written informed consent.

2.5. Data Analysis

The bulk of the data of intervention area was generated from MIRA Platform and was stored in MS-Excel sheets. And the data of prenatal registration of women in the control group was also entered in MS-Excel sheets. All Qualitative & Survey data was entered in Excel sheets, for both intervention and control groups members. The data was analyzed using EPI Info toolkit [13, 14]. We estimated proportion of Institutional Delivery (40.3% as per NHRM, Haryana for Nuh) as the standard to calculate the sample size for analysis, recognizing institutional delivery as one of the key practices and the most difficult to change behavior. The

estimated effect size was 0.342.

3. Results and Discussion

After 15 months of implementation of the project, an end evaluation was conducted with 134 women from each of the two groups – Intervention and Control areas. The other relevant data for study was also retrieved for these women in the intervention group from the MIRA platform. Also, the women in the control group, 134 of them were selected from the digital registers of women enrolled by ASHAs in the same time period and constraints. Also all other data regarding the ANCs, IFA, Tetanus vaccine etc. were generated using paper based survey tools and a survey was conducted with the selected women in the case group. Of the 134 women in the case group, two of them were no longer living in their earlier villages so they were replaced by new randomly generated women from the pregnancy list having same constraints, i.e. the time of registration and their first trimester for registration. We conducted Surveys of these women, verified the data from the PHC registers and had in-depth interaction with ASHAs and ANMs in group.

The purpose of the study was to analyze the uptake of health services and optimal communication required for bringing about a positive shift in the knowledge & attitudes. In doing so the data for both the groups was collected and analyzed.

Outcome indicators and the outcome of the process are reflected in the table below:

Table 1. *Outcomes & results.*

	Outcome Indicators	Case group (n=134)	Control Group (n=134)
A	Antenatal Check-up – ANC Indicators		
1	Women who received at least one ANC	67.16%	36.57%
2	Women who received three or more ANCs	44.03%	19.4%
3	Women who received ANC in the first trimester	62.69%	20.9%
B	Other Prenatal Care – Services Indicator		
4	Women who had at least one Tetanus injection	58.96%	26.87%
5	Women who received 100 or more Iron tablets	57.46%	43.28%
C	Postnatal care		
6	Total Institutional delivery	61.19%	36.57%
7	Delivery at home conducted by skilled health personnel	31.34%	29.1%
D	Postnatal care		
8	Mothers who received post-natal care within 48 hours of deliverz	79.85%	51.49%
9	Mothers who initiated breastfeeding within 6 hours of delivery	82.09%	72.39%
E	KAP based Messages (Prenatal)		
10	Women who could identify 2 or more Obstetrics danger signs during pregnancy	79.1%	53.73%
11	Women who could identify 2 or more food items as source of Iron	81.34%	41.79%
12	Women who could identify 2 or more food items as source of Proteins	74.63%	33.58%
13	Women who knew their expected date of delivery (+/-15 days)	69.4%	37.31%
F	KAP based Messages (Postnatal)		
14	Mothers who could recognize 2 or more new-born danger signs	75.37%	39.55%

*Difference between intervention and control groups were statistically significant at P<= 0.05

The results indicated a significant contribution of the MIRA Channel and its week-by-week prenatal care communication packs and other SBCC tools in the overall outcome of all the indicators. MIRA intervention demonstrated a 127% increase in uptake of all three ANCs in

the intervention area as compared to the control group. Institutional Delivery, a key component of the MCH indicator, demonstrated an improvement by over 67% and at the same time due to the increase of institutional deliveries, there ought to have been an overall lowering of home based

deliveries, but there was a small yet significant rise of 7.7% in home based deliveries assisted by skilled health personnel. In the other services related to Prenatal care there is 120% increase in uptake of Tetanus vaccination services (t>=1) and an increase in receiving IFA tablets by 33%, directly attributed to the constant remainders in the MIRA toolkit during week-by-week interaction with the pregnancy toolkit.

In the Postnatal services, we find a 55% increase in post-natal care services within first 48 hours of delivery, a significant change in behavior, an increase in 13.4%, in initiating breast feeding by mother within 6 hours of delivery. Also, it was found an increase by 90% in number of women, in the intervention area, who could identify at least 2 danger signs in the new-born, as compared to the control group (using a survey of icons approach).

Most exciting part of the study was the behavior shift due to the localized audio-visual messages and information capsules delivered to the women using MIRA Channel. We found that women in the intervention area, knew more about both Obstetrics and new born Danger signs and were better prepared to address the need in case of any such emergency. The study showed that 47% more women were able to identify 2 or more danger signs during the post-test survey. Also, we found in the intervention group, 95% more women were able to identify 2 or more sources of iron in their daily local meals than the women in the control group. Also, it was evident from the study that women, in the intervention area had much better control over their pregnancies. A total of 90 women (of the 134) in the intervention area had knowledge about their due dates of deliveries as compared to just 53 in the control group.

Also, upon comparing the number of visits made to the pregnant women with the indicators being tested under the study, it was observed that on average 13-18 household visits brings about significant positive shift in the overall indicators. The study showed that of the 134 women, 34 were visited 13-18 times during the course of their pregnancy and each visit was coupled with follow ups, tracking and information delivery. The KAP score of these 34 women was quite high (4.68) in comparison to the ones (24 women) who were visited 7-12 times (2.96). Also, a significant difference was seen in the uptake of services from only one woman receiving 3 or more ANCs; and more number of women (18) opting for home based delivery in comparison to institutional delivery (5) when visited up to 12 times and 19 women receiving 3 or more ANCs when visited up to 18 times. Also, it is important to note that women who were visited more than 13-18 times did not show major difference in the KAP score and uptake of services, which clearly suggests that visiting a woman 13-18 times is the optimal number of communications required for bringing about change in the behavior and practices of the beneficiaries. While this is an important, independent and incidental finding of this study, a discussion regarding how sustainable would such regular visits (13–18 times) be, and also will it be feasible in a Government Programme that would have to be scaled up to a large needy population base, the financial and programmatic implications of the same etc. are valid points to be considered, but are beyond the scope of this article and are discussed elsewhere [15, 16].

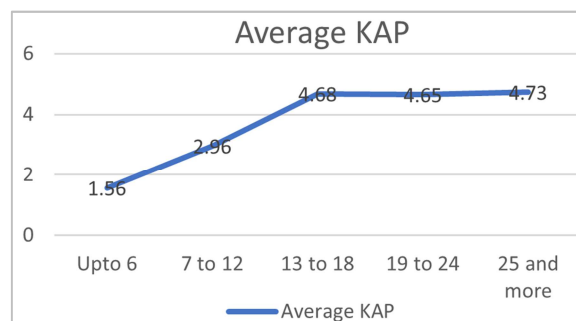**Figure 6.** *MIRA worker during a house visit.*

Figure 7. *Average KAP versus Visit blysis.*

4. Conclusion

Based on the observations of the study, it can be concluded that single window approach of MIRA is one of the key factors in increasing its usage and thereby making it sustainable. Its uniqueness of providing appropriate content using localized audio-visual communication approach makes it a 'Talking Toolkit' for millions of less literate rural women. This approach helps in increasing knowledge and building new demandIbehaviors. Also, the approach of using local women in designing and adaptation of content for MIRA Channel makes it a true grass-root application in terms of its acceptance and uptake. MIRA serves as a last mile extension both for real-time health management & referrals of the beneficiaries; and timely delivery of services by the public health system. MIRA Channel completes the loop by connecting the grass-root communities with the health system in the real-time. This makes the whole health system actionable and accountable. The multi-tier MIRA dashboard helps in monitoring the progress at all levels and brings in adequate amount of transparency in the operations at various levels.

Given below are few recommendations for designing & implementing a tech led innovation:

1) Digital tools should be designed with local women & communities for optimal localization & contextualization for ease of adoption by the

community & sustainability of the innovation.

2) Equipping CHWs with a locally customized mobile application for counseling and referrals is feasible, affordable, and highly acceptable among rural women and that it improves their health knowledge and behavior.

3) Consistent communication using digital toolkits helps the CHWs in delivering standard messaging & tracking which helps in providing quality health services [17].

4) 13-18 visits by the CHWs spread over 3 trimesters of pregnancy are optimal to achieve desired KAP results. Also, it reduces the burden on CHWs of frequently visiting the women so that the most pertinent cases can be attended to.

5) Digital toolkits can be easily adapted for scaling up in the other regions.

6) Such a strategy would be ideal for other LMIC like in Africa & Afghanistan. It will not only strengthen the health system but can also be used by individuals to manage their health & that of their family.

7) The above discussed Mobile MIRA Channel can be used as a platform tool wherein BCC could be looked into for other health conditions, be it for Communicable or Non-Communicable diseases and not just for Maternal and Child Health. So, an expansion of this BCC Model to other disease conditions / developmental issues and other geographies could be explored (of course with suitable modifications to the local context).

References

[1] Boerma T, Victora, CG, Sabin ML, et al., Reaching all women, children, and adolescents with essential health interventions by 2030, BMJ Global Health, 2020, https://doi.org/10.1136/bmj.l6986

[2] Flavia Rosa-Mangeret, Anne-Caroline Benski, Anne Golaz, Persis Z. Zala, Michiko Kyokan, Noémie Wagner, Lulu M. Muhe, and Riccardo E. Pfister (2022), 2.5 Million Annual Deaths—Are Neonates in Low- and Middle-Income Countries Too Small to Be Seen? A Bottom-Up Overview on Neonatal Morbi-Mortality. Trop. Med. Infect. Dis. 2022, 7, 64 doi: 10.3390/tropicalmed7050064.

[3] Ozimek JA, Kilpatrick SJ. Maternal Mortality in the Twenty-First Century. Obstet Gynecol Clin North Am. 2018 Jun; 45 (2): 175-186. doi: 10.1016/j.ogc.2018.01.004. PMID: 29747724.

[4] Das, Ujjwal, Barkha Chaplot, and Hazi Mohammad A"amathulla. 2021. "The Role of Place of Delivery in Preventing Neonatal and Infant Morta"ity Rate in India" Geographies 1, no. 1: 47-62. https://doi.org/10.3390/geographies1010004

[5] Sankar MJ, Neogi SB, Sharma J, Chauhan M, Srivastava R, Prabhakar PK, Khera A, Kumar R, Zodpey S, Paul VK. State of newborn health in India. J Perinatol. 2016 Dec; 36 (s3): S3-S8. doi: 10.1038/jp.2016.183. PMID: 27924104; PMCID: PMC5144119.

[6] Ministry of Health and Family Welfare, Government of India (2018), Health Atlas of Aspirational Districts, April 2018: doi: https://nhm.gov.in/New_Updates_2018/NHM_Components/R MNCHA/ADP/Health_Atlas_For_Web_18th_April.pdf

[7] Castillo, N. M. Vosloo, S, MIRA Channel: case study by UNESCO-Pearson Initiative for Literacy. 2017. Doi: https://unesdoc.unesco.org/ark:/48223/pf0000260598

[8] Surendran, A. (2020). Women, Work and Development in Rural India: A Catalogue of Voluntarism in Policy. *Social Change, 50* (1), 141–159. https://doi.org/10.1177/0049085719901088

[9] Dr Soumen A, Role of Asha, ANM & AWW health workers for development of pregnant women and children in India. 2018 Dec. International Journal of Advanced Research in Management and Social Sciences, doi: https://www.indianjournals.com/ijor.aspx?target=ijor:ijarmss &volume=7&issue=8&article=005

[10] Chokshi M, Patil B, Khanna R, Neogi SB, Sharma J, Paul VK, Zodpey S. Health systems in India. J Perinatol. 2016 Dec; 36 (s3): S9-S12. doi: 10.1038/jp.2016.184. PMID: 27924110; PMCID: PMC5144115.

[11] Sullivan LM, Weinberg J, Keaney JF Jr. Common Statistical Pitfalls in Basic Science Research. J Am Heart Assoc. 2016 Sep 29; 5 (10): e004142. doi: 10.1161/JAHA.116.004142. PMID: 27688237; PMCID: PMC5121512.

[12] Dean Andrew G., MD, MPH, Instructor's or Self Instructor's Manual for Computing with Epi Info Parts I and II (2007), University of Medicine and Dentistry of New Jersey, doi: http://www.epiinformatics.com/DownloadFiles/InstructorsMa nualEpiInfoI_II.pdf

[13] van Velthoven MH, Car J, Zhang Y, Marušić A. mHealth series: New ideas for mHealth data collection implementation in low- and middle-income countries. J Glob Health. 2013 Dec; 3 (2): 020101. doi: 10.7189/jogh.03.020101. PMID: 24363911; PMCID: PMC3868820.

[14] Aggarwal, Pradeep & Kakkar, Rakesh & Bijalwan, Rajiv & Kaur, Gagan Deep & Pandey, Vivek & Kumar, Santosh. (2016). Epi Info TM a mHealth tool for primary field data collection in subsample population of Uttarakhand-A cross sectional study. Indian Journal of Community Health. 28. 89 - 93.

[15] Agarwal S, Curtis SL, Angeles G, Speizer IS, Singh K, Thomas JC. The impact of India's accredited social health activist (ASHA) program on the utilization of maternity services: a nationally representative longitudinal modelling study. Hum Resour Health. 2019 Aug 19; 17 (1): 68. doi: 10.1186/s12960-019-0402-4. PMID: 31426801; PMCID: PMC6701148.

[16] Agarwal, S., Curtis, S. L., Angeles, G. *et al.* The impact of India's accredited social health activist (ASHA) program on the utilization of maternity services: a nationally representative longitudinal modelling study. *Hum Resour Health* 17, 68 (2019). https://doi.org/10.1186/s12960-019-0402-4

[17] Nanah A, Bayoumi AB. The pros and cons of digital health communication tools in neurosurgery: a systematic review of literature. Neurosurg Rev. 2020 Jun; 43 (3): 835-846. doi: 10.1007/s10143-018-1043-0. Epub 2018 Oct 17. PMID: 30334173.