

Assessment Of Mhealth Interventions In RMNCH Sector Of Rural India: A Case Study In Palwal District Of Haryana, India

Dr. Vani Aggarwal¹, Dr. A.M. Jose², Dr. Saba Siddiqui³ & Dr. Faraz Ahmad⁴

¹ Assistant Professor and Program Coordinator, Amity School of Economics, Amity University Haryana,

² Professor, Amity School of Economics, Amity University Haryana.

³ Assistant Professor, Department of Business Administration, College of Business Administration, Jazan University, Saudi Arabia.

⁴ Assistant Professor and Program Coordinator, Amity School of Economics, Amity University Haryana, ahmad_faraz@rediffmail.com, +91-9927003458

ABSTRACT:

This study is about the use of mHealth technology in a rural area of Haryana to understand its effectiveness in addressing health issues of Reproductive, Maternal, Newborn and Child Health (RMNCH). The research has looked at the problem from three angles: from the point of view of mHealth technology that is in use, the Frontline Health Workers (FHWs) and from the target groups of RMNCH. The Palwal district, in the Haryana State of India has been selected purposively as it is one among the backward districts of the State. A Primary Health Centre has been randomly selected for conducting the field study in 2019. The structured interview schedule was used to collect data from randomly selected respondents from FHWs and from expectant mothers and mothers of newborn children. The findings of the study have revealed that mHealth interventions are getting effective as most of the respondents favored the new technology.

The study confirms the hypothesis that ‘mHealth technologies have allowed community health workers to keep records of mothers and their children even in rural areas where there are no health facilities’. However, there are many problems to be addressed to make the health system more responsive to the needs of RMNCH. Some of them are like the access to the smart phones along with proper internet connection and better training of the FHWs and more conscientization of expectant mothers.

Keywords: mHealth; mixed-method approach; India; Maternal Health; Child Health; Health Indicators

1. INTRODUCTION

The health of its people is a prerequisite to attain and maximize the wealth of the nation. India is aiming to achieve good health for all its citizens. Among others, the health of mothers and children (RMNCH- Reproductive, Maternal, Newborn and Child Health) is of utmost importance as India still does not rank very high in its health indicators related to RMNCH. India is one among the nations of the world that have benefitted hugely from the development of ICT (Information and Communication Technology) in RMNCH such as mHealth⁵ (mobile Health). Mobile health technologies has ability to interact directly with patients and “to encourage peer-to-peer sharing as well as coaching on the part of health care providers through online communities of patients and providers” (Oerther.S et al, 2014). As a consequences of higher disease burden, infrastructural deficiencies, limited access to healthcare facilities, and shortage of healthcare workers and its impact on economic productivity of people are staggering and mHealth has been explored as a possible solution of overcomes these healthcare delivery barriers (Emmanuel.E et al, 2016).

1.1 Role of mHealth in Maternal and Child Healthcare Sector

“Mobile health (mHealth) interventions are rapidly gaining popularity for their potential to improve public health, and many developing countries see them as an important resource for frontline health workers (FHW)” (Johns Hopkins University: Global mHealth Initiatives, 2016)

With an introduction of mHealth services in maternal and child health sector, there has been a massive shift in the techniques used for child deliveries and their immunization planning. mHealth intervention in maternal and child healthcare sector includes multiple services such as mobile registration of a child at birth followed by access to other information on patient history via mobile for healthcare purposes, to complete and integrated patient health records that could be shared in real-time scenario across healthcare professionals and organizations. Traditional methods or paper-based methods cause supply-chain issues in maternal and child healthcare sector especially in drug stock management. For instance, the lack of knowledge about quantity and types of vaccines to carry for immunization causes difficulty in meeting local demand and generate a gap between demand for vaccines and the supply of vaccines.

Community health workers knock door to door and approach women in rural and remote areas of India, reminding mothers about vaccinations and other health information each day. It is difficult to carry long paper books/logbooks (to keep records) every day and make several entries on it

⁵ The provision of health-related services via mobile technology is called mHealth, abbreviated version for mobile Health. The benefits of mHealth services can be achieved by using mobile devices, such as mobile phones, patient monitoring devices, PDAs (Personal Digital Assistants), and other wireless devices. It involves the use and capitalization on a mobile phone's core utility of voice and short messaging service (SMS) as well as more complex functionalities and applications including general packet radio service (GPRS), third and fourth generation mobile telecommunications (3G and 4G systems), a global positioning system (GPS), and Bluetooth technology.

and on other giant papers as well. Despite these hard efforts, many children in India never complete their vaccinations either due to the communication gap or lack of access/willingness. This gives birth to diseases and deteriorates the health and productivity of the nation. mHealth services are considered a feasible option to facilitate quality healthcare deliveries in rural India as i) Mobile devices are ubiquitous and personal; b) Competition will continue to drive lower pricing and increase the functionality; c) Mobility by its very nature implies that users are always part of a network, which radically increases the variety, velocity, volume, and value of the information they send and receive.

1.2 Empirical Evidences on mHealth in RMNCH

The literature on mHealth is quite varied – conducted in different nations (mainly in Africa and Asia) by researchers who are sponsored by international donor agencies. It is found that government-sponsored studies in India are not available and noted that no study has been conducted in the State of Haryana. The review of literature has been done to identify the research gaps as well as to take stock of the existing knowledge in the area of study.

The study by Smisha Agarwal et.al (2016), which was conducted in the continents of Africa and Asia, has reported that Community Health Workers (CHW) are increasingly using Smartphone and Tablets over feature phones. The most frequently mentioned considerations in the selection of type of the mobile device included cost of the device, a long battery life to allow for frequent use and intermittent access to electricity for charging, screen size and attributes appropriate for the task and local availability of the device and its service centers.

A study in the Indian State of Uttar Pradesh by Prinja et al (Prinja, 2018) strongly suggested that the mHealth intervention as part of ReMiND program is cost saving from a societal perspective and should be considered for replication elsewhere in other states. Studies by Llozumba et al.(Llozumba, 2018) and Aberinde et al. (Aberinde, 2018) found that there has been a steady increase in mobile health (mHealth) interventions aimed at improving maternal health of women in low income and middle-income countries. Their review also found that there is evidence indicating that these interventions contribute to improvements in maternal health outcomes. Labrique et.al (Labrique, 2013) in their study has identified the key mHealth interventions that mattermost. These are: Client education and behavior change, Sensors and point of care diagnostics, Registries/vital events tracking, Data collection and reporting, Electronic health records, Electronic decision support, Provider-provider communication, Provider work planning, and scheduling, Provider training and education, Human resource management, Supply chain management, Financial transactions, and incentives.

The review of available literature provides an incomplete picture of the range of mHealth interventions currently being implemented, with lacking details of the types of technology being used and its readjustments in the State of Haryana, India, to support public health workers. The review of literature has made it clear that it is imperative to conduct a study in the Indian state of Haryana as no study has been conducted so far and considering its (mHealth) importance in

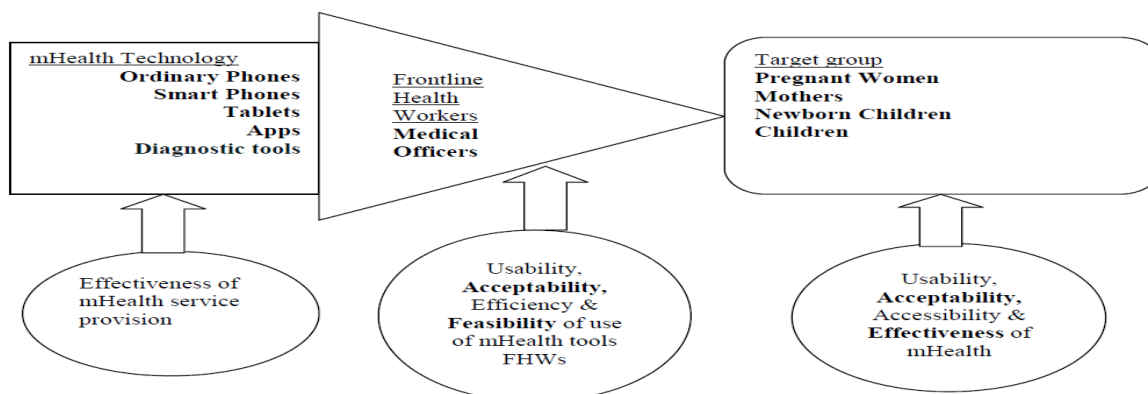
addressing health issues of RMNCH, and organizational issues of FHWs, the present study has been conducted in the following framework of analysis.

2. Material and Methods

2.1 Conceptual Framework of the study

From the review of available studies, it was found that optimal practices for implementing and evaluating the effectiveness of mHealth programmes are lacking in a developing country like India. This paper presents the finding of a study conducted in 2019 in the Palwal district of the state of Haryana, India. A study by the IDC (Institute for Development and Communication, 2014) had shown that while Haryana has been notified as one of the wealthy and developed states of India, its achievement in most of the health indicators has remained far from satisfactory. Palwal district is one among the backward districts of Haryana (Government of Haryana, 2015). Figure 1 shows the conceptualization of the research.

Figure 1: Conceptual Framework of the Study



2.2 Objectives of the Study

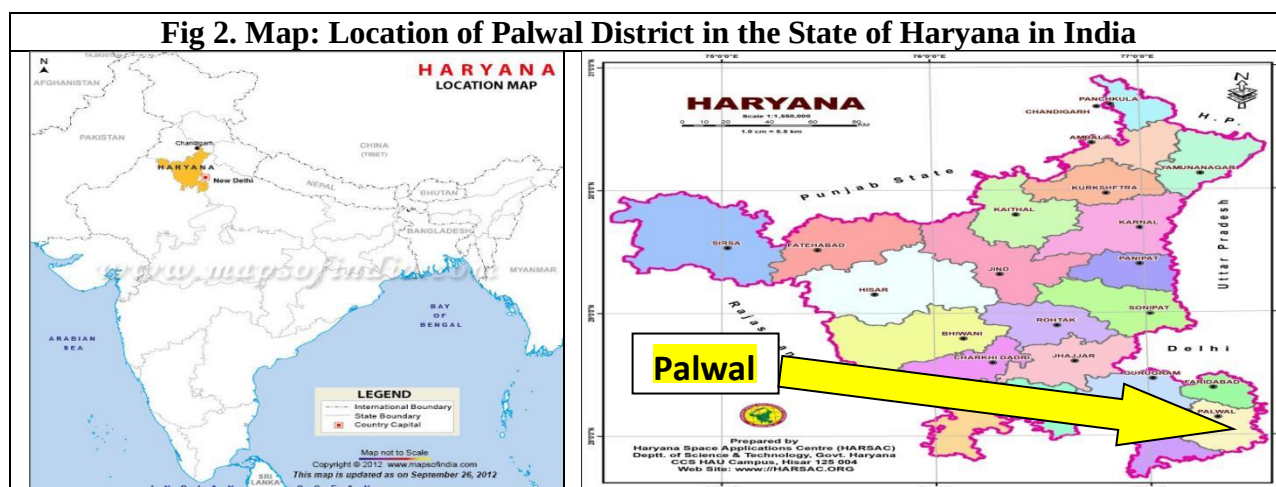
The overarching aim of the study is to highlight the impact of mHealth to improve maternal and child health in rural India. Therefore, the study seizes the opportunity to focus on analyzing the effectiveness of mHealth interventions for maternal and child health in rural India specifically in the Palwal district of Haryana. These are the broad objectives of the study: 1) To assess the perspectives of health providers/workers on the **feasibility** of using mHealth services in maternal and the child healthcare sector of the Palwal district of Haryana; 2) To assess the **acceptability** of mothers and pregnant women in the Palwal district to use mHealth services in the MCH sector of districts of Haryana; 3) To check **the effectiveness** of mobile health intervention to improve maternal and child health in Haryana.

2.3 Study Region

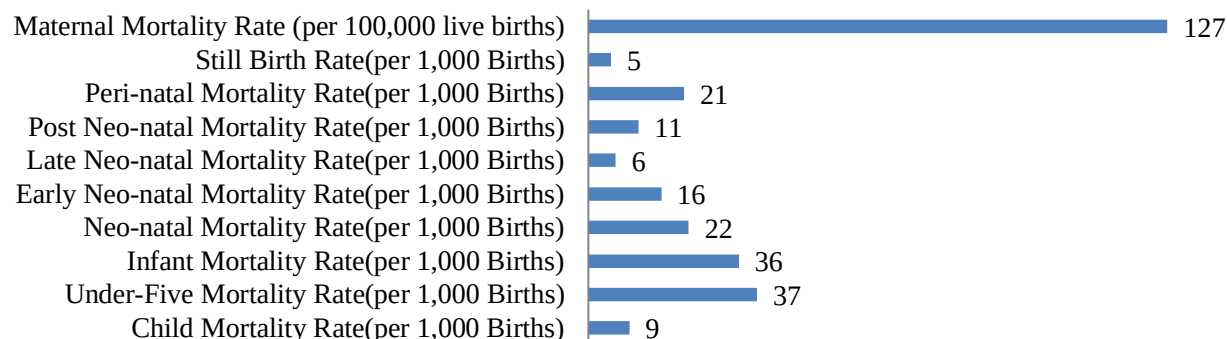
The Haryana state of north-central India was constituted in 1966 after the partition of Punjab between Hindi speaking population and Punjabi speaking population. At present, the health services by the Government in Haryana are being provided through a network of 63 Hospitals, 125 Community Health Centres, 509 Primary Health Centres and 2,636 Sub-Health Centres (Government of Haryana, 2019). Palwal became the 21st district of Haryana on 15 August 2008 (See Table-1 for the demographic details of Palwal District, Table 2 for MCH indicators in Palwal district of Haryana, Fig.2 for location of study region and Fig.3 for MCH indicators in Haryana).

Table 1 Demographic details of Palwal District, Haryana State and India				
S. No	Title	Palwal	Haryana	INDIA
1	Population	1,042,708	25,351,462	1,210,854,977
2	Area (sq. km.)	1,359	44,212	3,287,240
3	Population Density (inhabitants per sq.km.)	767	573	382
4	Population Growth Rate (decadal %)	25.76	19.9	17.64
5	Sex Ratio (females per 1000 males)	880	879	940
6	Literacy Rate (%)	69.32	75.55	74.04

Source: Government of India, Census 2011.



Source: Website of Government of Haryana

Fig.3 Maternal and Child Health Indicators of Haryana, 2016

Source: India Stat

Table 2 Maternal and Child health Indicators in district Palwal, Haryana

Maternity Care	
Mothers who had antenatal check-up in the first trimester (%)	30.7
Mothers who had at least 4 antenatal care visits (%)	19.0
Mothers whose last birth was protected against neonatal tetanus (%)	68.4
Mothers who consumed iron folic acid for 100 days or more when they were pregnant (%)	8.1
Mothers who had full antenatal care (%)	1.7
Mothers who received postnatal care from a doctor/nurse/LHV/ANM/midwife/other health personnel within 2 days of delivery (%)	28.6
Children who received a health check after birth from a doctor/nurse/LHV/ANM/midwife/other health personnel within 2 days of birth (%)	7.6
Delivery Care	
Institutional births (%)	56.2
Institutional births in public facility (%)	29.8
Home delivery conducted by skilled health personnel (out of total deliveries) (%)	11.5
Births assisted by doctor/nurse/LHV/ANM/other health personnel (%)	64.1
Births delivered by caesarean section (%)	8.5
Child Immunization	
Children age 12-23 months fully immunized (BCG, measles, and 3 doses each of polio and DPT) (%)	25.3
Children age 9-59 months who received a vitamin A dose in last 6 months (%)	43.6
Nutrition status of children	
Children under age 5 years whose birth was registered (%)	86.4
Children under age 3 years breastfed within one hour of birth (%)	28.3
Children under age 6 months exclusively breastfed (%)	50.8
Total children age 6-23 months receiving an adequate diet (%)	7.4
Breastfeeding children age 6-23 months receiving an adequate diet (%)	4.8

Household Profile	
Households with electricity (%)	93.2
Households with an improved drinking-water source (%)	93.6
Households using improved sanitation facility (%)	66.4
Households using clean fuel for cooking (%)	30.6
Households with any usual member covered by a health scheme or health insurance (%)	10.5
Total unmet need (%) for Family Planning	19.0

Source: (National Family Health Survey - 4, 2015-2016)

2.6 Ethical Considerations

Before the beginning of the research, the team has contacted the Primary Health Centre (Allika, Palwal) and got permission to conduct the study in their service jurisdiction. The study has followed all ethical considerations related to the research such as (i) received full consent from the participants to conduct the study, (ii) confidentiality of the data has been ensured, (iii) anonymity of individuals participating in the research has been ensured as well as no harm to the participants and respected their dignity, and (iv) no deception or exaggeration of about the aims and objectives of the research.

2.7 Study Design

The study used a mixed-design approach of quantitative and qualitative methods to check the acceptability and effectiveness of mHealth services in MCH sector of Palwal district, Haryana in 2019. Interviewer-administered questionnaires, focus group discussions (FGDs) with village women, and key informant interviews (KIIs) with health workers were employed.

2.8 Study Participants and Sampling

The main criteria of the study for the inclusion of households of Palwal district were the presence of 1) pregnant women, 2) lactating mother with child aged 0-12 months, 3) mother who gave birth within the study area, 4) mother who lived in the study area during pregnancy. The target population were mothers (lactating/childbearing age 15-49 years) and pregnant women. Random sampling technique was used to select households (the whole list was received from the PHI).

Table 3. Type of Interviews and Respondents		
Interview Types	No. of Interviews	Respondents
Focus Group Discussion	20 in total	Group of lactating mothers and pregnant women
Key Informant Interviews	15 in total	With ASHAs, ANMs, medical officer
Survey	45 in total	Pregnant women and lactating mothers

Overall, a total of 45 interviews of households were completed including mothers and pregnant women. The collection of qualitative data comprised of FGDs and KIIs. FGDs included 20

participants including mothers and pregnant women. Additionally, we conducted 15 KIIs which included healthcare providers such as ASHAs, ANMs, and medical officers from health facilities in the study district, to complement the focus groups (Table 3).

Table 4 Characteristics of sample respondents (n=45)					
Socio-demographic characteristics			Economic Characteristics		
Age classification(in Years)	Frequency	%	Occupation of Spouse	Frequency	%
< equal to 20 years	0	0	Farming	9	20.0
21-25 Years	26	57.8	Business	3	6.7
26-30 Years	15	33.3	Government Job	6	13.3
31-35 Years	2	4.4	Private Job	21	46.7
>35 years	2	4.4	Daily Wage Worker	6	13.3
Mothers level of Education			Household Income(Rs. per month)		
No formal Education	10	22.2	2000-5000	3	6.7
Primary	7	15.6	5000-10,000	20	44.4
Secondary	19	42.2	10,000-15,000	7	15.6
Senior Secondary	3	6.7	15,000-20,000	10	22.2
Graduate	6	13.3	Above 20,000	5	11.1
Religion			Economic Condition		
Hindu	43	95.6	APL	27	60.0
Christian	1	2.2	BPL	18	40.0
Muslim	1	2.2	House Ownership		
Others	0	0.0	Own	45	100.0
Community			Tenant	0	0
General	10	22.2	Nature of Family		
SC	19	42.2	Joint	39	86.7
OBC	16	35.6	Nuclear	6	13.3
ST	0	0.0			

Table 4 presents most of the respondents belong to 21-30 age groups (91%), and only about 62 % do have education secondary or higher level and 22% do not have any formal education. Almost all (except two) practices Hinduism and of which 42 % belong to the SC category and 36% belong to the OBC group which indicates that majority of the respondents belong to

socially backward groups in the society. As far as economic characteristics are concerned it is seen that 40 % belong to BPL families and almost 51% live less than Rs.10, 000 per month. Most of them do not have any organized sector job; rely mainly on a private job (47 %), farming (20%) and daily wage worker 13.3 %). All of them do have their own house but 86.7 % staying within a joint family.

2.7 Data Processing

The quantitative and qualitative data collected from the participants were screened for completeness and accuracy after the survey and interviews. Data were coded and entered in the excel sheets using dummy variables for qualitative data. Data were analyzed using various functions in the software for Windows. Descriptive statistics, frequency tables, percentage shares, and cross tabulations were run to generate output on all the relevant variables of the dataset. For instance, variables such as a reduction in maternal mortality rate, improved delivery care, improved registration of pregnant women, improved post-partum care and regulated fertility were analyzed to check the **effectiveness of mobile technology** for maternal health. Similarly, variables such as child immunization rate, improved nutritional status, reduced child mortality rate, reduced neonatal mortality rate, improved prenatal care of newborns, reduced infection, reduced stillbirth rate were analyzed to check the **effectiveness of mHealth solutions** for child health.

The FGDs and KIIs were collected and analyzed separately to get an accurate outcome from the study. Interviews of the ANMs and medical officers were analyzed thoroughly and repeatedly by the study members to ensure the accuracy of the information. Data were analyzed thematically and views from the participants (both health providers and health seekers) from the themes were presented as results for the study.

3. Results

3.1 Communication between health workers and clients via mobile phone: Effectiveness and Acceptability of mHealth

The results of the study show that participants who received follow-up call reminders for child vaccination and PNC visit and messages from health providers in the Palwal district are satisfied with the mHealth services in the MCH sector. Health seekers expressed high optimism toward receiving future follow-ups via mobile phones for maternal and child health. The high acceptability level of the health seekers for mHealth services was also demonstrated in the focus group discussions (FGDs) with the villagers (pregnant women and mothers), and key informant interviews (KIIs) of the health providers including Chief Medical Officer (CMO), Auxiliary Nursing Midwifery (ANMs), and Accredited Social Health Activist (ASHAs). After the introduction of mHealth intervention in the MCH sector of the Palwal district, mothers and pregnant women started receiving the follow-up calls regarding their PNC visit and messages for child immunization due date. They expressed high optimism towards receiving reminders on

mobile phone for PNC visit and immunization details of their children from health providers. Some of the mothers expressed high **acceptability** levels as demonstrated in the Table 5. Mothers and pregnant women feel more connected with the health workers due to continuous exchange of health information. After continuous use of mHealth services, mothers recognized that follow-up mobile calls and messages as a valuable reminder on their health and their children's health. The sentiments of healthcare providers –ASHAs, ANMs, Medical Officers– were also recorded during the study and they were also in accordance with these assertions (see Table 5).

Table 5 Response on effectiveness and acceptability of mHealth from the Mothers/Lactating Mothers/ ASHAs/ANM/ Medical Officer		
Sl No	Response statements from the Mothers/Lactating Mothers/ ASHAs/ANMs/ Medical Officer	Mode of data collection and type of respondents
1	"SMS and voicemail reminders on mobile phones reduced the concern about types of vaccination for children and PNC visits for pregnant women"	FGD- Mother-Palwal district, Haryana
2	"Information on intake of iron and calcium tablets during pregnancy helps women to give birth to a health child. Also, this widens the thinking of the family members as earlier they were against to take any medicines during pregnancy"	FGD- Mother-Palwal district, Haryana
3	"Follow-up reminders developed trust between partners. Sometimes family members do not agree upon taking any form of medicines or vaccination during pregnancy but voice mails regarding health information on significant development of baby by intake of calcium and folic acid during pregnancy develops trust"	FGD- Lactating Mothers- Palwal District
4	"Mobile phone reminders to pregnant women are helping village mothers and women to educate herself, family members on several pregnancy related issues and immunization of children"	KII- ASHAs- Palwal District
5	"Women becomes more aware about the vaccinations during pregnancy and also preferring more hospital deliveries under skill birth attendants"	KII-ANMs- Palwal district
6	"With the usage of tablets for child registration and PNC visit, data on immunization and other details are quick to access. In addition, it has reduced efforts of multiple entries in a logbook. Moreover, mHealth services simplified the work and now it is easy to search any entry on time"	KII-ANM- Palwal district
7	"After checking the records, ASHAs can easily approach to them. Health workers got training on the usage of tablets and also ASHAs are updating their knowledge on maternal and child health related issues using mHealth services"	KII-ANM-Palwal district

8	“mHealth services simplified the process of registration, record keeping, reporting, and monitoring of maternal and child health. Also, there is increase in immunization coverage due to SMS reminder on child immunization to each parent in the district”	KII- Medical Officer -Palwal district
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The introduction of mobile devices has enabled both the healthcare providers and seekers to access health information easily and quickly; for providers it has become easy to track patient's record, medical history, drug allergies and for seekers it has become easy to take medical advices from health experts, emergency care, access to medical facilities like ambulance, download medical reports, store their visits and access to health information on various health issues.

Mobile health applications could track a pregnant woman from a day one and remind her about the follow ups, weight, level of hemoglobin, vaccinations etc. during her pregnancy period. Further, these applications could track a child as well after her/his birth. Major causes of child deaths in Haryana are Asphyxia, low birth weight, Pneumonia, and other factors. There is a scope for full immunization of infants to raise the level to 100% with mobile health interventions.

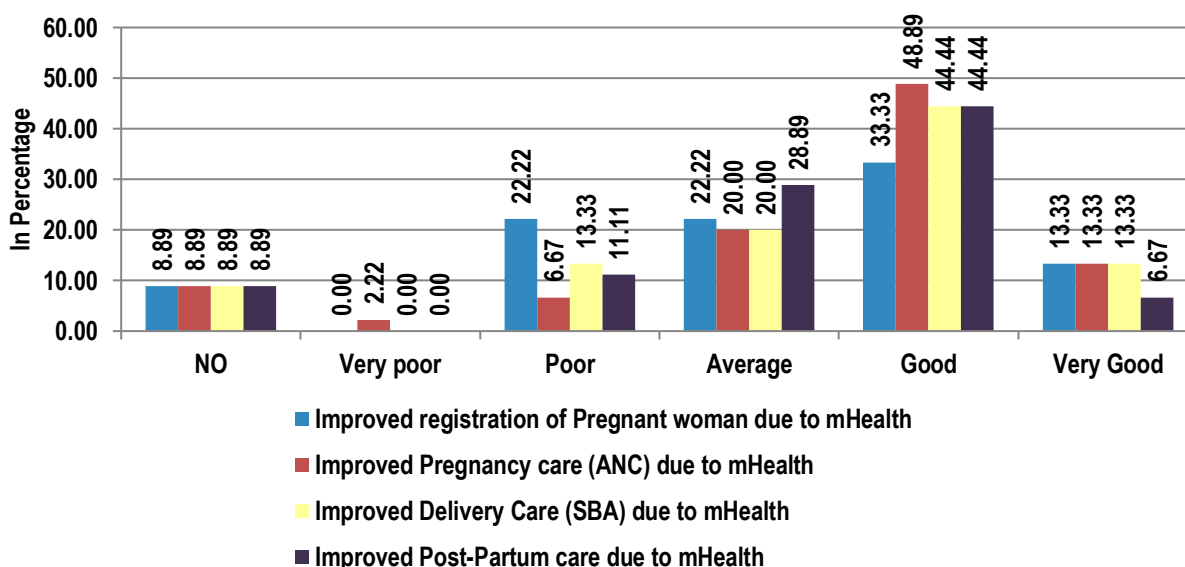
3.2 Effectiveness of mHealth in improving maternal and child health status

In a developing country like India, there is a prevalence of demand and supply gap in the healthcare facilities. Lack of accessibility and improper functioning of healthcare delivery are the major hurdles in the provision of effective healthcare facilities to population (Farhad.A et al, 2017). New innovative healthcare solutions such as eHealth, mHealth are emerging to combat healthcare delivery hemorrhage. The government of Haryana has implemented various mHealth interventions in the maternal and child healthcare sector. To check the effectiveness of mobile based interventions (mHealth) on maternal and child health outcomes in the Palwal district of India, the study considered the outcome variables mentioned in the Table 6.

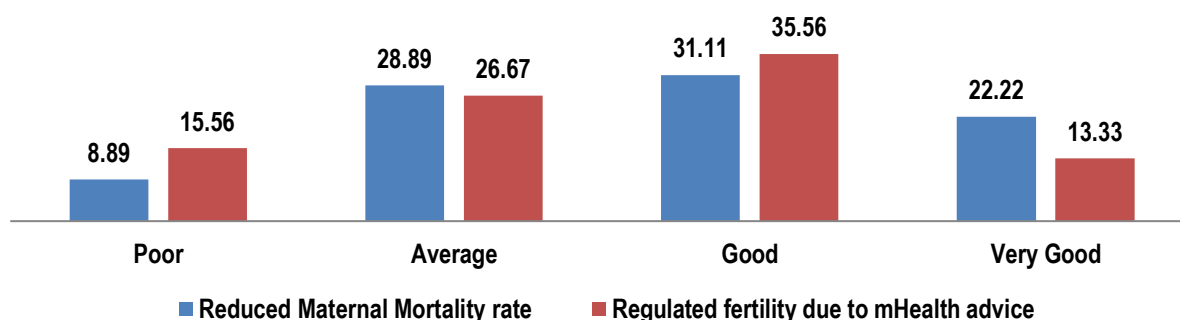
Table 6 List of outcome variables indicating effectiveness of mHealth on maternal and child health status	
Maternal Health	Child Health
Reduced Maternal Mortality rate	Change in Child Immunization Rate
Regulated fertility due to mHealth advice	Reduced Still Birth rate
Improved Post-Partum care	Reduced Neonatal mortality
Improved registration of Pregnant woman due to mHealth	Improved nutritional status due to mHealth advice
Improved Pregnancy care (ANC)	Reduced Infection due to mHealth
Improved Delivery Care (SBA)	Improved Post natal care for Newborns (PNC)
Timely communication to Expectant mothers on Health issues	

“Using mobile technology offers a tremendous opportunity for developing countries as India to advance in health care delivery by effectively utilizing scarce resources” (Farhad.A et al, 2017). The study collected the data of the households on the improvement in maternal and child health indicators after the introduction of mobile healthcare deliveries to assess improvements in maternal and child health outcomes in the Palwal district of Haryana. In the case of mHealth service provision to improve maternal health of the women household in Palwal, majority of the households reported that there is a ‘good’ and/or ‘very good’ improvement in registration of pregnant women (47%), ANC visits (62.22%), SBA delivery (58%) and post-partum care (51%) after the introduction of mobile healthcare deliveries in the Palwal district of Haryana (Fig. 4). This more than half of the sample population agrees upon the fact that mHealth services improved the maternal health facilities in the Palwal district of Haryana. In Haryana, nine percent deliveries are home based and only 12 percent of these home based deliveries are handled by a skill based personnel (MOFW, Government of India, 2015). This shows a great risk to a women health as 88 percent are under nonskilled professional and it might lead to a cause of death of a pregnant woman. There are two options; one is to provide skills to these non-skilled personnel and the second is to create health awareness among women to go for either institutional deliveries or skilled assistant supported home deliveries. mHealth applications could perform both functions by training non-skilled personnel and generate health awareness by using videos of these services.

Fig. 4 Effectiveness of mHealth Interventions on maternal healthcare service provision



Source: Survey Results

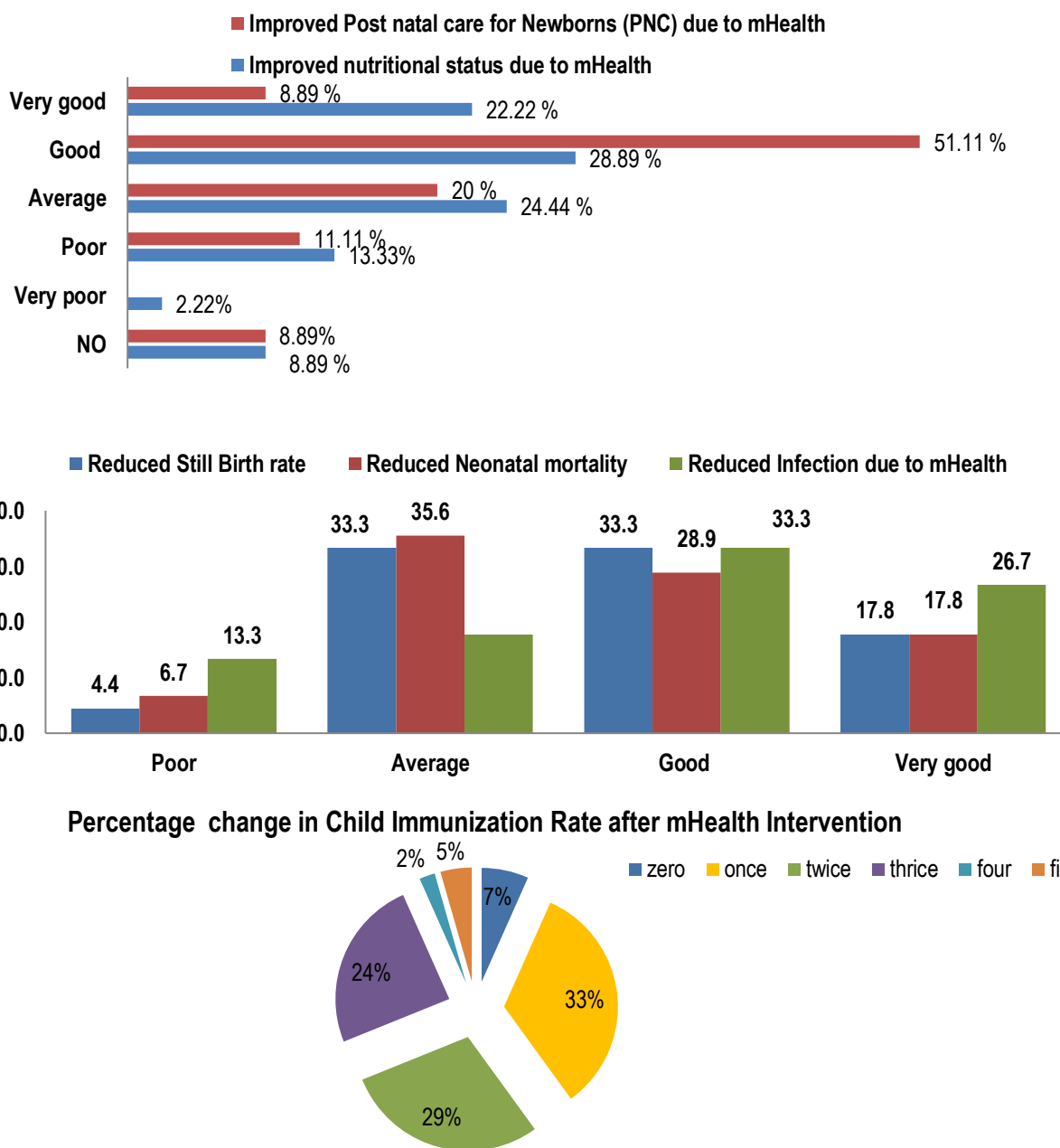
Fig- 5 Impact of mHealth Intervention on Maternal Mortality Rates and Fertility Rates

Source: Survey Results

The sample data collected from the Palwal district indicates the effectiveness of mHealth intervention on maternal care as after the mHealth intervention there is an improvement in maternal mortality rates and fertility rates. As per survey results, about 53 per cent of the respondents rated 'good' or 'very good' and 30 per cent reported the average score of mHealth deliveries in terms of improvement in maternal mortality rates (Fig. 5).

Similarly, about 49 percent of the target population rated 'good' or 'very good' in case of regulated fertility rates (Refer Fig 5). Health providers utilized different modes of mobile phone based communication such as voice message, text messages, videos, Smartphone applications to counsel households about consequences of abortions, how family planning can improve their social status, healthy children are better than more children etc. mHealth is catalyzing transformation of health system in Palwal district of Haryana; Tele medicine, Tele counseling made it possible to deliver healthcare services in rural and remote areas of India. Child mortality rates remain unacceptably high in rural India, particularly in the districts of Haryana. A popular approach to counter these high child mortality rates is interventions delivered using mobile based technology (mHealth). This paper studied the impact of mHealth interventions including Rapid SMS, client counseling, voice messages etc. on six indicators of child health: child immunization rate, still birth rate, neonatal mortality rate, postnatal care of newborns, nutritional status of children and infection among children (mentioned in table 6).

The study found that the implementation of mHealth services improved the postnatal care of newborns, nutritional status, and immunization rate and reduced the still birth rates, neonatal mortality rates and infection in the Palwal district of Haryana (refer fig.6). In the case of mHealth service provision to improve child health in Palwal, majority of the households reported that there is a 'good' and/or 'very good' improvement in PNC (60%), nutritional status of children (51%).

Fig- 6 Effectiveness of mHealth Interventions on Child Health in Palwal District

Source: Survey Results

Further, the results of the survey reports indicates that 46% households reported that there is a good/very good reduction in neonatal mortality rates, 51% reported that there is a good/very good reduction in still birth rates and 60% agreed on the fact that there is a good/very good

reduction in infection among children after the implementation of mHealth applications in the Palwal district of Haryana. In case of child immunization rate, 33% reported that mHealth applications increased child immunization rate one times while 29% reported that mHealth interventions twice increased the rate of child immunization among children in Palwal district of Haryana in 2019.

4. DISCUSSION

During pregnancy, it is important to have access to quality healthcare deliveries for both the mother and the development of the baby inside the womb of a mother. In developing countries like India, many women fail to visit hospitals three times which is recommended by the World Health Organization (WHO) due to lack of information and willingness to go to the hospitals or health centers. Inadequate care during pregnancy breaks a critical link in continuum of care and affects both the mother and child. Hence, mobile health solutions are required to promote healthy behaviors and parenting skills among mothers and other family members especially in rural areas of a developing country like India. In Indian economy, there are several challenges in the health system such as poor funding, poor access to healthcare facilities, shortage of medical staff, and low implementation of mobile health services. This eventually leads to high maternal and child mortality rates, low life expectancy, poor quality of healthcare deliveries and lower productivity with a presence of disguised unemployment.

Mobile health solutions are overcoming geographical barriers and reaching out even to remote areas of low- and middle-income countries. India is a developing country with growing mobile penetration and strong network. Hence, it is time that we adopt digitalization of healthcare deliveries in MCH sector especially mobile health services. The study unearthed that mHealth interventions are acceptable and effective in addressing many issues of attaining MCH in rural areas.

The study concludes that the implementation of mHealth solutions was effective at increasing the use of maternal and child healthcare deliveries when combined with additional support provided by the mHealth applications including training, monitoring, counseling etc. Overall, the study showed that mHealth interventions are acceptable and feasible solutions to the challenges of healthcare services such as accessibility, quality care and timely healthcare delivery in the Palwal district of Haryana, India. However, the respondents also highlighted certain barriers to mHealth solutions which need to be addressed such as lower mobile connectivity, lack of access to mobile phones to women and limited or erratic power supply in the Palwal district.

mHealth interventions targeting health providers, pregnant women, mothers, and children have the potential to reduce maternal and child mortality rate in rural India. Also, mHealth solutions provide equitable access, quality care and timely healthcare delivery in rural settings especially in a developing country like India. The findings of the study are vital for public health improvement and relevant to the policy makers in maternal and child healthcare deliveries. The

implementation of mHealth policies should be cautious of the barriers involved in the scale-up of mHealth interventions in the MCH sector.

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