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The role of an mHealth intervention in improving knowledge and skills of accredited social health activists in tribal areas of Gujarat, India: a nested study within an implementation research trial

Shobha Shah (shahshobha30@gmail.com)[1], Aakash Shinde[2], Ankit Anand[2], Dhiren Modi[2], Gayatri Desai[3], Hardik Bhatt[2], Ravi Gopalan[4], Nishith Dholakia[5], Prakash Vaghela[5], Shrey Desai[2], Pankaj Shah[2,3]

1.Women's Health and Training Center, Society for Education, Welfare and Action-(SEWA) Rural, Bharuch, Gujarat, India
2.Community Health Project, Society for Education, Welfare and Action (SEWA) Rural, Bharuch, Gujarat, India
3.Kasturba Maternity Hospital, Society for Education, Welfare and Action (SEWA) Rural, Bharuch, Gujarat, India
4.Argusoft India Ltd, Gandhinagar, Gujarat, India
5.Department of Health and Family Welfare, Government of Gujarat, Gandhinagar, Gujarat, India

Keywords
accredited social health activist, Implementation research, Knowledge and skills, Maternal, newborn and child health care, mHealth

Correspondence
Shobha Shah, Women's Health and Training Center, Society for Education, Welfare and Action (SEWA) Rural, Bharuch, Gujarat 393110, India.
Tel: 091-9428586746 |
Fax: 091-2645-220313 |
Email: shahshobha30@gmail.com

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ABSTRACT

Aim: To evaluate the effectiveness of an mHealth intervention in improving knowledge and skills of accredited social health activists in improving maternal, newborn and child health care in India.

Methods: This was a nested cross-sectional study within a cluster randomised controlled trial. The intervention was a mobile phone application which has inbuilt health education videos, algorithms to diagnose complications and training tools to educate accredited social health activists. A total of 124 were randomly selected from the control (n = 61) and intervention (n = 63) arms of the larger study after six months of training in Bharuch and Narmada districts of Gujarat.

Results: The knowledge of accredited social health activists regarding pregnancy (OR: 2.51, CI: 1.12–5.64) and newborn complications (OR: 2.57, CI: 1.12–5.92) was significantly higher in the intervention arm compared to the control arm. The knowledge of complications during delivery (OR: 1.36, CI: 0.62–2.98) and the postpartum (OR: 1.06, CI: 0.48–2.33) period was similar in both groups. The activists from the intervention arm demonstrated better skills for measuring temperature (OR: 4.25, CI: 1.66–10.89) of newborns compared to the control group.

Conclusion: The results suggest potential benefits of this mHealth intervention for improving knowledge and skills of accredited social health activists.

INTRODUCTION

India accounts for 19% of global maternal deaths and 21% of global childhood deaths (1). The maternal mortality ratio is 167 per 100 000 live births, and the infant mortality rate is 40 per 1000 live births (2,3). Major improvements have occurred in maternal, newborn and child health (MNCH) care coverage following the launch of the National Rural Health Mission (NRHM) programme in 2005 (4). Accredited social health activists (ASHAs) play a pivotal role in NRHM's strategy to strengthen the healthcare delivery system in rural India. ASHAs are expected to create awareness on health and its determinants, mobilise the community towards local health planning and increase utilisation of the existing health services (5). Evaluation of

Abbreviations

ASHA, accredited social health activist; CI, confidence interval; ImTeCHO, Innovative Mobile Health Technology for Community Health Operations; KMC, kangaroo mother care; LBW, low birthweight; MNCH, maternal, newborn and child health; NRHM, National Rural Health Mission; OR, odds ratio; ORS, oral rehydration solution; PHC, primary health centre; RCT, randomised controlled trial; SEWA Rural, Society for Education, Welfare and Action Rural.

Key notes

- The need for ongoing capacity building and refresher training of the health workers remains an important implementation challenge.
- mHealth strategies might be effective in improving skills and knowledge of accredited social health activists (ASHAs) who are providing maternal, newborn and child health services in villages within the government health system in Gujarat, India.
- mHealth strategies might be useful to overcome implementation challenges to ensure trained health workforce at scale.

the methods to improve the performance of ASHAs in terms of knowledge and skills in the domain of MNCH care is crucial to achieve development goals through the NRHM.

ASHAs are incentivised front-line health workers trained to provide MNCH services in their villages. Their tasks include mobilisation of pregnant women, mothers and children for using health services such as antenatal care, childbirth, home-based care of newborns and immunisation (6). ASHAs are supplied with essential medicines, such as antibiotics for providing treatment for common illnesses and nutritional supplements. Each ASHA is a member of a Village Health and Sanitation Committee which plans various health services (6).

Previous studies assessing knowledge and skills of ASHAs have exhibited gaps in different facets of their performance (7–9). Less than a quarter of ASHAs in the state of Maharashtra, India, were able to state the danger signs for which a child with pneumonia or diarrhoea should to be referred to a health facility (7). Only half of the ASHAs in Delhi knew that swelling of feet during pregnancy is a sign of severe anaemia (9). Research from central India (Madhya Pradesh) suggests that despite training sessions, gaps still exist in their understanding of various aspects of child morbidity (8). A Delhi-based study of healthcare delivery by ASHAs revealed that their knowledge was good, but their practices were inadequate. The study suggested this needs to be addressed through skill-based training related to good communication and problem-solving (9). Studies from Gujarat and Lucknow have emphasised the need for continuous capacity building to improve the knowledge and skills of ASHAs as well as improve their efficiency in the delivery of health services (10–12).

In recent years, mobile health (or mHealth) has been widely practised in low- and middle-income countries to provide health services, which include dissemination of health education, reminders, emergency response, support and monitoring (13). Due to the surge in mobile connectivity in recent years, there is an opportunity to use this platform to improve the capacity and workload of health workers in India (13,14). This study aimed to evaluate the effectiveness of an mHealth intervention [Innovative Mobile Health Technology for Community Health Operations (ImTeCHO)] in improving knowledge and skills of ASHAs in MNCH care. This study, a nested assessment within a larger cluster randomised trial, was carried out six months after an initial training to assess the effectiveness of both the training and the mHealth intervention.

METHODOLOGY

About the randomised controlled trial (RCT) and intervention

The larger RCT aims to implement and evaluate an innovative intervention based on mobile phone technology to improve the performance of ASHAs through better supervision and support in predominantly tribal and rural communities of Gujarat, India. This is a joint initiative of a voluntary organisation, SEWA Rural and the Gujarat state government. There are 11 primary health centres (PHCs) (with a catchment population of approximately 20 000 each) in each arm. ImTeCHO is an mHealth technology-based job aid locally developed to support ASHAs in performing their scheduled tasks in the field. ImTeCHO helps each ASHA in the following ways:

- scheduling her visits to infants and mothers in her village by automatic alerts via mobile phone;
- reminding all essential tasks to be performed at home visit;
- having inbuilt health education videos for behaviour change communication for effective counselling;
- providing inbuilt algorithms for diagnosis of high-risk low birthweight (LBW) infants and their treatment plans;
- training and regular updating of audio and video lectures in ImTeCHO to increase knowledge and skills;
- access to ImTeCHO helpline for improving skills and knowledge on MNCH care.

Some of the training component provided through the ImTeCHO application includes information about the importance of institutional delivery and antenatal examination, essential newborn care, exclusive breastfeeding, initiation of complimentary feeding and recognition of danger signs of pregnancy, newborn period and early infancy. The mobile platform was used to deliver short videos demonstrating the skills regarding the recognition of anaemia during pregnancy, measurement of weight and temperature of a newborn baby, measurement of breaths for recognition of pneumonia along with signs of dehydration during diarrhoea.

Along with the above-mentioned phone content to improve the knowledge and skills of ASHAs, classroom training was conducted jointly by trainers from SEWA Rural and the state government over seven days. The detailed objectives and description of the ImTECHO intervention have been published elsewhere (14).

The outcome indicators for the RCT are coverage of proven MNCH services as measured through baseline and endline surveys.

Study setting of the present nested study

This study was a nested cross-sectional study within the above-mentioned cluster RCT. The nested study was conducted with selected ASHAs from the study area in Bharuch and Narmada districts of Gujarat, India.

Sample size for the nested study

The sample size was calculated using two indicators: (i) the proportion of ASHAs with knowledge of the correct treatment for pneumonia (intervention = 0.50, control = 0.25); (ii) the proportion of ASHAs who demonstrated the correct method for weighing an infant (intervention = 0.25, control = 0.05). The formula shown was used to calculate the sample size.

$$n = \frac{(Z_\alpha + Z_\beta)^2 * (P_1 * (1 - P_1) + P_2 * (1 - P_2))}{(P_1 - P_2)^2}$$

The sample size was calculated at 55 ASHAs per group (assuming confidence level = 0.95 and power = 0.80) for this nested study.

Selection of ASHAs

In the RCT, the total number of ASHAs in the 11 intervention PHCs and 11 control PHCs were 283 and 265, respectively, with each given a unique number.

The baseline data collection occurred on the first day of training immediately after the ASHAs arrived at the training venue. Five ASHAs from each of the 11 PHCs were invited for data collection on the first day of training considering required sample size of 55 per arm. All ASHAs accepted the invitation for data collection, and therefore, 55 ASHAs were interviewed at the baseline.

After six months of completion of the training, data collection was carried out at the project headquarter. ASHAs were invited to arrive at the data collection venue on a predetermined date. Considering the required sample size of 55 per arm and potential no response rate, seven ASHAs from each of the 22 PHCs were randomly invited. So, 77 ASHAs were assessed for eligibility and invited from each arm. ASHAs who did not receive training for MNCH as per the government norms were excluded. Only ASHAs who had used the ImTeCHO mobile application for six months were selected for the nested study. Eligible ASHAs were contacted individually and invited to take part in the survey. Of 77 invited ASHAs, 63 ASHAs from the intervention arm and 61 ASHAs from the control arm were eligible and arrived at the venue for data collection.

Considering the methodology described above, the sample of ASHA for the baseline and endline evaluation was different. Detailed information and objectives of the nested study were shared with selected ASHAs. See Figure 1 for detailed information about the sample selection.

Data collection

Data collection was carried out using a pretested, structured questionnaire by data collectors who were trained in integrated management of newborn and childhood illness and were blinded to the study arms. Knowledge-related questions were completed in one-to-one interviews by data collectors at SEWA Rural head office, whereas questions related to the skills of ASHA were completed in the field by observation. Data collectors turned in the completed questionnaires to a quality control officer, who checked them for quality and completeness. To assess the quality of data, 10% of the sample was re-interviewed by the quality control officer. Data were entered by a data entry operator.

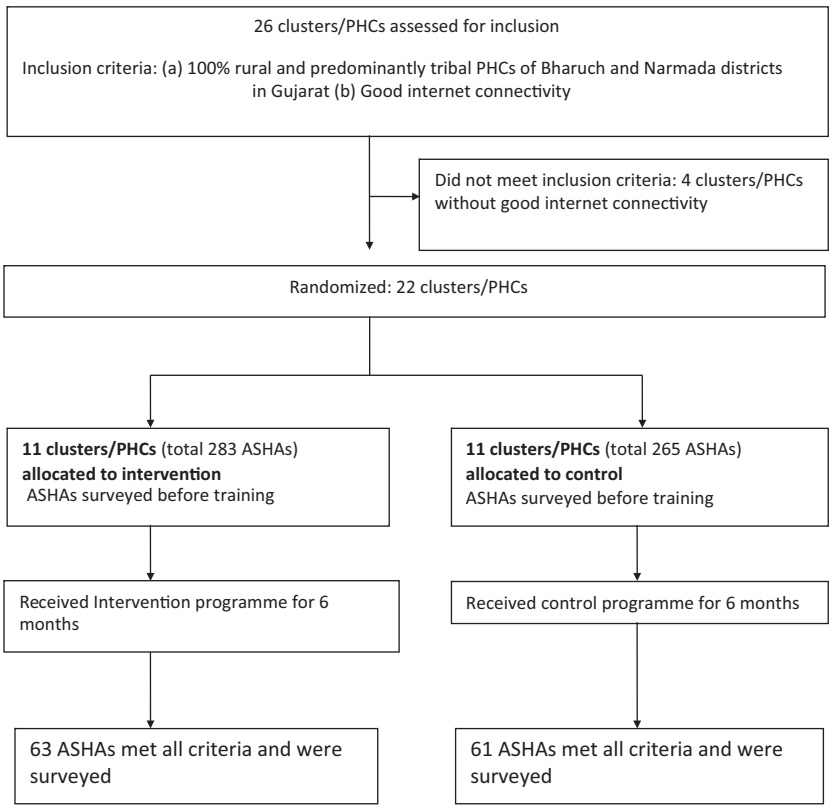

Figure 1 Study design and flow chart.

Data collection was conducted in July 2016 over a two-week period. Each ASHA in the study was given a monthly incentive of IRs 800 (US$ 12)/month for using a mobile phone. The monthly recharge cost for the Internet connection (1GB/2G) of IRs 179 (US$ 2.74) was borne by SEWA Rural.

Statistical analysis

Cross-tabulation was performed to see the differences between intervention and control clusters. Chi-square and Fisher's exact tests (for numbers of cases below five) were used to measure the differences between intervention and control groups. Adjusted and unadjusted odds ratios (ORs) with 95% confidence intervals (CIs) were generated. Multivariate logistic regression was used for each of the variables on knowledge and skills to generate the ORs for the intervention arm. The ORs were adjusted for caste and years of work experience as they were thought to be potential confounders. STATA version 12 was used to analyse the data (15).

Ethical issues

The trial was approved by the Ethics Review Committee of WHO and SEWA Rural Institutional Ethics Review Committee. Written informed consent from ASHAs was obtained for enrolment in the study. The confidentiality of the participants was maintained throughout the study, and personal information on ASHAs was removed from the final dataset.

RESULTS

Knowledge of ASHAs before training

During the training period, questionnaires to assess knowledge of 110 ASHAs (55 in intervention and 55 in control arm) were completed (Table 1). There was no difference between intervention and control arms in terms of knowledge on MNCH care.

Characteristics of ASHAs sampled for the survey after six months of training

Overall, 124 ASHAs (63 in intervention and 61 in control arm) were assessed. The average age of ASHAs was 32.9 years, 93% (116/124) were married, 61% (76/124) had primary education, 85% (105/124) were indigenous tribal, and 58% (72/124) had worked for more than five years (Table 2). Only 22% (45/124) covered a population of over 1000.

Knowledge of ASHAs regarding MNCH care after six months of training

The proportion of ASHAs who identified five pregnancy complications was significantly higher in the intervention (OR: 2.51, CI: 1.12–5.64) compared to the control group (Table 3). In the intervention clusters, 75% (47 of 63) of ASHAs had knowledge of at least five signs of newborn complications compared to 57% (35 of 61) in the control areas (OR: 2.57, CI: 1.12–5.92). Both ASHA groups knew about the advantages of kangaroo mother care (KMC), but knowledge regarding the impact of KMC on weight gain

Table 1 Knowledge of ASHAs at baseline

Knowledge area	Intervention (n = 55) n (%)	Control (n = 55) n (%)	Unadjusted OR (95% CI)
Minimum number of iron tablets (100) recommended during pregnancy	29 (52.7)	29 (52.7)	1.00 (0.44–2.26)
Any three danger signs or symptoms during pregnancy/childbirth/after childbirth	38 (69.1)	43 (78.2)	0.62 (0.24–1.60)
Breastfeeding within one hour of childbirth	52 (94.5)	52 (94.5)	1.00 (0.13–7.82)
Number and timing of ASHA home visits after childbirth	46 (83.6)	46 (83.6)	1.00 (0.32–3.13)
Starting complementary food at six months	50 (90.9)	51 (92.7)	0.75 (0.14–3.89)
Medicine (cotrimoxazole) for pneumonia which ASHA can provide	0 (0)	6 (10.9)	Not applicable
Medicine (ORS/Zinc) for diarrhoea which ASHA can provide	45 (81.8)	53 (96.4)	0.17 (0.02–0.87)

Table 2 Social and economic characteristics of ASHAs at endline (N = 124)

Characteristics	Intervention (n = 63) n (%)	Control (n = 61) n (%)	Unadjusted OR (95% CI)
ASHAs' age >29 years	38 (60%)	41 (67%)	0.74 (0.36–1.55)
Single/widowed/divorced/separated	3 (4.8)	5 (8.2)	0.56 (0.08–3.45)
More than eight years of formal education	23 (36.5)	25 (41.0)	0.83 (0.38–1.82)
Nontribal	17 (27.0)	2 (3.3)	10.90 (2.36–100.40)
Living in a joint extended family	31 (49.2)	38 (62.3)	0.59 (0.27–1.27)
More than five years of work experience	38 (60.3)	36 (59.0)	1.06 (0.48–2.30)
Covering more than 1000 population	22 (34.9)	25 (41.0)	0.77 (0.35–1.70)

Table 3 Knowledge of ASHAs about maternal, neonatal and infant health at endline

	Intervention clusters (n = 63) n (%)	Control clusters (n = 61) n (%)	Unadjusted OR (95% CI)	Adjusted* OR (95% CI)
Knowledge about maternal health and newborn care				
At least five signs or symptoms of pregnancy complications	33 (52.4)	19 (31.1)	2.43 (1.10–5.42)	2.51** (1.12–5.64)
At least three signs or symptoms of complications during labour	28 (44.4)	22 (36.1)	1.42 (0.65–3.11)	1.36 (0.62–2.98)
At least three signs or symptoms of postpartum complications	33 (52.4)	32 (52.5)	1.00 (0.46–2.14)	1.06 (0.48–2.33)
At least five signs or symptoms of newborn complications	47 (74.6)	35 (57.4)	2.18 (0.96–5.04)	2.57** (1.12–5.92)
At least three signs or symptoms of infection in child	16 (25.4)	13 (21.3)	1.26 (0.50–3.18)	1.48 (0.61–3.58)
Low birthweight cut-off (<2500 g)	51 (81.0)	46 (75.4)	1.39 (0.54–3.61)	1.44 (0.57–3.66)
At least five essential practices for care of LBW newborn	21 (33.3)	13 (21.3)	1.85 (0.77–4.52)	1.72 (0.73–4.05)
At least three steps of KMC	32 (50.8)	27 (44.3)	1.30 (0.60–2.80)	1.10 (0.52–2.36)
At least three signs or symptoms of pneumonia	30 (47.6)	23 (37.7)	1.50 (0.69–3.27)	1.86 (0.86–4.07)
Treatment (cotrimoxazole/amoxicillin) for pneumonia in infant	24 (38.1)	13 (21.3)	2.27 (0.96–5.51)	1.98 (0.84–4.67)
If the infant has diarrhoea, then what treatment should be given?				
ORS	62 (98.4)	61 (100.0)	Not applicable	Not applicable
Zinc	61 (96.8)	56 (91.8)	2.72 (0.42–29.45)	2.09 (0.38–11.56)
Other medicine	12 (19.0)	7 (11.5)	1.82 (0.60–5.87)	1.92 (0.67–5.50)
Refer to hospital	10 (15.9)	7 (11.5)	1.46 (0.46–4.85)	1.44 (0.48–4.31)
Other homemade medicine	14 (22.2)	16 (26.2)	0.80 (0.32–1.98)	0.90 (0.36–2.21)
Continue liquids	2 (3.2)	1 (1.6)	N/A	N/A
Knowledge about advantages of KMC				
Keeps newborn warm	63 (100)	61 (100)	N/A	N/A
Improves breastfeeding	6 (9.5)	9 (14.8)	0.61 (0.17–2.07)	0.71 (0.22–2.23)
Helps weight gain of newborn	54 (85.7)	36 (59.0)	4.17 (1.63–11.25)	4.08** (1.61–10.32)
Knowledge of correct age (six months) of starting supplementary feeding	61 (96.8)	59 (96.7)	1.03 (0.07–14.69)	0.78 (0.10–5.83)
Knowledge about foods which should be given to infant aged six months up to one year				
Continue breastfeeding	6 (9.5)	14 (23.0)	0.35 (0.10–1.08)	0.30** (0.09–0.94)
Dal (pulses)	61 (96.8)	58 (95.1)	1.58 (0.17–19.45)	1.18 (0.19–7.36)
Smashed rice, *khichdi* (rice with pulses) with ghee or oil	19 (30.2)	11 (18.0)	1.96 (0.78–5.08)	1.89 (0.77–4.65)
Vegetables – boiled potato	27 (42.9)	22 (36.1)	1.33 (0.61–2.92)	1.54 (0.71–3.35)
Fruits (guava, banana, mango, others)	54 (85.7)	37 (60.7)	3.89 (1.52–10.54)	3.41 (1.37–8.49)
Smashed bread in sweet milk	41 (65.1)	38 (62.3)	1.13 (0.51–2.51)	1.24 (0.57–2.72)
Rab (soup) of *Anganwadi* food	23 (36.5)	16 (26.2)	1.62 (0.70–3.76)	1.58 (0.70–3.57)
Quantity of food that should be given to an infant aged six months up to one year				
If breastfeeding, then feed three bowls three times a day	47 (74.6)	39 (63.9)	1.66 (0.72–3.87)	1.81 (0.79–4.17)
If not breastfeeding, then five bowls five times a day	13 (20.6)	6 (9.8)	2.38 (0.77–8.19)	2.86 (0.98–8.37)
Knowledge about foods that should be given to child aged between one and two years				
Thick *dal* (pulses) and bread with oil or ghee	40 (63.5)	36 (59.0)	1.21 (0.55–2.65)	1.39 (0.64–3.03)
Dal (pulses)	50 (79.4)	38 (62.3)	2.33 (0.98–5.67)	1.90 (0.83–4.38)
Fruits (guava, banana, mango, others)	46 (73)	41 (67.2)	1.32 (0.57–3.07)	1.19 (0.53–2.70)
Milk and milk products	19 (30.2)	24 (39.3)	0.67 (0.29–1.49)	0.65 (0.29–1.45)
Whatever made in home	58 (92.1)	55 (90.2)	1.27 (0.30–5.55)	1.79 (0.44–7.43)
Quantity of food that should be given to a child aged one to two years				
1-1/2 bowls five times a day	45 (71.4)	43 (70.5)	1.05 (0.45–2.44)	1.30 (0.56–3.03)

*Adjusted for caste and years of experience of ASHA.
**Statistically significant.

was significantly higher among the intervention group (OR: 4.08, CI: 1.61–10.32). Both groups exhibited similar knowledge about pneumonia symptoms and treatment, of giving oral rehydration solution (ORS) and zinc for diarrhoea, stopping exclusive breastfeeding once weaning is initiated, supplementary feeding practices in infants aged six months to one year. Correct knowledge about giving fruits such as bananas to a child was higher in the intervention compared to the control group (OR: 3.41, CI: 1.37–8.49; Table 3).

Skills of ASHAs regarding MNCH care after six months of training

The comparison of the skills of ASHAs by cluster is shown in Table 4. The proportion of ASHAs who washed their hands before checking newborns was significantly higher in the intervention group (OR: 2.49, CI: 1.09–5.70). ASHAs in the intervention group had significantly better counselling skills regarding supporting the whole body of the newborn (OR: 2.49, CI: 1.10–5.63) and keeping the chin close to the breast while breastfeeding (OR: 2.94, CI: 1.16–7.48) as

compared to the control group. The percentage of ASHAs having appropriate skills for preventing hypothermia by following the correct steps for wrapping the newborn (87% vs 72%), and the correct method of recording temperature (66% vs 36%) was higher in the intervention group compared to the control group.

DISCUSSION

Our study shows that the ImTeCHO application might be effective in improving skills and knowledge of ASHAs who are providing services in villages within the government health system. The results of the study show the potential usefulness of mHealth technology for updating knowledge and skills of ASHAs working in hard-to-reach areas to improve their work performance. However, there is a need for continuous capacity building and refresher training (16,17).

The use of mobile technology in disease control programmes (such as malaria or AIDS) has been shown to improve the overall practices of health workers (18,19). A systematic review on the effects of mHealth interventions in MNCH care has shown positive impact on utilisation of services (20). Studies in India on the use of mHealth for improving health worker capacity in MNCH care support this conclusion. The Solutions Aiding Knowledge for Health Improvement project in Nagpur demonstrated improvement in utilisation of healthcare services and recognition of danger signs of pregnancy by pregnant women (21). Another study in Bihar showed that using

Table 4 Skills of ASHAs in providing maternal, neonatal and infant health at endline

	Intervention clusters (n = 63) n (%)	Control clusters (n = 61) n (%)	Unadjusted OR (95% CI)	Adjusted* OR (95% CI)
Hand washing				
Washes hands with soap and water	26 (41.3)	14 (23)	2.36 (1.01–5.59)	2.49** (1.09–5.70)
Positions elbow upwards for drying	12 (19.0)	9 (14.8)	1.36 (0.47–3.99)	1.44 (0.53–3.90)
Taking respiratory rate of infant				
Availability of wrist watch	41 (65.1)	17 (27.9)	4.82 (2.11–11.14)	5.15** (2.28–11.65)
Removes clothes from abdomen	54 (85.7)	39 (63.9)	3.39 (1.31–9.22)	4.37** (1.60–11.92)
Newborn silent/not crying or sleeping	13 (20.6)	8 (13.1)	1.72 (0.60–5.21)	2.14 (0.77–5.94)
Counting method correct	25 (39.7)	5 (8.2)	7.37 (2.44–26.43)	6.89** (2.33–20.35)
Counted for one minute	47 (74.6)	19 (31.1)	6.49 (2.77–15.40)	5.69** (2.52–12.88)
Measurement of temperature in infant				
Availability of thermometer	56 (88.9)	33 (54.1)	6.79 (2.50–20.20)	6.71** (2.46–18.34)
Thermometer cleaned?	29 (46.0)	13 (21.3)	3.15 (1.35–7.56)	2.62** (1.14–6.00)
Correct placing of thermometer in axillary region	42 (66.7)	22 (36.1)	3.55 (1.59–7.96)	4.36** (1.92–9.89)
Time kept until alarm or one minute	53 (84.1)	39 (63.9)	2.99 (1.19–7.86)	3.20** (1.27–8.07)
Correct reading of temperature	55 (87.3)	36 (59.0)	4.77 (1.81–13.48)	4.25** (1.66–10.89)
Weighing newborn				
Adjust zero in weighing scale	20 (31.7)	17 (27.9)	1.20 (0.52–2.80)	1.11 (0.49–2.53)
Attach weight bag and again adjust zero	40 (63.5)	13 (21.3)	6.42 (2.71–15.55)	7.23** (3.07–17.04)
Correct positioning of newborn in bag	56 (88.9)	40 (65.6)	4.20 (1.52–12.71)	4.01** (1.46–10.98)
Reading weight at eye level	58 (92.1)	49 (80.3)	2.84 (0.85–10.94)	2.49 (0.78–7.95)
Supports bag with one hand when weighing newborn	45 (71.4)	40 (65.6)	1.31 (0.57–3.02)	1.77 (0.76–4.13)
Correct reading of weight	50 (79.4)	40 (65.6)	2.02 (0.84–4.95)	2.77** (1.10–6.97)
Wrapping of newborn				
Asks for clean cotton cloth	60 (95.2)	58 (95.1)	1.03 (0.13–8.04)	1.69 (0.25–11.67)
Correct positioning of newborn	55 (87.3)	44 (72.1)	2.66 (0.97–7.75)	2.76** (1.02–7.51)
Except face, all parts of newborn covered	43 (68.3)	31 (50.8)	2.08 (0.94–4.62)	2.39** (1.08–5.39)
Counselling about positioning of the newborn				
Neck straight or bent slightly back	22 (34.9)	11 (18.0)	2.44 (0.99–6.22)	2.14 (0.89–5.16)
Newborn's nose, face close to mother	12 (19.0)	3 (4.9)	4.55 (1.13–26.21)	3.73 (0.93–14.94)
Body close to mother	9 (14.3)	7 (11.5)	1.29 (0.39–4.37)	1.05 (0.34–3.33)
Whole body supported	47 (74.6)	33 (54.1)	2.49 (1.09–5.74)	2.49** (1.10–5.63)
Counselling about attachment of the newborn				
Chin close to or touching the breast	25 (39.7)	9 (14.8)	3.80 (1.49–10.26)	2.94** (1.16–7.48)
Mouth wide open	15 (23.8)	10 (16.4)	1.59 (0.60–4.37)	1.65 (0.65–4.22)
Lower lip curled back	37 (58.7)	25 (41.0)	2.05 (0.94–4.46)	1.77 (0.83–4.77)
More areola seen above the newborn's lips than below	56 (88.9)	49 (80.3)	1.96 (0.65–6.33)	1.42 (0.72–5.39)

*Adjusted for caste and years of experience of ASHA.
**Statistically significant.

the CommCare mHealth platform reduced inequities in the continuum of MNCH care services (22). A qualitative study in Uganda found that the use of mHealth was acceptable and perceived by women and health workers to improve implementation of newborn care practices (23). Considering the potential low cost, mHealth can become an important tool for empowering ASHAs to acquire appropriate knowledge and skills at regular intervals in remote rural areas.

The role of implementation research in the context of improving MNCH services in the public health system should be highlighted. We explored the perspectives of the health providers (ASHAs and PHC staff) to find the reasons for lower coverage of MNCH services in India through a series of interviews and field observations. Subsequently, the technology was jointly developed by SEWA Rural information technology partner and the state government to overcome some of the critical, genuine barriers faced by health providers. The motivations of health workers were leveraged for effective change management while introducing the intervention to improve its uptake. A team of investigators from multiple disciplines, including technology, voluntary sector and government, has improved the relevance of every step taken for this study starting from the articulation of the problem statement to its evaluation through a randomised trial in a real-life, project setting (14). ASHAs from the intervention arm demonstrated significant improvements in skills associated with measurement of temperature, weight and respiratory rate of neonates along with hand washing before performing examination. The knowledge about danger signs of pregnancy and neonatal period was significantly better among the ASHAs from the intervention arm compared to the control arm. Overall, the domains related to skills and knowledge which are to be demonstrated during pregnancy and neonatal period showed dramatic improvement compared to those related to postneonatal period. There might be two explanations for these results: First, ASHAs' role is seen to be more paramount during pregnancy and neonatal period compared to the postneonatal period in India; therefore, the ASHAs might have taken deeper interest in those components of the intervention which are related to the pregnancy and postneonatal period. Secondly, the skills and knowledge domains which were repeatedly reinforced through the use of mobile phone technology showed improvement compared to those domains which were addressed only occasionally.

The strengths of this study are the robust methodology of a randomised trial, and the data collectors being blinded to the study arm. Considering the small study sample and predominantly tribal ASHAs, further studies with a larger sample in nontribal areas and a longer duration may help to make the findings generalisable.

The intervention did not include all potential mHealth strategies for improving the knowledge and skills of ASHAs. Various options, such as text messages, free voice calls and the availability of a call centre for providing support around the clock, should be examined. Therefore, more research is required using an enhanced intervention. ImTeCHO, the mHealth tool, required an Internet connection at least once daily for login and to check work logs. We faced problems with the mobile network in a few remote areas. There is a rapid expansion of mobile phone access in India, and these challenges are likely to be addressed in the near future.

CONCLUSION

This study shows that the ImTeCHO application is useful in improving the knowledge and skills of ASHAs. Mobile phone technology should be explored further to provide ongoing training to ASHAs.

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CONFLICT OF INTEREST

The authors declare no competing interest.

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