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RESEARCH ARTICLE

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Evaluation of SIMESON, a training program to improve access to quality health care for pregnant women and newborn in different healthcare facilities of northern Bangladesh

Rina Das[1] | Fahmida Dil Farzana[1] | Zakia Sultana[2] | Kallol Mukherji[2] | Adnan Baayo[2] | Marufa Sultana[1] | Nausad Ali[3] | Mohammod Jobayer Chisti[1] | Shafiqul Alam Sarker[1] | Tahmeed Ahmed[1] | ASG Faruque[1]

[1]International Centre for Diarrhoeal Disease Research (icddr,b), Dhaka, Bangladesh

[2]Terre des hommes foundation (Tdh), Dhaka, Bangladesh

[3]Bangladesh Institute of Development Studies, Dhaka, Bangladesh

Correspondence
Rina Das, International Centre for Diarrhoeal Disease Research (icddr,b), Dhaka, Bangladesh.
Email: rina.das@icddrb.org

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Abstract

Aim: The study aims to explore the current knowledge and skills of healthcare providers already trained by SIMESON (simulation for essential skills for obstetrical and neonatal care), in reviewing perinatal health situations including current status of healthcare facilities and cost estimation.

Design: It was an observational study.

Methods: Cost estimation following both quantitative and qualitative approaches was also attempted.

Result: Knowledge and skills of 88 healthcare providers about the provision of normal delivery and immediate postpartum care, management of postpartum haemorrhage (PPH), retained placenta and use of bag and mask ventilation to help a baby breathe were found to be considerably strengthened following SIMESON training. During the 6 months after training, there were 477 PPH cases managed successfully with only one death; neonatal deaths observed were 6.6/1,000 live births; twice the number of facility deliveries; and 80% use rate of Ambu bag for helping baby breathe. The estimated cost per trainee was 395.68 USD, and 5.85 USD per beneficiary.

KEYWORDS

bag and mask ventilation, evaluation, helping baby breathe, perinatal health, PPH, SIMESON

1 | INTRODUCTION

Direct maternal deaths account for the majority of the 300,000 maternal deaths that occur each year around the world, and they are the main cause of death in low- and middle-income countries (Ameh et al., 2018). Access to maternal health care is improving in Bangladesh, and maternal deaths have declined significantly, but the maternal mortality rate is still a public health concern (196 per 100,000 live births in 2016) (National Institute of Population Research Training, International Centre for Diarrhoeal Disease Research, & MEASURE Evaluation, 2017). Nearly half of these deaths are due to postpartum haemorrhage (PPH) and eclampsia. These two causes are still playing a significant role in maternal deaths (rates remained unchanged between 2010–2016 in Bangladesh; Shah et al., 2016).

Newborn deaths are alarming, and half of these deaths occur during the very first day of life, while 86% of newborn deaths occur within their first week of life (Horton & Samarasekera, 2016). Many of these deaths can be prevented by giving training to health workers and developing their skills on some key issues related to perinatal care (Ariff et al., 2010). The percentage of births attended by trained health professionals has increased from 27% in 2010 to 50% in 2016 (Kibria et al., 2018). Moreover, pregnant women seeking institutional delivery care have increased from 23% in 2010 to 47% in 2016 (Siddique et al., 2018). Treatment seeking for pregnancy-related complications has increased from 29% in 2010 to 46% in 2016 (Filippi et al., 2016). Despite all these advancements, maternal and neonatal deaths are still enormously high.

2 | BACKGROUND

Emergency Obstetric Care is a set of internationally agreed-upon treatments for the most common problems (haemorrhage, (pre) eclampsia, sepsis, incomplete miscarriage or unsafe abortion and obstructed labour), all of which can lead to maternal mortality if left untreated. Two studies evaluated retention of knowledge and skills after in-service training that included all components of Emergency Obstetric Care. A randomized controlled trial including 36 healthcare providers conducted in Pakistan reported that knowledge was retained at 6 months (Ameh et al., 2018) while a hospital-based before-after study in Malawi reported retention of knowledge and skills at 3 months but not at 6 months post-training (Tang et al., 2016). Evidence demonstrates that simulation-based training enhances clinical practice, communication and teamwork abilities; thus, it becomes a popular training option for emergency obstetric care providers. (Phipps et al., 2012; Robertson et al., 2010; Bethany Robertson et al., 2009). However, most simulation training is resource intensive, making its adaptation to low-resource environments difficult (Hofmeyr et al., 2009; Walker et al., 2012). SIMESON (SIM for Simulation, ESON for Essential Skills for Obstetrical and Neonatal care) has been developed to address the needs of delivery service providers, particularly working in remote areas with limited access to facilities. SIMESON relies on a low-dose high-frequency approach (facility-based learning modules have been developed to improve competency and confidence of the healthcare team, thus, to save more lives during pregnancy and at birth). It demonstrated impressive improvements in the identification and management of PPH, newborn asphyxia and care of low birth weight babies (Nelissen et al., 2017). Terre des hommes foundation (Tdh) implemented SIMESON in Mali to reduce stillbirths as well as neonatal and maternal mortality (Terre des hommes foundation, 2015). This training protocol has been successfully piloted in Mali and is currently aiming at scaling up these encouraging achievements to other settings with unacceptably high rates of maternal and neonatal mortality. Through a total of 186 training sessions, overall skills improved by 45%, health facilities improved their competencies by 45%, and knowledge expanded by 90%. Impressive improvements were noted in the identification and management of PPH, newborn asphyxia and low birth weight baby care. Kurigram District is situated in North-East Bangladesh. It is a highly disaster-prone area and is known to be affected annually by heavy rains, waterlogging, flash floods, river erosion, and other disasters. Data obtained from the Kurigram Civil Surgeon office that is under the Ministry of Health and Family Welfare showed that in 2015 maternal mortality rate was 140 per 100,000 live births, half of them were due to PPH, the neonatal mortality rate was 28.2 per 1,000 live births, and death due to birth asphyxia was 28.4%. As a part of government and non-government efforts to tackle this situation, in 2019, Tdh implemented SIMESON in Kurigram aiming to increase the number of facility-based births conducted by qualified health personnel for expanding services to a larger number of women and newborn babies.

The majority of maternal deaths could be avoided if women had access to advanced antenatal care (ANC) and skilled prenatal and postnatal care services (Alfonso et al., 2015). Training of midwives in safe motherhood and lifesaving skills, training of comprehensive nurses who can deliver midwifery and nursing services and the establishment, as well as upgrading of health facilities that offer emergency obstetric care, have been the most commonly effective and cost-effective interventions in developing countries (Alfonso et al., 2015). In the literature, there are little data to support the cost-effectiveness of initiatives. Policymakers can use cost-effectiveness analysis to determine how to effectively distribute scarce in the wider catchment area.

Here, we aimed to measure the current knowledge and skills of SIMESON-trained healthcare providers in delivering perinatal health services, assess the perinatal heath situation and readiness of healthcare facilities for the management of maternal and neonatal emergencies and estimate the cost of SIMESON in Kurigram.

3 | METHODS

3.1 | Study design

It was an observational investigation. The study followed both quantitative and qualitative approaches among healthcare providers who received SIMESON training.

3.2 | Study sites and study population

The study was carried out in January 2020 in a total of 20 healthcare facilities. The facilities were as follows: Kurigram 250 bedded Sadar Hospital, eight Upazila Health Complexes, eight Health and Family Welfare Centres, one Mother and Child Welfare Centre and two Community Clinics in Kurigram, a northern district of Bangladesh. From the 32 healthcare facilities, 20 were selected purposively based on accessibility to delivery facilities, availability of staff trained in SIMESON and provision of perinatal health services in a running infrastructure. Eighty-eight government healthcare providers: 57

senior staff nurses, 14 midwives, 12 family welfare visitors, 3 family welfare assistants and 2 community healthcare providers who received SIMESON training and currently working in those facilities were assessed. During our final evaluation, we assessed 88 participants according to their availability in the healthcare facilities. We tried to contact the 148 participants, but unfortunately, some of them were transferred to another facility located in a different district, currently in training/deputation, some were on sick leave/annual leave/maternity leave, some were on night-shift duty, not reachable over the cell phone and the rest had partial training on SIMESON, thus not considered as potential respondent (Figure 1).

3.3 | Data collection

Healthcare staff members, working at different government health facilities, were the study participants who were selected through purposive sampling for observation of their perinatal care deliveries. A cross-sectional design was followed to collect quantitative data. Data were collected using paper-based standardized questionnaires that have been validated by the Tdh team. The questionnaires were based on an internationally accepted protocol on Helping Mothers Survive and Helping Babies Survive. Guidelines, checklists and questionnaires were developed based on Tdh's baseline report and our evaluation proposal as well as the literature review. Informed consent was taken from each participant in a written format. Data collection process included (i) review of hospital logs, observation of the place of care for delivery and surroundings, (ii) administration of self-administered multiple-choice questionnaire to the trained healthcare providers, (iii) observation of their birthing practices, management of PPH and retained placenta and helping baby breathe, (iv) in-depth interviews of the participants, pregnant mothers and their caregivers, who recently received perinatal care, key personnel of the facility, community leaders, local qualified healthcare providers and nurses and (v) financial record review to collect information on project implementation and monitoring related costs.

3.4 | Intervention

3.4.1 | SIMESON training program

The SIMESON project uses a mobile unit with two health workers specifically trained in medical simulation who make regular visits to each peripheral health facility to give practical training in essential procedures. The overall aims of the project are to save the lives of mothers and their babies at birth in four domains: knowledge about routine care of postpartum for the mother, helping baby breathe (Chaudhury et al., 2016), essential care for every baby (Thukral et al., 2015; World Health Organization, United Nations Population Fund, World Bank, & United Nations Children's Fund, 2015) and management of bleeding after birth (Evans et al., 2014; Nelissen et al., 2015). Additionally, the program involved specialized technologies (e.g. mannequins and video recordings) that allowed trainees to imagine a scenario that imitates the real-life setting without affecting patient safety (Campbell et al., 2009).

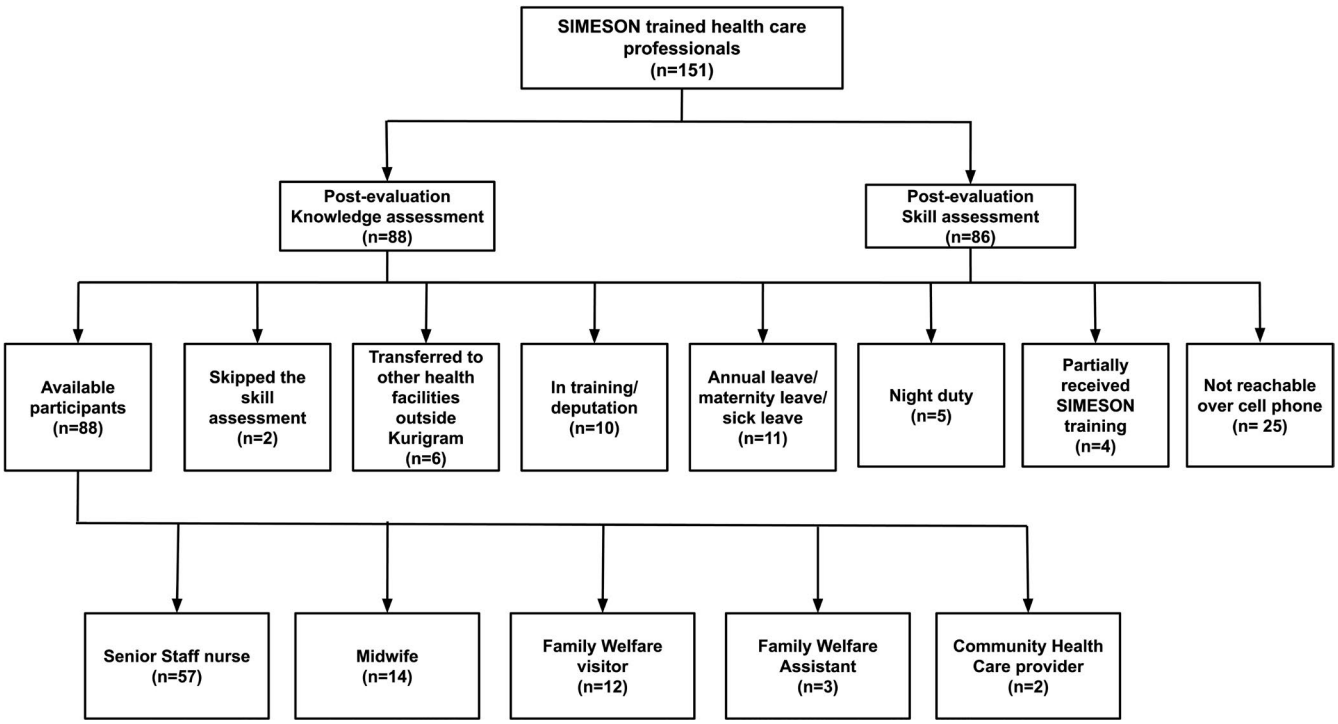

FIGURE 1 Flow diagram of the participants evaluated during post-intervention assessment

3.4.2 | Strengths of the SIMESON training program

- ongoing and recurrent, enables repeated life-saving action to be taken;
- personalized with short sessions, to ensure maximum impact;
- decentralized, which allows each caregiver to access training, wherever remote they may be;
- in situ, which means health workers do not have to go away to be trained and can, if necessary, continue working at their health facility;
- practical, uses simulated procedures on a dummy for training purposes and monitors situations without endangering patients' lives; and
- context specific, with a kit of simulation equipment and culturally sensitive image banks focused on obstetric and basic neonatal care: postpartum haemorrhage, neonatal resuscitation and correct use of a Partograph.

Tdh used a collaborative approach to adapt the SIMESON and team-training program to make it culturally and contextually applicable to the local settings of Kurigram. The training started in April 2019 with 148 healthcare providers from 32 intervention facilities. Among them, 128 participants completed the 6-month training. The training was led by eight trainers who conducted exercises, awareness assessments and team-training events during the training. Over the intervention period, trainers gave monthly refresher training and monitored the performance, lasting about 2–3 hr, at each facility.

3.5 | Evaluation

The evaluation team comprised of individuals with clinical, qualitative and quantitative research expertise with national and international public health exposures. Three months after completion of the training, the evaluation team members visited the field site for formal data collection in January 2020.

3.5.1 | Knowledge and skill assessment

To examine the current knowledge status, quality of service delivery, scopes for improvements and any likely scale-up, we measured the impact of training on providers' knowledge through a self-administered questionnaire, which providers filled out immediately before the commencement of the skill assessment during the final evaluation. Healthcare providers who participated voluntarily were asked to answer a set of questions or statements. The knowledge assessment contained 33 questions of multiple choice on core topics that were responded to by the participants. The skill assessment had 65 statements in which participants were required to demonstrate the SIMESON step by step in a mannequin. The team comprised of two members, who were physicians with both clinical and public health research background who observed the skill assessment part. The team visited every healthcare facility, and the participants demonstrated the steps in front of the evaluators. By using a validated guideline and checklist, the participants were evaluated for the SIMESON training skill. The guidelines along with the checklist and their necessary modifications were discussed thoroughly during the field visit in different health facilities of Kurigram district. The post-intervention skill assessment is totally bias free as the baseline evaluation was not done by the same team. We were, however, able to collect these data from 88 (68.75%) for knowledge assessment and 86 (67.2%) for skill assessment out of the 128 providers during the evaluation (others could not be reached at the time of evaluation).

3.5.2 | Facility assessment

Of the 32 healthcare facilities, having the SIMESON training program, we visited 20 facilities during the evaluation based on accessibility to delivery facilities, availability of staff trained in SIMESON and the provision of perinatal health services in a currently running infrastructure. We included perinatal health information, ANC and postnatal care information, number of deliveries and newborn health information, and essential resources required communication services, health registers/logs and basic protocols, delivery room essential requirements/medical equipment and supplies, essential drugs required and information on access to healthcare facilities.

3.5.3 | Qualitative research

We interviewed healthcare providers and pregnant women at the intervention facilities. For this, we conducted in-depth interviews (IDIs), key informant interviews (KIIs) and informal interviews for assessing challenges and barriers to the delivery of high-quality care and their familiarity with SIMESON training. The qualitative research was conducted with a purposive sample through 14 IDIs, 6 KIIs and 3 informal interviews who participated voluntarily after giving written informed consent. IDIs were conducted among senior staff nurses, midwives, family welfare visitors, family welfare assistants, sub-assistant community medical officers and community healthcare providers. Guidelines were used to reveal information of interest and to allow interviewees to express their opinions and ideas in their own words. Interviews were undertaken until the saturation point was reached, that is, no new information was generated with further interviewing. Six KIIs were conducted, and the key informants were elected representatives of the people of the locality, nursing supervisor and monitoring officer of Tdh. Interviews for both IDIs and KIIs lasted for ~30 min. Three informal interviews of hospitalized pregnant women after childbirth were conducted for assessing satisfaction levels for the services and

obstetric care given by healthcare facilities. Each of these interviews lasted for ~10–15 min. The verbatim was recorded on tape recorders and transcribed concurrently.

3.5.4 | Cost estimation

From the SIMESON training program perspective, economic costs were calculated for the analytical period between February and December 2019. Program expenditures data were collected from SIMESON's financial statements, and expenses were divided into capital and operating expenditures. Interviews were conducted with Tdh's main program staff to understand the specific plan in phases and to identify the categories of costs by each of the activities. These costs associated with the SIMESON program were listed and estimated accordingly. Expenditures for staff included expenses for project team members. Materials and equipment included costs of the services needed for the project, whereas the costs for facilities covered the cost of using some non-organization-owned workspaces. Other costs included recurrent cost items such as rent, utilities, printing, information technology installation and bills, cell phone, phone bills, stationery, janitorial, housekeeping supplies, leaflet, brochure, announcement materials, facilities for food, lodging, transportation, the recreation of participants and remuneration for the faculties. All costs are expressed in CHF (Swiss Franc) with an exchange rate of 1 CHF = 1.03 USD (US Dollar) for January 2020.

3.6 | Data quality and survey supervision

Data collectors were properly oriented and trained on the tools before data collection. Overall data quality and survey were supervised by the study investigators. Local-level coordination was facilitated by additional staff members of the Kurigram Tdh team. Data quality was checked randomly by the investigators through on-the-spot monitoring.

3.7 | Data analysis

Data entry was done by the data management team who were not involved in data collection. Data cleaning, updating, range check, duplication check, consistency check, frequency check and cross-tabulation were performed by two separate data management assistants who were also involved in crosschecks. Raw data were rechecked if there were any discrepancies. Data were entered into SPSS, and descriptive statistics such as frequency distribution, percentage and tabulations were performed as part of data analysis. We focused on descriptive statistics with quantitative data and utilized a framework approach (widely known as thematic analysis or qualitative content analysis) with both the combined strategies of deductive and inductive types of analysis to deal with the qualitative data (Gale et al., 2013).

3.8 | Ethical consideration

Tdh has a memorandum of understanding with the Ministry of Health and Family Welfare in Bangladesh. Under this memorandum, Tdh is responsible for conducting the formal assessment and evaluation in collaboration with the family planning authorities. The study was initiated after getting approval from the Institutional Review Board of icddr,b, which is comprised of the Research Review Committee and Ethical Review Committee. Signed written informed consent was obtained from the participants. The respondents had the freedom to withdraw themselves from participation at any point in the study. The consent form was read out to the participant if he/she was unable to read (particularly the women of the locality). The confidentiality of the participants was maintained strictly.

4 | RESULTS

4.1 | Knowledge assessment: comparison between baseline and post-intervention

After a comparison between baseline and evaluation findings, we found that (i) knowledge about normal vaginal delivery and routine postpartum care increased: washing hands before normal delivery even before wearing the gloves (9.9%–98.9%), provision of family planning advice according to the need of the couple (9.9%–88.6%) and current recommendation on performing episiotomy (37.1%–72.7%); (ii) newborn care: knowledge about helping babies to survive increased about consequence of suctioning unnecessarily or frequently (8.6%–64.4%) and in which area to be observed to diagnose severe jaundice in newborn (47.0%–67.8%); and (iii) maternal complications: knowledge about bleeding after completion of birth increased, especially for the cervical tear (19.2%–62.1%) and manual removal of placenta (25.8%–62.1%; Table 1).

4.2 | Skill assessment: comparison between baseline and post-intervention

4.2.1 | Skills about normal delivery and routine care in immediate postpartum for the baby

Skills about normal delivery and routine care in immediate postpartum for the mother increased to 100% in case of almost all components and 86.3% in case of proper perineal wash. During the care of the newborn, the percentage of the newborn who had temperature measured soon after birth got reduced (41.9%–34.9%),

TABLE 1 Knowledge assessment: comparison between baseline and post-intervention

Knowledge assessment	Baseline (%) (*n* = 151)	Post-intervention (%) (*n* = 88)
(i) Normal delivery and routine care in post-partum for the mother and helping babies survive		
Washing hand for the delivery even if wearing gloves	15 (9.9)	87 (98.9)
Current recommendation on performing an episiotomy	56 (37.1)	64 (72.7)
Correct chronology of AMTSL (Active management of third stage of labor)	49 (32.5)	54 (61.4)
Provision of family planning: advice according to the needs of the couple	15 (9.9)	78 (88.6)
Time of measuring the newborn's heart rate	16 (10.6)	82 (94.3)
Consequences of suctioning a baby unnecessarily	13 (8.6)	59 (64.4)
(ii) Essential care for every baby		
Initiation of breastfeeding within the first hour after birth	99 (65.6)	72 (82.8)
Normal temperature range	96 (63.6)	72 (82.8)
Which area to be observed to diagnose severe jaundice in newborn	71 (47.0)	59 (67.8)
(iii) Bleeding after birth complete		
Postpartum care after bimanual compression	92 (60.9)	63 (72.4)
Management of PPH due to atony	54 (35.8)	57 (65.5)
Management of PPH if uterotonics failed	23 (15.2)	36 (41.4)
Initiation of manual removal of placenta	13 (8.6)	43 (49.4)
Circumstances for manual removal of the placenta	39 (25.8)	54 (62.1)
Medications are given before manual removal of placenta	34 (22.5)	53 (60.9)
Check cervical lacerations	29 (19.2)	54 (62.1)

TABLE 2 Skills about routine care in immediate postpartum for the baby: comparison between baseline and post-intervention

Skill assessment	Baseline (%) (*n* = 148)	Post-intervention (%) (*n* = 86)
Routine care in immediate postpartum for the baby		
Alertness and muscle tone	39 (26.4)	67(77.9)
Measurement of the temperature	62 (41.9)	30 (34.9)
Counting of respiratory rate for a full minute	53 (35.8)	33 (38.4)
Weight measurement of the newborn	83 (56.1)	76 (88.4)
Examination of the baby in the mother's arm	64 (43.2)	86 (100)
Breastfeeding and bonding	82 (55.4)	86 (100)

counting the respiratory rate for one full minute was slightly increased (35.8%–38.4%), and skills increased in observed level of alertness and muscle tone (26.4%–77.9%) and weight measurement (56.1% to 88.4%). Practice to initiate breastfeeding within the first hour of birth and keeping the baby in mothers' arms, not with other relatives, were both raised to 100% from 55.4% and 43.2%, respectively (Table 2).

4.2.2 | Skills about atony and postpartum haemorrhage

Increased in looking for bleeding (66%–100%), checking bladder and catheterizing the woman (31%–70%), measuring pulse and blood pressure and initiating IV infusion along with oxytocin administration (47%–74.4%), bimanual compression technique (9%–76.7%), rechecking of the uterus (37%–95.5%), massaging of the uterus and the practice of respectful maternity care (39%–100%; Figure 2).

4.2.3 | Skills about retained placenta and manual removal of the placenta

Increased in repeating 10 IU IM oxytocin, encouraging emptying of the bladder, giving diazepam 10 mg IM and starting IV line with normal saline to prevent shock. Administering IV antibiotics, giving oxytocin 20 IU in 1 L saline if the placenta is not removed, an examination of the placenta, checking uterine tone and its massaging, removal of the placenta and controlled cord traction for each contraction (Figure 3).

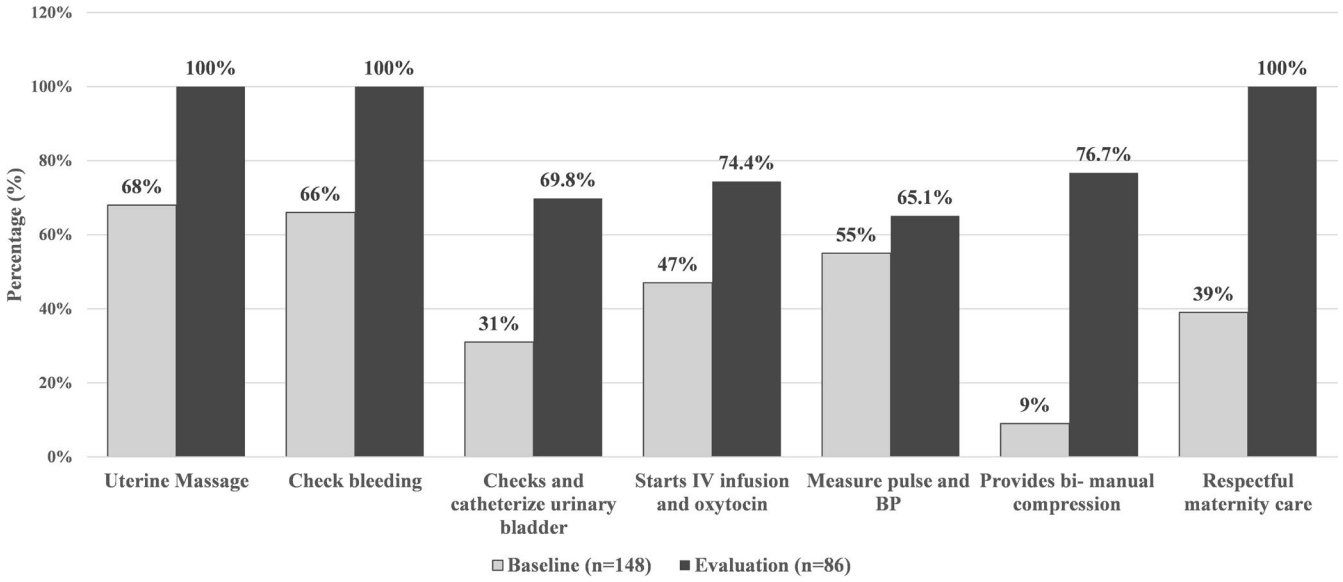

FIGURE 2 Skills about atony and postpartum haemorrhage: comparison between baseline and post-intervention

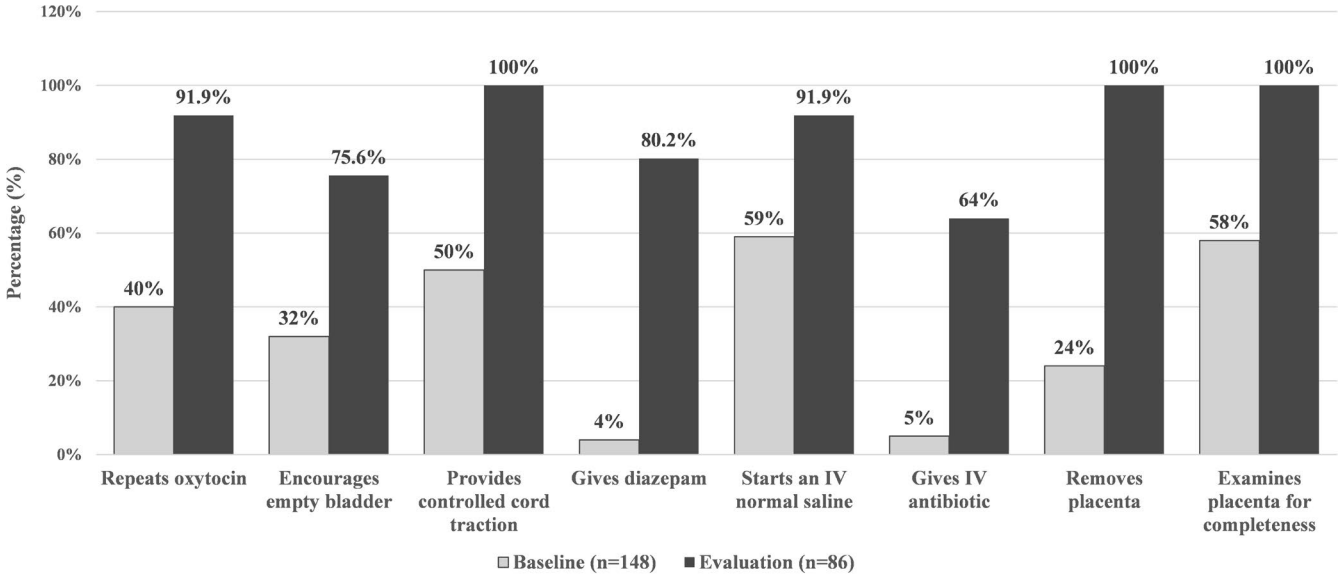

FIGURE 3 Skills about retained placenta and manual removal of the placenta: comparison between baseline and post-intervention

4.2.4 | Skills about bag and mask ventilation

All the participants correctly demonstrated the steps related to bag and mask ventilation during the evaluation, except the step of ventilating at 40 breaths per minute (range is 30–50 per minute) was reported from 37%–83.7%.

4.2.5 | Skills about helping baby breathe

Increased in evaluating newborns' chest movement, effective ventilation, ventilation with bag and mask within the golden minute, close observation of the baby, recognition of the breathing in baby and normal heart rate, continuous ventilation, squeezing of the bag harder and removal of secretions from the mouth and nose raised. Skills related to the removal of wet clothes reduced from 87%–67.4% (Figure 4).

4.3 | Facility assessment

During the baseline assessment, the number of facility deliveries in 59 healthcare facilities was 1007 and in 6 months that almost doubled during the evaluation, where a quarter of the deliveries were performed by the caesarian section. About 478 mothers experienced PPH. There were two maternal deaths (at baseline, it was $n = 3$), among them one was due to PPH and another one was as a result of eclampsia. About 43.9% PPH was due to cervical or vaginal tear, 26% from prolonged labour and 20% as a result

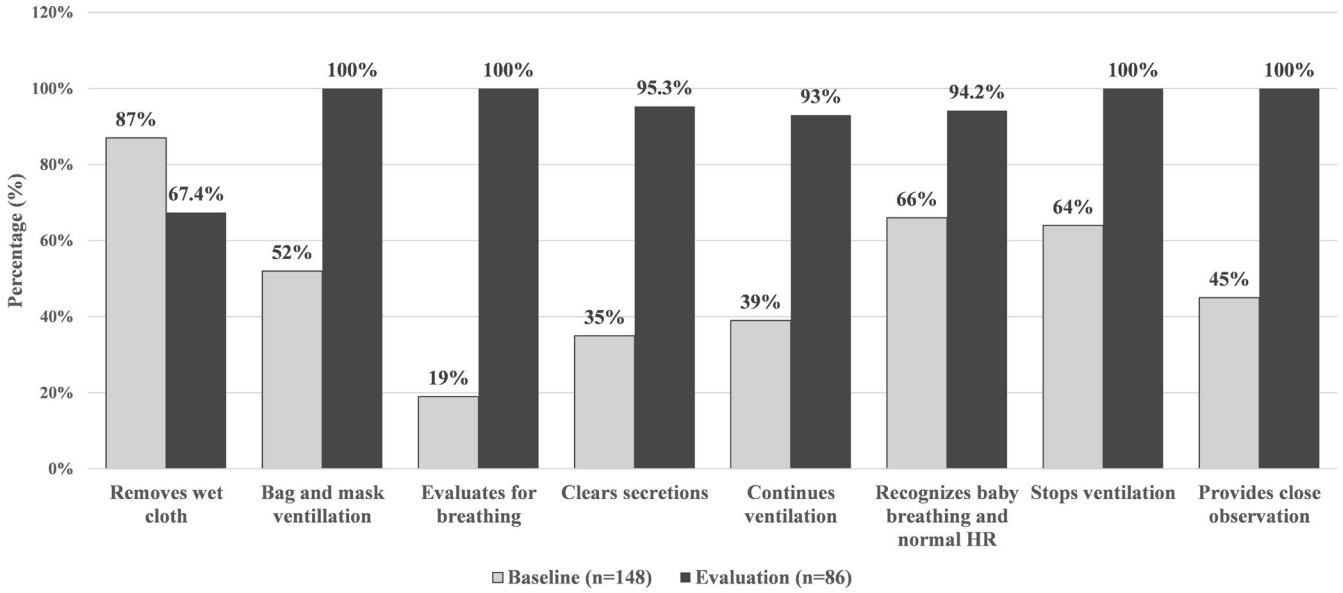

FIGURE 4 Skills about helping baby breathe: comparison between baseline and post-intervention

TABLE 3 Facility assessment: comparison between baseline and post-intervention

Health information	Baseline ($n = 59$)	Post-intervention ($n = 20$)
Facility delivery	1,007	2,661
Number of PPH managed in the HCFs	107	478
Maternal death	3	2
Causes of PPH	Not measured	43.9% due to cervical/vaginal tear
Neonatal mortality	Not measured	6.6/1,000 live births
Facility available	**Baseline (%) $n = 59$**	**Post-intervention (%) $n = 20$**
Soap/alcohol hand rub for hand hygiene	16 (27.1)	20 (100)
Functional delivery table	47 (79.6)	19 (95.0)
Three coloured waste bins	23 (38.9)	11 (55.0)
Baby scale	34 (57.6)	14 (70.0)
Ambu bag	41 (69.5)	16 (80.0)
Baby length board	28 (47.5)	9 (45.0)
Antibiotics for mother		
Oral	48 (81.3)	17 (85.0)
IV	12 (20.3)	8 (40.0)
Oxytocin supply	15 (25.4)	15 (75.0)
IV fluid supply	48 (81.3)	13 (65.0)
Clear referral criteria	Not measured	14 (70.0)
Complaints box or register/log	Not measured	8 (40.0)
Informed consent procedure	Not measured	17 (85.0)

Abbreviations: HCFs, healthcare facilities; IV, intravenous; PPH, postpartum haemorrhage.

of retained placenta. Other causes included uterine atony, retention of products of conception, placenta previa, maternal infection and maternal comorbidities (e.g. maternal high blood pressure and diabetes mellitus; Table 3). Neonatal death was 6.6 per 1,000 live births; among them, eight newborn died because of low birth weight and birth asphyxia.

All the facilities had soap/alcohol hand rub for hand hygiene, 95% facilities had a functional delivery table, 55% facilities had three

coloured waste bins, 70% facilities reported the presence of baby scale, and 80% facilities had Ambu bag; only 45% facilities mentioned having baby length board. Eighty-five percent of facilities had oral antibiotics, and 40% indicated availability of the IV antibiotics for mothers, 75% of facilities were maintaining oxytocin supply, and 65% of facilities had IV fluid supply (Table 3).

All facilities visited during evaluation indicated that no fees were required for normal delivery and newborn care, 70% of facilities had clear referral criteria, 40% indicated the presence of complaints box or register/log and those facilities had accountability mechanisms for addressing the mistreatments or violations, and 85% facilities had informed consent procedure (Table 3).

4.4 | Findings from qualitative research

The qualitative data highlighted the expectations of providers about the training and its effect on their knowledge and skill. Representative quotations from IDIs, KIIs and informal interviews are thematically shown here.

4.4.1 | Theme 1. The overall perception of SIMESON training

Participants appreciated the experience immensely and were thankful for getting the opportunity to be included in the training. Some of them stated that the training had refreshed their knowledge of essential skills, while others suggested including some new topics in the training curriculum. Participants expected an improvement in their skills due to this training and desired more training opportunities like this. They also acknowledged improvements in their competence and confidence during the management of obstetric and neonatal emergencies, as well as coordination and collaboration between patient-providers. "*... I learned a lot from SIMESON training ... and now if I face such kinds of emergencies, I can manage that... I believe SIMESON training helped me a lot*."

4.4.2 | Theme 2. The objective of SIMESON training

The respondents understood that the main objective of the SIMESON training was to reduce maternal and neonatal mortality. Few more information was obtained from interviews, for example, the number of institutional deliveries increased, ideal labour rooms being set up, quality of maternal and newborn care increased, hygiene during normal vaginal delivery better maintained as of late, application of PPH management techniques (e.g. bimanual compression) and helping baby breathe skill acquired. "*..... the objective was to increase the practice of normal delivery in Health Care Facility.... sometimes, home delivery causes complications..... that's why they targeted to increase the number of facility delivery..... and eventually reduce maternal and neonatal mortality.*"

4.4.3 | Theme 3. Effectiveness of SIMESON training

The participants mentioned that the SIMESON training helped them to improve their skills about normal vaginal delivery, which were reflected through their comments.

> "There are certain instructions like what we should do during normal delivery, who would be the in-charge of what etc. in detail. This (the SIMESON training) has significantly improved my skills..." and "This training helped us in remembering the things that we need to apply during the management of normal vaginal delivery of a pregnant woman".

4.4.4 | Theme 4. Benefits of the training

It was refreshers training for most of the participants.

> Tdh (SIMESON) served as a supplementary training, which helped me to overcome my shortcomings in conducting normal delivery.....

About the benefits of the pregnant women, the participants quoted, "*Women died previously due to lack of skill in managing PPH.....*" and "*The women are happy now, they said that they would recommend others to go for normal delivery in the health facility.*"

About the benefits of the newborn, participants mentioned, "*We used to be very nervous during baby resuscitation, now we can handle it quite well.*" and "*Now we use the penguin sucker; we have learned how to help a baby breathe.....*"

4.4.5 | Theme 5. Experience of the participants after the training

Tdh team successfully improved the skills of healthcare personnel in normal vaginal delivery, the participants have become more aware of hygiene, the whole process is more organized and systematic now, the confidence of participants has increased significantly, and they have learned new techniques like bimanual compression and wearing gloves. PPH management is currently done more efficiently.

> If we see excessive bleeding in PPH, right away we apply bi-manual compression to manage the case.

4.4.6 | Theme 6. Challenges faced

Because of the shifting duty hours, there was limited availability of the participants during the training period. It was difficult to organize all the participants in a prefixed time because of their heavy

workload. The participants found it difficult to engage themselves in the training with full concentration when it was arranged during their duty hours. Lack of understanding of the patients' attendants about the use of the bag and mask for the resuscitation of the neonate and reluctance of others to disclose their pregnancy status and to attend the ANC in due time were other challenges encountered.

4.4.7 | Theme 7. The satisfaction of the participants

Participants were doing their tasks more efficiently in recent days. This was hands-on training that helped the participants to retain their skills aptly. The duration of any maneuver related to normal vaginal delivery, baby resuscitation and management of PPH has significantly reduced, and the processes themselves have become much easier to perform. About respectful maternity care, one participant said, "……. *from the training, we also learned to express empathy towards the mother and the baby…….*"

4.4.8 | Theme 8. Suggestions for improvement

Participants were asked about what they might recommend for enhancing the quality of training. Most of them recommended extending the training period, including more sessions and regular conduction of such training.

> The training had a short duration, ended rather quickly, if more time were allocated for the training, we would have learned better.

Some participants proposed to shorten the training hours but increase the training period. There was a strong consensus among attendees that more health professionals should be included to participate in the training to support facility-wide progress.

> The number of participants should be increased (a diverse group of staff); all the staff members (of a facility) need to know about these things …….

Participants suggested including more clinical topics like management of eclampsia, how to repair a perineal tear and Kangaroo mother care. Participants who are currently serving at the peripheral government health centers stated that they could not apply some of the skills acquired through the simulation training because of a lack of medical and obstetrical instruments.

> If the equipment can be arranged, it would be good to perform the procedures we have learned in the training…… we do not have sufficient instruments in the facility ……. some of the equipment has become old and rusty.

4.5 | Cost estimation

The cost estimation of the SIMESON training program revealed costs of 395.68 USD per trainee (healthcare provider) and 5.85 USD per indirect beneficiary (mother and newborn) who sought care from facilities (Table 4).

5 | DISCUSSION

This is one of the few studies that specifically combined both knowledge and skills for quality of care to minimize maternal and neonatal mortality in a single intervention and, to our knowledge, the first to use SIMESON as the training tool in Bangladesh. Here, we found that SIMESON training has expanded the knowledge and skills of healthcare providers in treating obstetric and neonatal emergencies. Moreover, the perceptions of the healthcare providers suggest that this type of training is very much helpful in their capacity building and they are eagerly looking forward to the continuation of the training for a longer period in the larger population. By visualizing the facility assessment results, we can comprehend that the training resulted in improvements as regards the number of facility delivery and decreased maternal and neonatal mortality.

Healthcare providers who took part in a simulation-based training course on obstetric emergencies of a tertiary care university hospital of the UK also reported a noticeable improvement in both of their knowledge and skills when dealing with real-life emergencies observed in prospective follow-up research (Reynolds et al., 2011). The incorporation of training with the "learning by doing" approach meant that professionals understood and practised all the skills of emergency obstetric and neonatal emergency care and minimized the limited learning opportunities identified in prior emergency obstetric and neonatal emergency care training sessions (Gueye et al., 2017). A multi-country study in Ghana, Malawi, Nigeria, Kenya, Tanzania and Sierra Leone showed that after standardized "skills and drills" training, healthcare providers retain knowledge and skills for up to 12 months (Ameh et al., 2018). In Guatemala, PRONTO training is effective at improving provider knowledge and self-efficacy in training curriculum. Knowledge and self-efficacy scores improved significantly in all areas of teaching (Walker et al., 2015). After a comparison between baseline and evaluation, knowledge increased in washing hands before normal delivery, even before wearing the gloves, provision of family planning advice according to the need of the couple, current recommendation on performing an episiotomy and where to look for cervical tear and the skill of manual removal of placenta. About neonatal care, knowledge also increased in understanding the adverse consequence of suctioning a newborn when performed unnecessarily and which part of the baby to be observed to diagnose severe jaundice in case of a newborn. Similarly, a mixed-method study on integrated simulation training on emergency obstetric and neonatal care and respectful maternity care in Ghana observed that providers' knowledge increased from an average of 61.6% at pre-test to 74.5% at post-test (Afulani et al., 2020).

TABLE 4 Cost estimation of SIMESON training program

Cost components	Inputs	CHF	USD	% of the total cost
Capital expenditures	National Coordinator Health	867	893.01	1.76
	Project officer	1,350	1,390.5	2.74
	Basic training	9,491	9,775.73	17.4
	Capital (i.e. laptop)	261	268.83	0.5
	BCC (i.e. poster and leaflet)	6,967	7,176.01	12.8
	Staff/personnel (i.e. staff nurses)	30,278	31,186.34	55.4
Total capital expenditures		49,214	50,690.42	86.0
Operating expenditures	Regular training	5,030	5,180.9	8.8
	Stationeries	165	169.95	0.3
	Meeting	345	355.35	0.6
	Social mobilization (i.e. communications)	753	775.59	1.3
	Conveyance for service provider (i.e. local transport and rent a car)	1,348	1,388.44	2.4
Total operating expenditures		7,641	7,870.23	13.4
Total cost		56,855	58,560.65	100.0
Cost per direct beneficiary ($n = 148$)		384.16	395.68	
Cost per indirect beneficiary ($n = 10,000$)		5.68	5.85	

Abbreviations: CHF, Swiss Franc; USD, US dollar.

During skill assessment, we found that participants were very prompt in conducting normal delivery. Researchers have reported that an intensive training session for vaginal deliveries on an obstetric mannequin or birth pelvis model at the beginning of the obstetrics clerkship automatically and substantially improved the self-assurance of medical students to engage in an uncomplicated, supervised attempt for vaginal deliveries in a teaching hospital of Canada (Sabourin et al., 2014). A quasi-experimental study conducted in Pakistan reported significantly better post-training results after a simulation-based normal delivery skill learning (Shah et al., 2017). Participants usually did not miss any steps. Data from several other simulation studies found that the application of deliberate practice to simulation training narrowed differences in performance in pediatric residents of the USA and obstetric and neonatal emergencies of Northern Guatemala (Cordero et al., 2013; Fahey et al., 2013).

Properly following the steps of the PPH management procedure was also increased from baseline to evaluation. In Northern Tanzania, skills expanded from 19% before, to 43% immediately after, to 48% at 9 months after training on bimanual uterine compression (Nelissen et al., 2015). Similar work has shown that multidisciplinary in situ simulation activities enhance the management of obstetric emergencies such as PPH and are a safe and effective way to develop skills and improve healthcare processes (Lutgendorf et al., 2017). The skills of the trainees on the management of retained placenta and manual removal of the placenta were highly improved in all the steps of the procedure from baseline. Studies have observed that trainees exhibited positive changes in attitude as well as the perception of overall team performance in a simulated environment of obstetric emergency care (Robertson et al., 2009). Similar research studies have reported that active training methods, such as simulations, case-based learning, hands-on skills training and direct feedback reviews, are components of successful in-service training to enhance healthcare providers' knowledge and skills in Cuernavaca, Mexico (Bluestone et al., 2012; Cohen et al., 2012).

All the participants correctly performed the steps about the bag and mask ventilation. Similar program assessments that took place in India and Kenya, which were strongly acceptable, demonstrated increased confidence, enhanced knowledge and acquired skills (Thukral et al., 2015). Performance about helping baby breathe also increased from baseline to post-intervention. Skills related to the evaluation of chest movement, effective ventilation and ventilation with bag and mask within the golden minute raised significantly. Participants in a program on helping babies breathe for neonatal resuscitation in resource-limited settings (Pakistan and Kenya) demonstrated high satisfaction, high self-efficacy and advancement in knowledge and skills (Singhal et al., 2012). During the management of newborn babies immediately after birth, skills about the measurement of the newborns' temperature and removal of wet clothes were decreased from baseline; it was probably due to giving more emphasis on other steps like the bag and mask ventilation, eye medication and convulsion assessment while avoiding others by the participants.

According to Bangladesh Maternal Mortality and Health Care Survey 2016, the most common causes of maternal mortality were haemorrhage (31%), followed by eclampsia and abortion-related complications (National Institute of Population Research Training et al., 2017). Haemorrhage and eclampsia accounted for 55% of all maternal deaths in 2016 (National Institute of Population Research

Training et al., 2017). At baseline, 107 PPH cases were managed in the healthcare facilities, and there were three maternal deaths. In our evaluation, we found two maternal deaths due to PPH and eclampsia, which were lower than that of the national data. We found that cervical and vaginal tears (45%) were the main causes of PPH. However, the causes of PPH varied in different studies. Studies on associated factors of PPH in Pakistan reported that PPH is caused by cervical, vaginal and perineal tears occurring in 24% cases (Naz et al., 2008), and a similar study in Nigeria revealed cervical and vaginal tears occurring in 14% cases (Selo-Ojeme & Okonofua, 1997). In Zimbabwe, a case–control study reported that cases were much more likely than controls to have a traumatic delivery involving the vagina or cervix and causing tears, which accounted for more than one-third of the haemorrhage (Tsu, 1993).

Bangladesh Demographic and Health Survey (BDHS) 2017–2018 indicated a neonatal mortality rate of 30 per 1,000 live births in 2015 in Bangladesh (Zaman et al., 2019). In our evaluation, post-intervention neonatal deaths were at 6.6 per 1,000 live births. This observation represented the neonatal death among facility-based deliveries and did not include the number of neonatal deaths in the community; this might explain the reasonable lower number of neonatal deaths in the 20 healthcare facilities. Worldwide, the major causes of neonatal mortality are low birth weight and birth asphyxia (de Almeida et al., 2015; Bahl et al., 2012), and we observed similar results during our evaluation. The number of institutional deliveries almost doubled from baseline to evaluation, and according to BDHS 2017–2018, facility delivery has increased from 15%–50% in Bangladesh in the last 10 years (Zaman et al., 2019).

The results of the performance evaluation showed that providers appreciated the quality of the training, which included both the information context and the skill content. The respondents understood that the main objective of the SIMESON training was to reduce maternal and neonatal mortality. Several studies showed that their intervention incorporated contents of deliberate training such as engaged learners, well-defined objectives, resident-level complexity and concentrated repeated training with direct input from professional trainers (Campbell et al., 2009; McGaghie et al., 2011).

Participants were experiencing several issues during and after successful completion of the training such as improving the skills in managing normal delivery. They also had positive opinions about the training. They acknowledged changes in their expertise and trust in treating obstetric and neonatal crises, as well as coordination and collaboration between patient and provider. In a similar study in Ghana, more than 95% of the participants reported that the training was beneficial for them and that they should use the skills acquired in their real life (Afulani et al., 2020). Some of the participants mentioned that the exchange of greetings and respect as well as the provision of continued support to the pregnant women who are in labour should be an essential part of respectful maternity care that they learned from the training. Different research results indicate that comprehensive training that gives healthcare providers with the ability to understand, practise and comment on their delivery of supportive maternity care in the sense of intense emergency obstetric simulations has the potential to increase the childbirth experience of women in low-resource settings (Afulani et al., 2019).

After experiencing several challenges and difficulties, participants still have satisfaction about the SIMESON training; this was a hands-on training that helped the participants to retain skill aptly. Similar changes have been identified in the skills of pediatric and internal medicine residents after several deliberate practice sessions over longer periods in Tripler Army Medical Center, Honolulu, and the internal medicine residency program at Northwestern University, Chicago, respectively (Sawyer et al., 2011; Wayne et al., 2006). The duration of any maneuver about normal delivery, baby resuscitation and management of PPH has reduced, and the process has become much easier.

Increasing the knowledge and skill of healthcare providers by implementing the SIMESON training program is the most effective and single intervention with reasonable costs for reducing maternal and neonatal mortality. SIMESON training program is a low-cost program in a rural area of Bangladesh. Although we have done the cost estimation of SIMESON, we were not able to compare our results with other programs because of a lack of similar studies with identical technicality, timeline and geography. The cost per indirect beneficiary was considerably low, whereas the estimated cost per direct beneficiary (trainee healthcare providers) was reasonable.

Both qualitative and quantitative approaches, relatively large sample for quantitative study design, diversity in participants to capture maximum variability by the qualitative research design and site visits to facilitate real-life observations were the strengths of the evaluation.

6 | LIMITATIONS

The evaluation had some limitations. Shorter time available for evaluation during clinical rotations of the participants limited enough opportunities for knowledge and skill assessment. We were unable to assess actual (real-life) improvements in the skill of obstetric and neonatal emergencies and knowledge retention as the practices were mainly observed in the mannequin except for a few normal deliveries with essential care of newborn babies in a real-life situation at facilities. Advanced analyses were not done because of a lack of access to baseline data by the evaluation team. According to the BDHS data, there is a general increase in facility delivery in Bangladesh. We had the similar observation in our study, which may not be attributable to the SIMESON training alone. This is another limitation of the study. Finally, convenience sampling was used for qualitative research and lack of a control without SIMESON; findings from the study may not be generalizable outside the resource-poor settings. Our results indicate that this SIMESON training is practical, appropriate and efficient in resource-limited environments in improving maternal and child health in Bangladesh.

7 | CONCLUSION

Post-training skills of healthcare providers strengthened in all four components of maternal and newborn care. Through this training, there were improvements in the quality of care for maternal and neonatal health services at the government healthcare facilities of Kurigram. Taking up such training may guide efforts to give healthy, sensitive, respectful and high-quality obstetric and neonatal care even in remote rural settings of a larger population in Bangladesh. As most of the skills and knowledge increased from baseline, we recommend the SIMESON training to continue with regular monitoring and periodic evaluation. To improve the quality of subsequent training, the causes of knowledge and skill reduction in some components should be explored. Incorporating the management of eclampsia and suturing skill component in the training to manage perineal tear will further reduce maternal morbidity and mortality. Kangaroo mother care component should be introduced to reduce neonatal mortality. However, sustainability is depending on implementing the training with similar materials and methodologies by the Bangladesh Government as one of the components of regular refresher training in expanded areas.

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CONFLICT OF INTEREST

The authors declare no conflict of interest regarding the publication of this paper.

AUTHOR CONTRIBUTIONS

Tdh conceived and developed the SIMESON training program. Tdh and icddr,b evaluation team developed the data collection tools. RD managed the dataset and analysed the data, developed the tables/graphs and wrote the initial draft of the manuscript. RD and FDF developed the qualitative research guideline, and FDF wrote the result for the qualitative part. MS and NA analysed the cost estimation part. SAS, MJC, TA and ASGF critically reviewed the manuscript and gave intellectual inputs. All authors contributed to the final version of the paper.

DATA AVAILABILITY STATEMENT

Because of concerns about participants' confidentiality, data are available on request. The full dataset has not been stored in a public repository as it contains participants' names, contact numbers, institution names and a few identifiers that may lead to the identification of individual participants. However, the identification of participants is not possible from the data presented in the article as it contains summarized results only. The full dataset is freely available upon written request to the icddr,b Research Administration. Request for the study dataset may be sent to Armana Ahmed, icddr,b. Email: aahmed@icddrb.org.

ORCID

Rina Das https://orcid.org/0000-0001-7499-7278
Tahmeed Ahmed https://orcid.org/0000-0002-4607-7439

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SUPPORTING INFORMATION

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