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A pilot study on the simulation-based training for Ethiopia skilled birth attendants

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ABSTRACT

This simulation-based Ethiopia Midwife Train-the-Trainer program for skilled birth attendants is one part of the China-UK Global Health Support Program (GHSP) activities and an approach to improving the Ethiopia trainers' midwifery teaching skills. This pilot study aimed to evaluate the effectiveness of a simulation-based training for Ethiopia skilled birth attendants. This program was divided into three stages. In Stage 1, Fudan team trained 5 trainers from Ethiopia. In Stage 2, Fudan team supervised and evaluated the 1st stage Ethiopia trainers to train their peers becoming the trainers in Fudan University. In Stage 3, Fudan team evaluated the training program implementation in established Advanced Midwifery Practice Center in Tirunesh Beijing General Hospital. The participatory observational method was used for process evaluation and the Kirkpatrick model was used for effectiveness evaluation. The Ethiopia staff's teaching skills for simulation-based midwifery training were strengthened and their abilities to deal with various complicated obstetric situations were improved by group explanation, questions, rehearsal, and step-by-step interactive teaching ($p < .01$). The mean score of total mastery degree was 3.48 ± 0.16 by self-assessment and 3.63 ± 0.16 by peer-assessment in stage 2, and 3.27 ± 0.24 by self-assessment and 3.38 ± 0.34 by peer-assessment in stage 3.The GHSP-OP4-V01 Ethiopia Midwife Train-the-Trainer Program has received positive response in Ethiopia by in-depth interview and questionnaire survey. This study demonstrated that the simulation-based training is an effective approach for midwifery Train-the-Trainer program in Ethiopia.

1. Introduction and background

High maternal and neonatal mortality rates are considered enormous public health problems, especially in developing countries (Ueno et al., 2015). Yaya et al. (2014) found a maternal mortality ratio of 425 per 100,000 live births, and a neonatal mortality ratio of 27 per 1000 live births in south-west Ethiopia, which indicated mortality rates are still lagging behind the Millennium Development Goals (MDG, 2014) targets. Reducing maternal and neonatal mortality are crucial elements of the MDGs (MDG, 2014) and the Sustainable Development Goals (SDGs) (SDG, 2014). Evidence has shown that availability of skilled birth attendants (SBAs) during pregnancy and for early postnatal checkups is a key strategy for reducing maternal and neonatal mortality (Berhan; Berhan, 2014; McKinnon et al., 2014; Tarekegn et al., 2014), and will help in attaining the MDGs and the SDGs (Fekadu and Regassa, 2014). Thus, the importance of having SBAs to provide emergency obstetric care at all levels to avert maternal and newborn deaths cannot be over emphasized (Fagbamigbe et al., 2017).

There is a critical shortage of SBAs in Africa. The World Health Organization reported that there are only 2.6 physicians and 12.0 nursing/midwifery personnel per every 10,000 people in Africa (Ameh & van den Broek, 2015). The SBAs coverage is also low. Based on the Ethiopia Demographic and Health Survey 2011, skilled delivery utilization is very low with only 10% of women having delivered with an assistance of SBAs (Tarekegn et al., 2014). Actually, the skilled birth attendants in Ethiopia included midwifes and health care extension workers. The critical shortage of SBAs is a recognized barrier to the provision of health care, and is of great concern to many African countries facing persistently high maternal and neonatal mortality (Asamoah et al., 2014; Fagbamigbe et al., 2017).

Many countries have made great efforts to increase health-care providers to ensure improved coverage for maternal and newborn

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health (Fagbamigbe and Idemudia, 2015). Available evidence from Africa, Asia and Latin America/Caribbean (Singh et al., 2014), as well as from Democratic Republic of Congo and Zambia in Africa(Carlo et al., 2010), suggested that the midwifery skills of health workers could be upgraded to a safe level through short in-service trainings which were associated with improved pregnancy outcomes. Thus, there is a need to strengthen the training for SBAs in Africa and build the capacity of health-care providers to recognize and manage emergency obstetric problems during pregnancy, childbirth and the postpartum period (Ameh & van den Broek, 2015).

Simulation is a valuable technique in the education of health professionals (Barnabè et al., 2018). It lets persons to experience a real event by creating an environment with the view of practice, learning, evaluation, or testing (Bajaj et al., 2018). Maternal and neonatal collapse as a result of critical intrapartum complications is usually rapid and often unpredictable; obstetric health-care workers need to be optimally equipped to manage these life-and-death situations (Gülmezoglu and Lawrie, 2015). Using the simulation-based training model, the learner can be immersed in realistic situations, have the advantage of increasing the frequency of clinical experiences without training on real patients and enable repetitive practice (Curran et al., 2015), which have demonstrated improvement in the management of emergency obstetric care in several studies (Gale et al., 2016; Semwanga et al., 2016).

However, in Africa, high-quality medical training resources are limited. High-fidelity interactive simulators are prohibitively expensive to purchase and maintain, and unaffordable for many resource-limited countries (Skelton et al., 2016).

China has made substantial health commitments to Africa in the past several decades. Apart from the Chinese medical team program, China also has assisted in the construction of health facilities, the contribution of medical equipment and drugs, and the training of African health care workers (Lin et al., 2016). Several studies have suggested that simulation can be effective for teaching and can be adapted for a variety of health professionals in diverse settings to improve patient safety at little cost (Skelton et al., 2016; Bajaj et al., 2018). With funding from China-UK Global Health Support Program (GHSP), we are actively promoting the construction of an “Advanced Midwifery Practice Center” in Tirunesh Beijing General Hospital which is a Chinese-aided hospital in Addis Ababa, the capital of Ethiopia, where we will help the Ethiopia trainers to carry out the simulation-based training for SBAs and improve their midwifery training skills through simulation.

This Ethiopia Midwife Train-the-Trainer program is one part of the project “Pilot Interventions to Apply Relevant Chinese Practices and Experiences to Improve the Health of Women and Children in Low-income Countries in Asia and Africa” (GHSP-OP4-V01), which was launched in 2015 with the aim of improving the quality of local maternal and neonatal care and reducing maternal and neonatal morbidity and mortality. There is little substantive information and knowledge gaps exist on how international cooperation and activities can best be used as tools for the management of global health and attainment of the SDGs (Wang and Sun, 2014; Wang et al., 2016). Fudan university took the lead in exploring the model of setting up a professional midwifery skills training center in cooperation with a China-assisted Ethiopia local hospital and a Chinese medical team, aiming to improve the Ethiopia trainers’ skills for midwifery teaching. Therefore, we conducted this pilot study to evaluate whether a simulation-based Train-the-Trainer model can be used effectively to supplement midwifery training in Ethiopia. We hope this study helps in promoting international cooperation to make continuous improvements to the training program, providing evidence to sustain the China-UK global health supported program and ensuring limited resources in Ethiopia are well spent.

2. Methods

2.1. Design

The Ethiopia Midwife Train-the-Trainer program started in 2015. It was divided into three stages. In stage1, Fudan team carried out 5-days simulation-based midwife training for 5 Ethiopia medical staffs including two doctors, two midwifes, and one obstetrics project officer in the advanced midwifery practice center of Fudan University School of Nursing on January, 2016. In stage 2, two Ethiopia trainers from the first stage conducted a 5-days simulation-based midwife training for four new Ethiopia trainees and one Executive Director of Ethiopia midwives association as an observer on November, 2016 in Fudan University School of Nursing with the help and supervision of Fudan team. In stage 3, one Ethiopia trainer from the second stage and a Chinese doctor from the Ethiopia 20th Chinese Medical Team worked together on the 5-days simulation-based midwife training for five Ethiopia midwives with the assist and supervision of Fudan team in the established Advanced Midwifery Practice Center in Tirunesh Beijing General Hospital on January, 2018.

All of the trainees were selected from the Tirunesh Beijing General Hospital and Marie Stopes International Ethiopia. They have never been exposed to the simulation-based training before. They played roles as trainer, trainee and operator in turn in the different scenario rehearsals until they master how to conduct the midwifery training with the simulation system. The purpose of this study was to evaluate the effectiveness of a simulation-based training for SBAs using the Ethiopia Midwife Train-the-Trainer Program.

The Chinese training and supervision team was comprised of obstetrician, midwifes, and neonatal experts from School of Nursing, Obstetrics and Gynecology Hospital, Children's Hospital of Fudan University, and technical specialists for the simulation system. The Gaumard Victoria simulation delivery system S2200 was used for repeatable teaching exercises and scenario rehearsals. We conducted the simulation-based midwifery training together for the nursing students at least five times each year and had rich experience about the training. Before the project was launched, our team rehearsed all of the programmed scenarios at least three times in advance. English is the only language being used during the simulation-based training. All the training materials made in English including simulator specifications, instructor's handbook, trainee's handbook, training room management handbook, courseware and a set of scenarios were provided to all the participants without reservation. Each of these scenarios was programmed based on the Ethiopia local obstetric emergency situation, and determined by the Chinese and Ethiopia medical team, including a checklist of steps that should ideally be performed. Moreover, at the end of the scenario rehearsal, debriefing was necessary for evaluating the Ethiopia training team's performance and proposing deficiencies and improvements in order to make further improvement in the future simulated midwifery training.

In stage 1and 2, there were a total of 13 training items including working with simulated mum, fetus and infant, scenario editing, external pelvimetry, leopold maneuvers, episiotomy repair, normal delivery, dystocia, breech delivery, postpartum hemorrhage, preeclampsia, and neonatal asphyxia resuscitation being carried out based on the high-simulated delivery system step by step from simple to complex and easy to difficult. Considering the limited simulated resources and short training duration in Ethiopia, we chose 9 from the original 13 training items in stage 3, which included working with the simulators, scenario editing, external pelvimetry, leopold maneuvers,

normal delivery, dystocia, and postpartum hemorrhage.

2.2. Evaluation

During the second and third round of the Midwife Train-the-Trainer program, we carried out the process and effectiveness evaluation to the Ethiopia trainees. The participatory observational method was used for process evaluation and the Kirkpatrick model was used for effectiveness evaluation. The process evaluation included the training preparation, contents, hours, and methods. During the role-play process, the critical points used for evaluating three roles were made by the Chinese training team. There were 2 supervisors for the assessment of trainers, 2 for trainees, and 2 for operator in the first and last scenario rehearsals. The number of critical points was 10 for trainer, 10 for trainee and 9 for operator in the second round of training (Appendix 1), while in the third round of training, the number of critical points was 10 for trainer, 10 for trainee and 18 for operator (Appendix 2). If the measure was well done, we clicked the Pass and scored 1, if not, we clicked the Fail and scored 0. The scoring model of centesimal system was used. For example, if the trainer or trainee passed 9 among 10 critical points, we scored 90, while the operator passed 8 among 9 critical points, we scored 89.

The four level Kirkpatrick model (Kirkpatrick, 1996) was applied for the evaluation in form of training feedback questionnaires and in-depth interviews. Kirkpatrick's evaluation strategies represent one of the most comprehensive strategies for evaluating the effectiveness of the program. This model comprises four essential levels of evaluation (Kirkpatrick and Kirkpatrick, 2006) (Fig. 1) and in this pilot study, the second and third round of training was assessed only according to level 1 and 2. All of the questionnaires were developed in English.

Training feedback questionnaires included self- and peer-assessment for knowledge and skills learned in the second and third round of the Midwife Train-the-Trainer program. All raters provided feedback using a Likert scale ranging from 1 (none) to 4 (all) to score each dimension on knowledge and skills. Since it is the first time for the two rounds of Ethiopia trainees to carry out the simulation-based midwife training, we did not conduct a pre-test of the related knowledge and skills at the beginning of the Midwife Train-the-Trainer program.

The in-depth interview included a checklist of questions to assess the perspective of the training and was conducted in the second round of training. It was performed by a trained interviewer coming from Malawi. In order to maintain the quality of data to be collected, the interview was performed using the local languages if necessary. Based on the preprogrammed interview outline (Appendix 3), the trained interviewer carried out the qualitative interview for four of the Ethiopian medical staff. The interviewer recorded the words in the interview by face-to-face communication and arranged the data in English at the end of the interview.

A survey of the evaluation of the simulation training was done by a questionnaire when the third round of training finished. The questionnaire contained 11 items. When answering the former 10 questions, if the interviewee agrees with the claim, click 'Yes', if not, click 'No', and if she or he has no idea, please click 'I don't know'. The last question was to rate how satisfied they were with the simulation-based midwife

Figure 1. Kirkpatrick model for program evaluation

(Modified from Kirkpatrick & Kirkpatrick 2006).

Fig. 1. Kirkpatrick model for program evaluation.

Table 1
Characteristics of participants (n = 16).

Characteristics	Number	%
Age (years) (Mean ± SD)	32.44 ± 6.83	
Gender		
Male	6	37.5
Female	10	62.5
Occupation		
Doctor	4	25.0
Midwife	9	56.2
Director	1	6.3
Project officer	2	12.5
Nationality		
Ethiopian	13	81.3
Chinese	3	18.7

training on a 5-point scale (1 = very dissatisfied and 5 = very satisfied) (Appendix 4).

2.3. Ethical approval

The project was approved by Institutional Review Board, School of Public Health, Fudan University (IRB#2015-11-0569). Written consent was gained from the participants to use their anonymous feedback in the study and videos during the simulation training.

2.4. Statistical analysis

Collected data were managed and analyzed using SPSS version 19.0. Descriptive statistics were calculated for participant characteristics. Results are reported as number, percentage, mean, and standard deviation. Paired-samples t-tests (two-tailed) were conducted to compare the mean scores of roles in the first and last scenario. To assess the inter-rater reliability, we calculated the percentage of agreement between the two assessors. All reported p values were two-tailed and set at 0.05.

3. Results

3.1. Characteristics of participants in this program

Table 1 shows the characteristics of the total of 16 participants. The mean age was 32.44 ± 6.83 years (range 23–50 years). Among the 16 participants, three doctors are from the Chinese medical team in Ethiopia, two doctors and seven midwifes from Ethiopia Tirunesh Beijing Hospital, one midwife from Marie Stopes International Ethiopia (MSIE), one director from the Ethiopian midwives association, and the other two project officers are engaged in work related to midwifery.

3.2. Process evaluation by participatory observation

The material and procedure of the simulation-based training for SBAs was well prepared. The Ethiopia trainers, with instructions from the handbook made by the Chinese medical team, were more aware of the training objectives, content and methods and fully prepared themselves with the training procedure with the support of Chinese medical team the day before the start of the two rounds of training.

Table 3
Paired T-test outcomes for role assessment.

Role assessment	First rehearsal Mean ± SD	Last rehearsal Mean ± SD	*T value*	*P* value
The second round of training(n = 6)	65.67 ± 3.33	91.33 ± 2.88	−17.393	.000
The third round of training(n = 7)	64.29 ± 4.50	84.29 ± 6.08	−8.198	.000

Note: Mean ± SD was the average score of the three roles in each rehearsal and the maximum mark is 100.

The details about the content, hours and methods of the two rounds of training are presented in Table 2. This training highlighted the features of simulation of real delivery scenarios and multidisciplinary team collaboration. Midwives, medical doctors and clinical officers are trained together by teams of experienced specialist obstetricians, midwives or neonatal nursing experts. Various teaching methods were adopted like group and reflective learning, role-play, interactive learning, and debriefing, thus the trainees were immersed into their role of midwife trainer quickly.

During the role-play process, there were two supervisors for the assessment of trainers, two for trainees, and two for operators in the first and last scenario. A paired t-test outcomes for role assessment of the two rounds of training showed significant improvement in the last scenario rehearsal ($p < .01$) (Table 3). Inter-rater agreement in "pass/fail" was 100% for both scenarios.

3.3. Effectiveness evaluation with the Kirkpatrick model by the Ethiopia staff of the second round of training

Data collected from in-depth interview at the end of the second round of training showed satisfactory reaction about the OP4-V01 program and Midwife Train-the-Trainer program at the first Kirkpatrick level. They spoke highly of the OP4-V01program. Commentary among the group included: "*The program is aimed to improve maternal and neonatal situation especially in underdeveloped countries like in our country Ethiopia, we have high maternal mortality radio (MMR), so the program is suitable and significant to address the challenge we are facing.*" And "*The program aim at developing competence for midwives in skills with a different approach and the use of simulation process is one of the high-tech way to develop skills hence it will improve care for the health professionals especially for mothers and children.*" Moreover, they indicated the Midwife Train-the-Trainer program is "*very significant*", which brings them "*a very interesting learning experience in simulation-based midwifery training*" and "*all scenarios depicted challenges faced in Ethiopia.*"

Four of the interviewees (100%) indicated that the training objective was "*definitely*" just like they said, "*The objective is to decrease maternal death in Ethiopia and this training is highly related to the objectives*

Table 2
Content, hours and method of the two rounds of training.

Content	The second round of training(hours)	The thirdround of training(hours)	Method
Working with the simulators	12	16	Group and reflective learning
External pelvimetry	2	1	Interactive learning
Leopold's maneuvers	2	1	Interactive learning
Episiotomy repair	2	/	Interactive learning
Simulate normal delivery	2	2	Role play & debriefing
Simulate dystocia delivery	4	4	Role play & debriefing
Simulate postpartum hemorrhage	2	4	Role play & debriefing
Simulate preeclampsia	2	/	Role play & debriefing
Simulate newborn resuscitation	4	/	Role play & debriefing
Total	32	28	

Table 4
Mean scores of mastery degree obtained by self and peer assessment.

Training topics	The second round of training		The third round of training	
	Self-assessment Mean ± SD (n = 4)	Peer-assessment Mean ± SD (n = 4)	Self-assessment Mean ± SD (n = 5)	Peer-assessment Mean ± SD (n = 5)
Working with mum	3.75 ± 0.50	4.00 ± 0.00	3.40 ± 0.55	3.80 ± 0.45
Working with birthing fetus	3.50 ± 0.58	3.50 ± 0.58	3.40 ± 0.55	3.40 ± 0.55
Working with infant	3.25 ± 0.50	3.75 ± 0.50	2.40 ± 0.55	2.40 ± 0.55
Scenario editing	3.25 ± 0.50	3.25 ± 0.50	3.20 ± 0.45	3.00 ± 0.00
External pelvimetry	4.00 ± 0.00	3.50 ± 0.58	3.80 ± 0.45	3.80 ± 0.45
Leopold maneuvers	3.50 ± 0.58	3.50 ± 0.58	3.60 ± 0.55	3.80 ± 0.45
Episiotomy repair	3.25 ± 0.50	3.50 ± 0.58	/	/
Simulate normal delivery	3.75 ± 0.50	4.00 ± 0.00	3.40 ± 0.55	3.40 ± 0.55
Simulate breech delivery	3.50 ± 0.58	3.25 ± 0.50	/	/
Simulate dystocia	3.25 ± 0.50	3.75 ± 0.50	2.80 ± 0.45	3.20 ± 0.84
Simulate postpartum hemorrhage	3.50 ± 0.58	4.00 ± 0.00	3.40 ± 0.55	3.60 ± 0.55
Simulate preeclampsia	3.50 ± 0.58	3.75 ± 0.50	/	/
Simulate newborn resuscitation	3.25 ± 0.50	3.50 ± 0.58	/	/
Total[a]	3.48 ± 0.16	3.63 ± 0.16	3.27 ± 0.24	3.38 ± 0.34

Four-point Likert-type scale for the mastery degree (1 = all, 2 = most, 3 = little, 4 = none).
[a] Total means the average score of all the training topics' mastery degree.

covered and program objectives hence they were definite." Half of them considered the training time was short and suggested the time needed to be adjusted to 10–15 days if practical so that the skills are thoroughly grasped. As for the training content, all of them indicated that the training content was "*good with a good flow*." When talking about the assessment of the training, all of them indicated that "*Assessment was objectively structured with feedback given appropriately.*"

All of the participants basically grasped the skills of simulation-based midwifery training. They rehearsed the real obstetric emergency scenarios with the simulator and believed that the simulation training can improve midwives' ability to provide safe care. Commentary among the group included: "*in Ethiopia their training model are not like Victoria (the training model used in this program) by which it is better for them to create similar situations to teaching and grasping the knowledge and skills easily. The other training part like episiotomy management is good and makes it easy for proper skills attainment.*" The others reported using the following expression: "*the simulator gives a chance to perform different task and it is easy to use given full knowledge for the trainers. In addition, it mimics the real scenario and its operation interface is friendly so as to be easy to run once practiced repeatedly.*"

In order to assess the overall performance of the trainees, we asked four trainees from Ethiopia to complete a self-assessment and four expert obstetricians and midwives to serve as observers from China (n = 3) and Ethiopia (n = 1) to rate the Ethiopian trainees' knowledge and skills learned in this program at the end of the training. The mean scores of mastery degree obtained by the self- and peer-assessment are presented in Table 4. From it, what and how the Ethiopia medical team learned in the five-day simulation-based midwifery training were clear and helpful to assess the overall performance of the trainees.

When being asked 'what's your suggestion on our future simulation training?', one participant expressed the issue as follows: "*It is important training, in future training should be expanded both in preservice and service areas. If students learn how to use this modem efficiently, then we would not be worried of the skills gap when they graduate. It should also be established in midwife organization where we have trainers.*"

For the second Kirkpatrick level, in response to the question 'what's your plan to carry out the simulation training if the simulation center established in Ethiopia?', four interviewees commented as follows. One participant noted, "*I will help to create more awareness to simulation-based midwifery training to promote Hospital delivery and also teach the midwives, clinicians and students at hospital.*" One participant stated, "*I will transfer skills learned here into clinical practice.*" Another participant believed, "*All midwives and nurses will be trained on the new skills soon by means of simulation training.*"Finally, one participant summed up, "*Since we have trainers and they are recruited into our organization, I plan to share the information with them and equip them with the skills so that they can provide training to other people. I will also lobby for establishment of a CPD training center and target those in service. I will discuss with staff the knowledge gained and board.*"

3.4. Evaluation of the simulation training by the Ethiopia staff of the third round of training

7(100%) interviewees liked this simulation-based midwifery training. All of them considered that simulation needs to be done in midwifery training and hope more simulation-based midwifery training be conducted in the future. They all believed that learning initiative and motivation, ability of information assessment and knowledge application, practice, communication with patient, teamwork ability, as well as critical thinking could be improved by simulation training. When evaluating the satisfaction degree of this training, six interviewees (85.7%) gave the 'very satisfied', and two (14.3%) gave the 'satisfied'.

4. Discussion

Based on our knowledge, there are no previous reports of midwifery training through simulation system in Ethiopia. Simulation replicates clinical experiences without patient risk, which remains uncommon in lower-income countries (Patricia et al., 2014). Due to the creation of Ethiopian's first centre for simulation-based training for SBAs, we secured funding for equipment, developed the Midwife Train-the-Trainer program, trained the local medical staff to teach, and adopted the evaluation of process and effectiveness to reveal whether the simulation-based training was feasible, effective and acceptable in Ethiopia. Our experience indicates that simulation can be applied in low-income settings by offering an inexpensive, flexible and practical form of experiential learning that can be tailored to suit local needs, which was consistent with other similar studies (Nelissen et al., 2014; Patricia et al., 2014).

Aligned with World Health Organization report (World Health Organization, 2006) and 2011 Ethiopia Demographic and Health survey, the training content was specifically designed to meet the needs and resources in Ethiopia. The midwife training was developed to address major obstetric causes of maternal and neonatal deaths. All of the simulation scenarios planned, implemented, and facilitated by obstetricians and midwives were tailored to suit local needs in this pilot

study. It offered trainees exposure to a wider breadth of obstetric emergency conditions than they would have experienced from clinical attachments alone, and it was different from other simulation trainings for SBAs, which only focused on a certain scenario, such as postpartum hemorrhage (de Melo et al., 2018), or neonatal care (Mduma et al., 2015). In this study, the training content was abundant and specific, and each scenario involved a debriefing session to discuss, develop, and reinforce concepts of resuscitative care and crisis resource management, which helps to improve the obstetric emergency skills of the Ethiopian medical staff.

Moreover, unlike other simulation trainings (Mduma et al., 2015; Shilkofski and Hunt, 2015), this training not only addressed the improvement of knowledge and skills on obstetric care, but also focused on grasping the function and use of the simulation delivery system. Considering the simulation-based training for the SBAs will be sustained in Ethiopia, it was imperative for the Ethiopian medical staff to have the sufficient skills to work with simulative Mum, birthing baby and infant. Since the advanced simulation delivery system had more complicated functions, even 12 h (37.5%) were spent in the training of the simulation delivery system, some of the participants still reported in the interview at the end of the second round of training that they needed more time to be familiar with the simulation delivery system, and more guidance on the software to control the simulator, which was consistent with Nelissen et al. (2014). Thus, we increased to 16 h to help the Ethiopia staff of the third round of training to be familiar with and master the function of the simulators. But the mean score of the mastery degree of working with infant and scenario editing was still lower which indicated the training time was still not enough. Accordingly, we suggest for future training programs in other low-income settings that the best time for training of simulation delivery system should be extended to 24–36 h.

However, there is a gap between performance in knowledge and skills. Monitoring and evaluation with validated tests is recommended, and should be part of training (Nelissen et al., 2014). In our study, a checklist for the assessment of skills performance was developed by the Chinese training team. During the scenario, the role of trainer, trainee and operator was evaluated respectively by the supervisors with the corresponding assessment checklist. According to our results, pass or fail ratings may be appropriate for skills tests as it showed 100% inter-rater agreement. If these issues are addressed, simulation-based midwifery training has great potential to help improve the quality of SBAs regarding management of dystocia, postpartum hemorrhage, pre-eclampsia or neonatal resuscitation.

The Kirkpatrick model provides a thorough understanding of the effectiveness of a training program (Kirkpatrick, 1996). In this study, whatever by self or peer evaluation, the training items were mastered well by the participants. Based on their wonderful performance during the simulation-based training, we firmly believed that the Ethiopia medical team could handle the common obstetric emergency conditions more competent and confident, which is consistent with systematic reviews showing that simulation-based education results in an immediate and significant increase in knowledge and skills of participants (Nelissen et al., 2014; Henriksen et al., 2018). This will provide insight into the extent to which experiential learning through simulation and clinical skills training prepares midwives for practice. Moreover, the comments from the two rounds of Ethiopian medical staff demonstrated that the simulation-based training was helpful and they were satisfied with it and enjoyed the opportunity to carry out it for SBAs in Ethiopia. These positive responses to the Midwife Train-the-Trainer program indicated that simulation training increased enjoyment as well as confidence. This replicates work done in other low-resource settings where simulation has been demonstrated as being acceptable and preferable to role-play scenarios.

Self-assessment alone is an inadequate measure for performance assessment (Eva and Regehr, 2005; Davis et al., 2006). In this pilot study, the knowledge and skills of simulation-based training were evaluated by self- and peer-assessment. The results of self-assessment and the observational data from peer-assessment on obstetric emergency management after the training also provided evidence that the Ethiopian medical staff performed well in simulated maternal and neonatal care. All of the supervisors reached an agreement that the Ethiopian medical staff not only mastered the knowledge about the simulation, but also had the basic skills to cooperate to carry out the simulation-based midwifery training.

5. Limitations

Our study has several limitations. Firstly, the sample size was small and the group was heterogeneous, which may affect generalisability. Secondly, since the training time was very short and it was all of the participants first contact with the simulation-based training, we didn't take the pre-test before the training which may have weakened the impact of the simulation-based training. Thirdly, English is not the native language for everybody. Ineffective communication was sometimes a hindrance to shared understanding of a situation which may bring a bias based on the observers' own cultural viewpoints and resultant conclusions. Fourthly, it was a pilot study to evaluate whether a simulation-based Train-the-Trainer model can be used effectively to supplement midwifery training in Ethiopia. Neither experience nor lessons can be learned. All the interview questions and evaluation index developed by ourselves may lead to bias or subjectivity. Finally, each stage of simulation-based midwifery training only lasted 5 days, and the increased levels of knowledge and skills can not translate into change of behavior in the labor ward or improved patient outcomes so quickly. Thus, the training was assessed only according to level 1 and 2 of the Kirkpatrick model. In addition, improved knowledge and skills were measured immediately after the trainings, we are not sure whether this effect can be maintained over time. Since the Advanced Midwifery Practice Center was successfully built in Tirunesh Beijing General Hospital and the first time simulation-based training was well conducted in it, we could further assess the sustained effect on birth outcomes. Further study would be required in the future.

6. Conclusion

The simulation-based midwifery training was feasible, effective, acceptable, and significantly improved learners' knowledge and skills as demonstrated by data collected from the evaluation of process and effectiveness. The findings indicate that simulation can be applied in low-income settings by offering an interactive, flexible and practical form of training for SBAs. This pilot study highlights the importance of simulation-based training and reinforces the value in establishing Ethiopia's first center for simulation. It was in line with the strategic direction of the Ethiopian midwifes association to strengthen the skill of birthing attendants and should be expanded to other areas in Ethiopia and other developing countries. The Kirkpatrick model has been used to assess the impact of training courses as it relates to reaction and learning (levels 1 and 2) but rarely as it relates to the transfer of acquired knowledge, skills and management strategies into clinical practice and the impact on patient outcome (levels 3 and 4) (McGaghie et al., 2010; Kumar et al., 2018). Future research should therefore also focus on the clinically relevant third and fourth level of the Kirkpatrick model to explore the impact of the training on clinical performance and patient outcome.

Conflicts of interest

The authors declare that they have no competing interests.

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Authors' contributions

All authors: training faculty, writing and revision of manuscript. Ying Zhao, Yan Hu, Xu Qian: data collection/interpretation, table and figure creation, writing and revision of manuscript. All authors have read and agreed to the final version of this manuscript and have equally contributed to its content and to the management of the case.

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Appendix 1. Instructions: The following are the critical points for trainer, trainee and operator, if it is well done, please click'✓'in the blank under YES, if not, please click'✓'in the blank under NO and tell us the reason briefly in the blank under COMMENTS.

Critical Points for Trainer	YES	NO	COMMENTS
Scenario is realistic.			
Scenario is feasible.			
Describe the scenario information clearly.			
Role assignment is reasonable.			
Time control is good.			
Respect all of the trainees.			
Debriefing is comprehensive and deep.			
Evaluation is fully and definite.			
Summary is clear and concise.			
Fully competent for the role of trainer.			
Critical Points for Trainee	**YES**	**NO**	**COMMENTS**
Observe the labor process.			
Make preparation for AROM*.			
Correctly assess maternal status after AROM*.			
Encourage urination and empty bladder.			
Correctly assess fetal status after AROM*.			
Correctly use pitocin during labor.			
Guide pushing.			
Make preparation for vacuum-assisted delivery.			
Communicate and cooperate with other obstetric staff well.			
Communicate with puerpera well.			
Critical Points for Operator	**YES**	**NO**	**COMMENTS**
Simulators (mum and baby) are ready.			
The wireless link between control tablet PC and simulator is established.			
The control tablet PC is running.			
The virtual monitor PC is setup.			
The parameters programmed display right.			
Sufficiently lubricate the fetus and birth canal.			
Voice dialogue is normal operating.			
The scenario is good running.			
The parameters adjustment at any time are well done.			

*AROM means artificial rupture of membrane.

Appendix 2. Instructions: The following are the critical points for trainer, trainee and operator, if it is well done, please click'✓'in the blank under YES, if not, please click'✓'in the blank under NO and tell us the reason briefly in the blank under COMMENTS.

Critical Points for Trainer	YES	NO	COMMENTS
Scenario is realistic.			
Scenario is feasible.			
Describe the scenario information clearly.			
Role assignment is reasonable.			
Time control is good.			
Respect all of the trainees.			
Debriefing is comprehensive and deep.			
Evaluation is fully and definite.			
Summary is clear and concise.			
Fully competent for the role of trainer.			

Critical Points for Trainee	YES	NO	COMMENTS
Correctly massage the fundus.			
Assess maternal bladder status.			
Correctly use oxytocin according to doctor's order.			
Assess postnatal maternal vital signs.			
Observe the shock index closely.			
Make preparation for blood transfusion.			
Make preparation for uterine probing and packing.			
Operate in aseptic ways.			
Communicate with puerpera well.			
Communicate and cooperate with other obstetric staff well.			

Critical Points for Operator	YES	NO	COMMENTS
Simulators (mum and baby) are ready.			
The wireless link between control tablet PC and simulator is established.			
The control tablet PC is running.			
The virtual monitor PC is setup.			
The parameters progammed display right.			
Insert the vertex delivery rod.			
Fill the lubrication reservoir with mineral oil.			
Place birthing baby in the abdominal cavity.			
Sufficiently lubricate the fetus and birth canal.			
Attach umbilical cord to birthing baby.			
Arrange birthing baby into a start position.			
Position delivery ring and securely connect birthing baby.			
Insert the placenta into the placenta cavity.			
Connect the cover power connector.			
Press down firmly to secure the contraction cover.			
Voice dialogue is normal operating.			
The scenario is good running.			
The parameter adjustment at any time is well done.			

Appendix 3. Interview Outline.

1	What do you think about this GHSP-OP4-V01 program?
2	What do you think about this simulation training?
3	What do you think about the objectives of this training?
4	What do you think about the time of this training?
5	What do you think about the content of this training?
6	What do you think about the evaluation of this training?
7	Do you think the midwifery knowledge and skill can be improved by this simulation training?
8	What's your suggestion on our future simulation training?
9	What's your plan to carry out the simulation training if the simulation center established in Ethiopia?

Appendix 4. Evaluation of the simulation training

The following are the items for the evaluation of the simulation training, if you think so, please click '√' in the blank under YES,if not, please click '√' in the blank under NO, and if you have no idea, please click '√' in the blank under 'I don't know'.

Items	YES	NO	I don't know.
1. Like this simulation-based midwifery training.			
2. Simulation need to be done in midwifery training.			
3. Hope more simulation-based midwifery training in the future.			
4. Improve learning initiative and motivation.			
5. Improve information assessment ability.			
6. Improve knowledge application ability.			
7. Improve communication ability with patient.			
8. Improve practical operation ability.			
9. Improve teamwork ability.			
10. Improve critical thinking ability.			

11. Please give us your satisfaction evaluation of this simulation-based midwifery training.

① Very dissatisfied( )
② Dissatisfied( )
③ Medium( )
④ Satisfied( )
⑤ Very satisfied( )

References

Ameh, C.A., van den Broek, N., 2015. Making it Happen: training health-care providers in emergency obstetric and newborn care. Best Pract. Res. Clin. Obstet. Gynaecol. 29, 1077–1091. https://doi.org/10.1016/j.bpobgyn.2015.03.019.

Asamoah, B.O., Agardh, A., Cromley, E.K., 2014. Spatial analysis of skilled birth attendant utilization in Ghana. Global J. Health Sci. 6, 117–127. https://doi.org/10.5539/gjhs.v6n4p117.

Bajaj, K., Minors, A., Walker, K., Meguerdichian, M., Patterson, M., 2018. No-go considerations" for in situ simulation safety. Simulat. Healthc. J. Soc. Med. Simulat. https://doi.org/10.1097/SIH.0000000000000301.

Barnabè, F., Giorgino, M.C., Guercini, J., Bianciardi, C., Mezzatesta, V., 2018. Management simulations for Lean healthcare: exploiting the potentials of role-playing. J. Health Organisat. Manag. 32, 298–320. https://doi.org/10.1108/JHOM-07-2017-0191.

Berhan, Y., Berhan, A., 2014. Skilled health personnel attended delivery as a proxy indicator for maternal and perinatal mortality: a systematic review. Ethiop J Health Sci 24 (Suppl. l), 69–80.

Carlo, W.A., Goudar, S.S., Jehan, I., Chomba, E., Tshefu, A., Garces, A., et al., 2010. Newborn-care training and perinatal mortality in developing countries. N. Engl. J. Med. 362, 614–623. https://doi.org/10.1056/NEJMsa0806033.

Curran, V., Fleet, L., White, S., Bessell, C., Deshpandey, A., Drover, A., et al., 2015. A randomized controlled study of manikin simulator fidelity on neonatal resuscitation program learning outcomes. Adv Health Sci Educ Theory Pract 20, 205–218. https://doi.org/10.1007/s10459-014-9522-8.

Davis, D.A., Mazmanian, P.E., Fordis, M., Van Harrison, R., Thorpe, K.E., Perrier, L., 2006. Accuracy of physician self-assessment compared with observed measures of competence: a systematic review. J. Am. Med. Assoc. 296, 1094–1102. https://doi.org/10.1001/jama.296.9.1094.

de Melo, B.C.P., Rodrigues Falbo, A., Sorensen, J.L., van Merriënboer, J.J.G., van der Vleuten, C., 2018. Self-perceived long-term transfer of learning after postpartum hemorrhage simulation training. Int. J. Gynaecol. Obstet. 141, 261–267. https://doi.org/10.1002/ijgo.12442.

Eva, K.W., Regehr, G., 2005. Self-assessment in the health professions: a reformulation and research agenda. Acad. Med. 80, S46–S54.

Fagbamigbe, A.F., Hurricane-Ike, E.O., Yusuf, O.B., Idemudia, E.S., 2017. Trends and drivers of skilled birth attendant use in Nigeria (1990-2013): policy implications for child and maternal health. Int J Womens Health 9, 843–853. https://doi.org/10.2147/IJWH.S137848.

Fagbamigbe, A.F., Idemudia, E.S., 2015. Barriers to antenatal care use in Nigeria: evidences from non-users and implications for maternal health programming. BMC Pregnancy Childbirth 15, 1–10. https://doi.org/10.1186/s12884-015-0527-y.

Fekadu, M., Regassa, N., 2014. Skilled delivery care service utilization in Ethiopia: analysis of rural-urban differentials based on national demographic and health survey (DHS) data. Afr. Health Sci. 14, 974–984. https://doi.org/10.4314/ahs.v14i4.29.

Gale, T.C., Chatterjee, A., Mellor, N.E., Allan, R.J., 2016. Health worker focused distributed simulation for improving capability of health systems in Liberia. Simulat. Healthc. J. Soc. Med. Simulat. 11, 75–81. https://doi.org/10.1097/SIH.0000000000000156.

Gülmezoglu, A.M., Lawrie, T.A., 2015. Impact of training on emergency resuscitation skills: impact on Millennium development Goals (MDGs) 4 and 5. Best Pract. Res. Clin. Obstet. Gynaecol. 29, 1119–1125. https://doi.org/10.1016/j.bpobgyn.2015.03.018.

Henriksen, K., Rodrick, D., Grace, E.N., Brady, P.J., 2018. Challenges in health care simulation: are we learning anything new? Acad. Med. 93, 705–708. https://doi.org/10.1097/ACM.0000000000001891.

Kirkpatrick, D., 1996. Revisiting kirkpatrick's four-level model, great ideas revisited series. Train. Dev. 50, 54–59.

Kirkpatrick, D.L., Kirkpatrick, J.D., 2006. Evaluating Training Programs: the Four Levels, third ed. Berrett-Koehler Publication, San Francisco.

Kumar, A., Nestel, D., East, C., Hay, M., Lichtwark, I., McLelland, G., et al., 2018. Embedding assessment in a simulation skills training program for medical and midwifery students: a pre- and post-intervention evaluation. Aust. N. Z. J. Obstet. Gynaecol. 58, 40–46. https://doi.org/10.1111/ajo.12659.

Lin, S., Gao, L., Reyes, M., Cheng, F., Kaufman, J., El-Sadr, W.M., 2016. China's health assistance to Africa: opportunism or altruism? Glob. Health 12, 83. https://doi.org/10.1186/s12992-016-0217-1.

McGaghie, W.C., Issenberg, S.B., Petrusa, E.R., Scalese, R.J., 2010. A critical review of simulation based medical education research: 2003-2009. Med. Educ. 44, 50–63. https://doi.org/10.1111/j.1365-2923.2009.03547.x.

McKinnon, B., Harper, S., Kaufman, J.S., Abdullah, M., 2014. Distance to emergency obstetric services and early neonatal mortality in Ethiopia. Trop. Med. Int. Health 19, 780–790. https://doi.org/10.1111/tmi.12323.

MDG, 2014. United nations, New York. The Millennium development Goals report. www.un.org/milleniumgoals/2014.MDG.report/MDG.2014.English.web.pdf [last accessed 22.06.15].

Mduma, E., Ersdal, H., Svensen, E., Kidanto, H., Auestad, B., Perlman, J., 2015. Frequent brief on-site simulation training and reduction in 24-h neonatal mortality-An educational intervention study. Resuscitation 93, 1–7. https://doi.org/10.1016/j.resuscitation.2015.04.019.

Nelissen, E., Ersdal, H., Ostergaard, D., Mduma, E., Broerse, J., Evjen-Olsen, B., et al., 2014. Helping mothers survive bleeding after birth: an evaluation of simulation-based training in a low-resource setting. Acta Obstet. Gynecol. Scand. 93, 287–295. https://doi.org/10.1111/aogs.12321.

Patricia, L., Jonathan, B., Georges, N., Christian, M., Sara, W., Peter, B., 2014. Development of a simulation and skills centre in East Africa: a Rwandan-Canadian partnership. Pan African Medical Journal 17, 315. https://doi.org/10.11604/pamj.2014.17.315.4211.

SDG, 2014. United nations secretary general report. A/68/970-Open working group of the general assembly on sustainable development Goals. 12 August 2014. https://sustainabledevelopment.un.org/topics/sustainabledevelopmentgoals [last accessed 22.06.15].

Semwanga, A.R., Nakubulwa, S., Adam, T., 2016. Applying a system dynamics modelling approach to explore policy options for improving neonatal health inUganda. Health Res. Pol. Syst. 14, 35. https://doi.org/10.1186/s12961-016-0101-8.

Shilkofski, N., Hunt, E.A., 2015. Identification of barriers to pediatric care in limited-resource settings: a simulation study. Pediatrics 136, e1569–1575. https://doi.org/10.1542/peds.2015-2677.

Singh, K., Brodish, P., Suchindran, C., 2014. A regional multilevel analysis: can skilled birth attendants uniformly decrease neonatal mortality? Matern. Child Health J. 18, 242–249. https://doi.org/10.1007/s10995-013-1260-7.

Skelton, T., Nshimyumuremyi, I., Mukwesi, C., Whynot, S., Zolpys, L., Livingston, P., 2016. Low-cost simulation to teach anesthetists' non-technical skills in Rwanda. Anesth. Analg. 123, 474–480. https://doi.org/10.1213/ANE.0000000000001434.

Tarekegn, S.M., Lieberman, L.S., Giedraitis, V., 2014. Determinants of maternal health service utilization in Ethiopia: analysis of the 2011 Ethiopian Demographic and Health Survey. BMC Pregnancy Childbirth 14, 161. https://doi.org/10.1186/1471-2393-14-161.

Ueno, E., Adegoke, A.A., Masenga, G., Fimbo, J., Msuya, S.E., 2015. Skilled birth attendants in Tanzania: a descriptive study of cadres and emergency obstetric care signal functions performed. Matern. Child Health J. 19, 155–169. https://doi.org/10.1007/s10995-014-1506-z.

Wang, S., Lifson, M.A., Inc, i F., Liang, L.G., Sheng, Y.F., Demirci, U., 2016. Advances in addressing technical challenges of point-of-care diagnostics in resource limited settings. Expert Rev. Mol. Diagn. 16, 449–459. https://doi.org/10.1586/14737159.2016.1142877.

Wang, X., Sun, T., 2014. China's engagement in global health governance: a critical analysis of China's assistance to the health sector of Africa. Journal of Global Health 4, 010301. https://doi.org/10.7189/jogh.04.010301.

World Health Organization, 2006. Beyond the Numbers: Reviewing Maternal Deaths and Complications to Make Pregnancy Safer. WHO, Geneva 2006. http://whqlibdoc.

Yaya, Y., Eide, K.T., Norheim, O.F., Lindtjørn, B., 2014. Maternal and neonatal mortality in south-west Ethiopia: estimates and socio-economic inequality. PLoS One 9, e96294. https://doi.org/10.1371/journal.pone.0096294.