Original Research

Knowledge and Skills Retention Among Frontline Health Workers: Community Maternal and Newborn Health Training in Rural Ethiopia

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Introduction: We examined the degree to which the skills and knowledge of health workers in Ethiopia were retained 18 months after initial maternal and newborn health training and sought to identify factors associated with 18-month skills assessment performance.

Methods: A nonexperimental, descriptive design was employed to assess 18-month skills performance on the topics of Prevent Problems Before Baby Is Born and Prevent Problems After Baby Is Born. Assessment was conducted by project personnel who also received the maternal and newborn health training and additional training to reliably assess health worker performance.

Results: Among the 732 health workers who participated in maternal and newborn health training in 6 rural districts of the Amhara and Oromia regions of Ethiopia (including pretesting before training and a posttraining posttest), 75 health extension workers (78%) and 234 guide team members (37%) participated in 18-month posttest. Among health extension workers in both regions, strong knowledge retention was noted in 10 of 14 care steps for Prevent Problems Before Baby Is Born and in 14 of 16 care steps of Prevent Problems After Baby Is Born. Lower knowledge retention was observed among guide team members in the Amhara region. Across regions, health workers scored lowest on steps that involved nonaction (eg, *do not* give oxytocin). Educational attainment and age were among the few variables found to significantly predict test performance, although participants varied substantially by other sociodemographic characteristics.

Discussion: Results demonstrated an overall strong retention of knowledge and skills among health extension workers and highlighted the need for improvement among some guide team members. Refresher training and development of strategies to improve knowledge of retention of low-performing steps were recommended.

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INTRODUCTION

Despite progress on Millennium Development Goals 4 and 5, maternal and newborn mortality continues to be a serious problem worldwide, particularly in low- and middle-income countries where 99% of these deaths occur.[1] In Ethiopia, a country of nearly 85.9 million where the great majority of people 84% live in rural areas, maternal and newborn mortality remains a serious problem. In 2011, the maternal mortality ratio was estimated at 676 deaths per 100,000 live births; neonatal mortality was estimated at 37 deaths per 1000 live births.[2]

Most experts agree that timely provision of a package of evidence-based practices can reduce maternal and newborn deaths.[3] Delays in the receipt of this package have been associated with decision making by women and families, geographic and economic barriers, and perceived or actual poor quality of facility-based care.[4]

Efforts to reduce delays in care provision have taken many forms. One prevalent strategy has been to extend the care supply chain by training not only the professional health care providers at peripheral health facilities but also by task-shifting through the training and deployment of more proximal frontline health workers, thereby better integrating health workers into the overall care system.[5,6] Frontline health workers include volunteer community health workers, traditional birth attendants (TBAs), as well as a variety of other paid paraprofessionals (eg, health extension workers and lady health workers) who attend women during pregnancy or during the birth and/or provide health education. It has been shown that the extension of maternal and newborn health care by trained health workers yields improved care provision and self-care behaviors and often contributes to better birth outcomes[7–12] and reduced neonatal mortality.[13,14] While most studies have shown positive outcomes, some have not. One study, for example, found that after the introduction of Essential Newborn Care training to community-based birth attendants, the rate of newborn death did not decrease in the week following implementation, although the stillbirth rate did decline.[15]

- ✦ Once embedded in a system of use (the provision of community-based training and care provision) and ongoing coaching and observation, health workers retain maternal and newborn health skills.
- ✦ Regional variations in retained skills are observed, reflecting regional differences in policy interpretation and implementation in the distribution and use of misoprostol (Cytotec).
- ✦ Intercadre variations in retained skills are also observed, largely reflecting the extent to which members of each cadre are directly involved in the actual provision of maternal and newborn health care, especially during the critical birth-to-48-hours period.

Training has been the primary approach to prepare health workers to provide appropriate and timely maternal and newborn health care. Training efforts have focused on basic specific skills, such as recognizing postpartum hemorrhage and providing misoprostol (Cytotec),[16] recognizing sick newborns and the need for referral,[17] and home-based essential neonatal care.[18] The American College of Nurse-Midwives' Home-Based Life Saving Skills (HBLSS) program offers a comprehensive program of maternal and newborn health care training.[19] The HBLSS program uses a cascade training approach, similar to other programs in which training extends across multiple levels of trainees and the numbers of people trained increases with each level (eg, health consultants, master trainers, and trainers). After receiving training, one level is responsible for training the next level down with support from higher levels, as needed.[20] These programs differ in the extent to which they emphasize didactic or participatory methods such as hands-on training and practice[11] and follow-up supervision after the initial training.[18]

Health worker training programs have used a number of strategies to evaluate and demonstrate change in health workers' skills and knowledge. Evaluation efforts have entailed (solely or in combination) pre- and posttraining knowledge tests,[8] observation of skills by trainers,[11] objective simulated clinical examinations,[20] health worker self-reports,[20] and interviews with end users (community members who are the intended recipients of the care/education).[11] Some have also conducted evaluations a while after the posttraining to assess retention of knowledge and skills over time.[8,20] In all cases, the evaluations have demonstrated that training significantly enhances health worker skills and knowledge. Moreover, follow-up evaluations have indicated that, although scores may have slipped from immediate posttraining, health worker skills and knowledge remained substantially above baseline over time.[21,22]
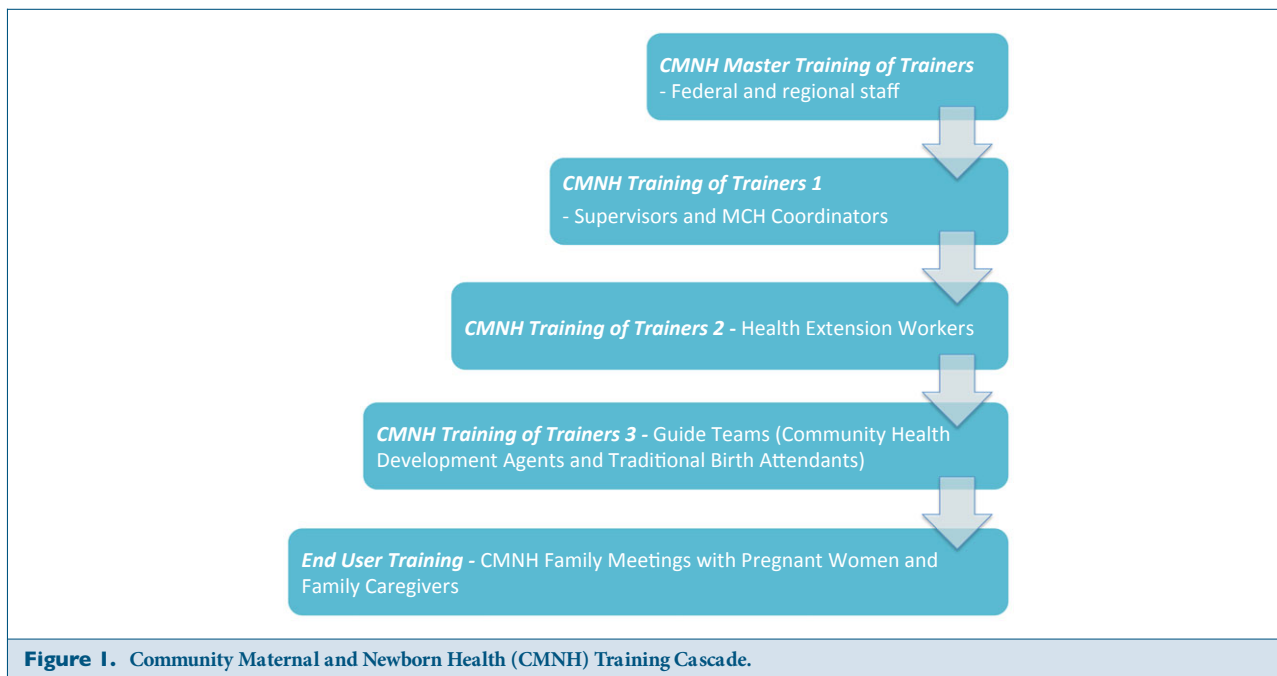
A major intervention component of the Maternal and Newborn Health in Ethiopia Partnership (MaNHEP) has entailed the provision of maternal and newborn health training to health workers, including health extension workers, community health development agents, and TBAs. Health extension workers are young women with 10 years of primary and secondary school education and one year of certificate-level health training that consists of 16 packages.[23] Health extension workers provide select reproductive health services including antenatal and postnatal care, family planning, and birth attendance, although their level of hands-on experience with birth may be limited. Community health development agents have minimal, yet variable, levels of maternal and newborn health training. Community health development agents are members of the community who are chosen by the community or organization to work as volunteers in health-related activities such as community mobilization and health education. Traditional birth attendants do not have formal training, but may have learned skills passed on from older generations. They have long been trusted to provide labor and birth care to women in their communities, especially in rural areas of Ethiopia.

MaNHEP maternal and newborn health training—and the Community Maternal and Newborn Health (CMNH) Family Meetings that the health workers ultimately conducted with women and their families—are based on the HBLSS program. This program emphasizes antenatal care and birth preparedness practices, illness recognition, and referral, where possible. It also emphasizes the elimination of potentially harmful practices, such as prelacteal feeding, putting oil or butter on the cord stump, and bathing the newborn before 24 hours. CMNH training uses pictorial presentation, storytelling, discussion, experience sharing, and demonstrations followed by practice using pictorial checklists called Take Action Cards. Training seeks to create a safe and welcoming learning environment where everyone is respected for their unique contributions (eg, trainers sit on the floor with participants; sitting in a circle; use of the local language to encourage participation).

Health workers were trained in a cascade that extended across 4 levels of trainees in order to reach women and their family caregivers in the community. The training cascade (Figure 1) began with maternal and newborn health consultants training federal and regional staff (master training of trainers), followed by 3 levels of training of trainers (supervisors and coordinators, health extension workers, and guide teams). In total, 91 health extension workers and 638 guide team members were trained. Pre- and posttraining evaluation procedures and performance test results have been previously described.[24]

Guide teams are composed of community health development agents, TBAs, wise women, and wise men who are consulted for problems related to mothers and newborns. Guide team members are selected because of their interest, experience, or current roles and responsibilities in the community, and their ability to teach and facilitate discussion. Guide team members commit to spend at least 4 to 6 hours weekly conducting CMNH meetings with pregnant women and their families. This work involves traveling within 3 to 4 villages.

Figure 1. Community Maternal and Newborn Health (CMNH) Training Cascade.

The figure shows a descending cascade of boxes connected by downward arrows:

- **CMNH Master Training of Trainers** - Federal and regional staff
- **CMNH Training of Trainers 1** - Supervisors and MCH Coordinators
- **CMNH Training of Trainers 2** - Health Extension Workers
- **CMNH Training of Trainers 3** - Guide Teams (Community Health Development Agents and Traditional Birth Attendants)
- **End User Training** - CMNH Family Meetings with Pregnant Women and Family Caregivers

CMNH training materials include a demonstration kit (newborn, placenta, uterus, and breast models; razor blade; 5% chlorine; cord tie; soap; waterproof placenta container; apron; cloths; and a cup, bowl, and spoon); a Take Action Card booklet; and a master list, guide team record, and trainers' manual.

This article examined the degree to which health worker skills and knowledge were retained 18 months after initial training (January 2011-June 2012) and identified sociodemographic factors associated with 18-month skills assessment performance.

METHODS

At the beginning of the project, a total of 732 individuals (94 health extension workers and 638 guide team members) were given CMNH training and received pre- and posttraining skills assessments. The respondents were distributed across 51 *kebeles* (Ethiopia's smallest administrative unit, with an approximate population of 2500-5000 each) in the 6 MaNHEP project *woredas* (third-level administrative divisions of Ethiopia that are managed by a local government and composed of a number of *kebeles*—a district). Of these, 75 health extension workers (78%) and 234 guide team members (37%) were involved in the 18-month skills assessment. Participants were randomly selected to participate. Over one-half of the guide team members were community health development agents (54%), while the remaining members were TBAs.

Pre-training and immediate posttraining test scores are provided elsewhere.[23] A performance assessment of health extension workers' and guide team members' (community health development agents and TBAs) skills was first conducted at baseline before training (pretest) and then re-administered immediately after training (posttraining posttest). As part of the MaNHEP 2012 data gathering at the

end of the project, a similar assessment was conducted 18 months after the initial training (18-month posttest).

Skills Checklist

The skills checklist is the principal assessment instrument developed based on the content of the training and contains the same steps as the pictorial Take Action Cards. There are 14 steps for Prevent Problems Before Baby Is Born (care during labor and birth) and 16 steps for Prevent Problems After Baby Is Born (care immediately after birth). A similar checklist was used for pretesting before training and posttraining posttesting. The 18-month posttest checklist incorporated additional demographic data, including the trainee's experience with management activities, attending the birth, referring clients, and volunteer-based activities.

Scoring Method

Scoring was conducted by maternal and newborn health specialists. Participants were asked to demonstrate the steps for Prevent Problems Before Baby Is Born and Prevent Problems After Baby Is Born. Each care step was scored either one (1) (correctly completed the step in full) or zero (0) (omitted or completed the step partially/incorrectly). Composite scores were computed by summing the score for each care step for a maximum possible score of 14 points for Prevent Problems Before Baby Is Born and 16 points for Prevent Problems After Baby Is Born.

Validity and Reliability of Observations

The maternal and newborn health specialists who conducted the skills assessment received both the initial maternal and newborn health training provided to the health workers, as well as a day-long training on how to conduct an 18-month

posttesting of health workers. The aims of this training were to develop a common understanding of the skills checklist and to establish interrater reliability of the skills assessment. The program, led by MaNHEP's maternal and newborn health consultants, included an in-depth discussion about what constitutes a full point for each step. Maternal and newborn health consultants co-scored assessments with the maternal and newborn health specialists until scoring was deemed consistent across testers.

Data Management and Analysis

Data were entered into a spreadsheet. These data were compared against the completed skills checklist results, cleaned, and exported to SPSS[25] and STATA[26] for further analysis. Simple frequencies for sociodemographic variables, average scores for each skill step, and composite scores for each topic were computed. Chi-square tests, independent *t* tests, and one-way analysis of variance (ANOVA) tests were used to assess regional variation and differences across health worker cadres. Two sample *t* tests were computed to compare the mean differences in posttraining and 18-month posttest scores. Finally, a linear regression model was fitted for 18-month performance on Prevent Problems Before Baby Is Born and Prevent Problems After Baby Is Born in order to identify sociodemographic characteristics associated with higher or lower 18-month posttest scores. The covariates in this analysis included age (continuous); education (continuous); marital status (dichotomous); experience (continuous); health worker type (categorical); number of births (continuous); experience with referrals (continuous); region (categorical); and district (categorical). Prior to analyses, dummy variables were created for health worker type and district so that comparisons could be made between each cadre/district versus all other cadres/districts combined (eg, TBAs compared to community health development agents/health extension workers).

RESULTS

Respondent Characteristics

Sociodemographic characteristics and information about trainees' experiences with maternal and newborn health service provision are provided in Table 1. There were significant differences in age and marital status across the 3 health worker cadres ($P < .001$). As expected, the health extension workers were younger and less likely to be married than community health development agents and TBAs. Similarly, health extension workers had more years of formal education on average (10.1 years) than community health development agents (4.3 years) and TBAs (0.4 years). Community health development agents in Amhara were older and more likely to be married, but less likely to be educated than community health development agents in Oromiya.

More than 60% of community health development agents (70%) and TBAs (65%) reported prior volunteer experience in the community involving various health-related issues; in contrast, more than 80% of health extension workers reported no prior involvement in volunteer activities. On average, community health development agents and TBAs had worked

as a volunteer for 4 years (SD, 5.3) and 8 years (SD, 10.0), respectively. Furthermore, a large proportion of community health development agents (67%) and health extension workers (68%) reported experience with managerial activities in the local government structure.

Nearly all health extension workers and TBAs (94% and 94%, respectively) had attended at least one birth since the posttraining posttest. Conversely, more than 60% of community health development agents had not attended any births. Significant variation was also observed in the number of births attended by TBAs (20.2 [SD, 17.9]) and health extension workers (10.9 [SD, 10.9]). Regional variation was also observed. Health extension workers and TBAs in the Amhara region were found to attend a significantly higher number of births as compared to health extension workers and TBAs in the Oromia region ($P = .001$).

More than half of the health extension workers (66%), community health development agents (56%), and TBAs (74%) reported experience with at least one client/patient referral since posttraining posttesting. Of these, most referrals were made for birth or related reasons (68% of health extension workers; 80% of community health development agents; 86% of TBAs). The average number of referrals made by the 3 cadres (health extension worker, community health development agent, and TBA) was 2.6, 1.6, and 3.2, respectively. The 2 regions showed comparable results, with the exception of TBAs in Amhara who had referred a significantly higher number of cases than TBAs in Oromiya.

Nearly one-third of each cadre of health workers reported managing at least one life-threatening maternal complication (health extension worker, 36%; community health development agents, 22%; TBAs, 34%). Similarly, 21% of health extension workers, 13% of community health development agents, and 29% of TBAs reported managing at least one life-threatening newborn condition (Table 1).

Posttraining and 18-Month Posttest Results

Prevent Problems Before Baby Is Born

Substantial knowledge retention was noted in 11 of 14 care steps and 13 of 14 care steps among health extension workers in the Amhara and Oromiya regions, respectively. Detailed results of posttraining and 18-month posttests can be found in Table 2 for the topic Prevent Problems Before Baby Is Born. All cadres scored more than 90% in both post training and 18-month posttests on "preparing a clean birth kit" and "drinking or eating light foods every hour."

All categories of health workers scored more than 85% in the 18-month posttest for "referral plan" and "woman and helpers wash hands before and during labor and use hand protection."

Regional variation was observed in the misoprostol step. In this step, health workers counsel families regarding the importance of storing misoprostol in the home or of knowing a birth attendant from whom misoprostol can be obtained when labor begins. For example, among all 3 cadres of health workers in the Amhara region, the 18-month posttest scores for "storing misoprostol in home or know birth attendant with it" were significantly lower compared to posttraining posttest

Table 1. Background Characteristics of Health Care Workers Who Took the 18-Month Posttest (June–July 2012)

Characteristics	Amhara			Oromiya			Total: Cadre Comparison				Regional Comparison		
	HEW (n = 36)	CHDA (n = 58)	TBA (n = 63)	HEW (n = 39)	CHDA (n = 68)	TBA (n = 45)	HEW (n = 75)	CHDA (n = 126)	TBA (n = 108)	P Value	HEW P value	CHDA P value	TBA P value
Age, mean (SD), y	25.3 (3.6)	40.6 (7.3)	43.2 (8.0)	23.8 (1.6)	35.5 (8.1)	43.1 (8.3)	24.5 (2.9)	37.8 (8.1)	43.2 (8.1)	<0.001	0.03	<0.001	0.93
Marital status, n (%)										<0.001	0.001	0.16	<0.001
Single (never married)	9 (25.0)	0 (0.0)	0 (0.0)	10 (38.5)	13 (19.4)	0 (0.0)	19 (30.6)	4 (3.2)	0 (0.0)				
Married	23 (63.9)	57 (98.3)	30 (47.6)	16 (61.5)	40 (59.7)	35 (83.3)	39 (62.9)	116 (92.8)	65 (61.9)				
Divorced/widowed	4 (11.1)	1 (1.7)	33 (52.4)	0 (0.0)	14 (20.9)	7916.7	5 (6.5)	5 (4.0)	40 (38.1)				
Years of schooling, mean (SD)	10.1 (0.3)	3.3 (3.2)	0.4 (1.4)	10.2 (0.5)	5.1 (3.4)	0.4 (1.1)	10.1 (0.4)	4.3 (3.4)	0.4 (1.3)	<0.001	0.42	0.003	0.72
Voluntary Engagement													
Prior involvement as a volunteer, before MaNHEP, n (%)	9 (25.0)	33 (56.9)	31 (49.2)	1 (3.8)	54 (80.6)	37 (88.1)	10 (16.1)	87 (69.6)	68 (64.8)	<0.001	<0.001	0.01	<0.001
Years worked as volunteer, mean (SD)	1.3 (2.4)	4.6 (6.7)	5.8 (9.1)	0.08 (0.4)	3.4 (3.5)	12 (10.3)	0.8 (1.9)	4 (5.3)	8.3 (10.0)	<0.001	0.005	0.22	0.002
Management role in government system, ever, n (%)	16 (44.4)	30 (51.7)	9 (14.3)	26 (100)	54 (80.6)	15 (35.7)	42 (67.7)	84 (67.2)	24 (22.9)	<0.001	<0.001	0.002	0.005
Births attended													
Any births since posttraining posttest, n (%)	32 (94.1)	16 (27.6)	61 (96.8)	24 (92.3)	31 (46.2)	38 (90.5)	54 (93.7)	47 (37.6)	99 (94.3)	<0.001	0.13	0.21	0.02
No. total births attended, mean (SD)	15.2 (12.5)	1.9 (4.7)	24.4 (20.4)	5.2 (4.0)	2.2 (4.5)	13.8 (10.8)	10.9 (10.9)	2.0 (4.6)	20.2 (17.9)	<0.001	<0.001	0.69	0.001
Any referrals made since posttraining posttest, n (%)													
Birth-related	15 (41.7)	27 (46.6)	41 (65.1)	12 (46.2)	31 (46.3)	25 (59.5)	27 (43.5)	56 (44.8)	66 (62.9)	0.16	0.07	0.83	0.41
Total (for any reason)	22 (62.9)	34 (58.6)	50 (79.4)	18 (69.2)	36 (53.7)	27 (64.3)	40 (65.6)	70 (56.0)	77 (73.7)	0.62	1.0	0.61	0.71
No. referrals made since posttraining posttest, mean (SD)													
Birth-related	0.8 (1.3)	1.0 (1.6)	2.7 (3.8)	0.9 (1.7)	0.9 (1.5)	1.3 (1.5)	0.9 (1.5)	1.0 (1.6)	2.1 (3.2)	<0.001	0.8	0.7	0.01
Total (for any reason)	2.6 (3.3)	2.0 (2.8)	4.1 (4.8)	2.6 (3.4)	1.3 (1.7)	1.8 (1.9)	2.6 (3.1)	1.6 (2.3)	3.2 (4.1)	0.001	1.0	0.1	0.001
Any life-threatening cases managed since posttraining posttest, n (%)													
Maternal	17 (47.2)	12 (20.7)	28 (44.4)	5 (19.2)	15 (22.4)	8 (19.0)	22 (35.5)	27 (21.6)	36 (34.3)	0.02	0.31	0.82	0.2
Newborn	8 (22.9)	4 (6.9)	18 (28.6)	5 (19.2)	12 (17.9)	12 (28.6)	13 (21.3)	16 (12.8)	30 (28.6)	0.03	0.58	0.1	0.72
No. life-threatening cases managed													
Maternal, mean (SD)	0.9 (1.2)	0.3 (0.6)	1.2 (1.9)	0.27 (0.6)	0.3 (0.9)	0.4 (1.0)	0.6 (1.1)	0.3 (0.7)	0.9 (1.6)	0.002	0.2	0.51	0.01
Newborn, mean (SD)	0.3 (0.6)	0.1 (1.3)	0.7 (1.5)	0.3 (0.7)	0.3 (0.8)	0.5 (0.9)	0.3 (0.7)	0.2 (0.6)	0.6 (1.3)	0.003	1.0	0.08	0.52

Abbreviations: CHDA, community health development agent; HEW, health extension worker; MaNHEP, Maternal and Newborn Health in Ethiopia Partnership; SD, standard deviation; TBA, traditional birth attendant.

Table 2. Comparison of Health Worker Posttraining Posttest (January 2011) and 18-Month Posttest Results (June–July 2012) for Prevent Problems Before Baby Is Born Among Only Health Workers, Assessed at Both Testing Periods (n = 306)

Percentage Who Correctly Demonstrated the Skill (%)	Amhara						Oromiya					
	HEW		CHDA		TBA		HEW		CHDA		TBA	
	Posttraining posttest	18-month posttest	Posttraining posttest	18-month posttest	Posttraining posttest	18-month posttest	Posttraining posttest	18-month posttest	Posttraining posttest	18-month posttest	Posttraining posttest	18-month posttest
Prevent Problems Before Baby Is Born	n = 36	n = 36	n = 58	n = 58	n = 63	n = 63	n = 39	n = 39	n = 65	n = 65	n = 45	n = 45
Plan for birth: clean birth kit	97	100	100	98	98	94	100	95	100	100	100	100
Misoprostol (Cytotec) stored in home, or know birth attendant with it	72	42[e]	79	24[f]	71	17[f]	54	74	86	74	60	58
Clean: woman, helpers, environment	97	86	97	81[e]	90	84	85	77	94	92	96	91
Referral plan (people, money, transport)	89	92	93	88	81	86	95	90	94	94	93	96
Call for helpers when labor begins	89	75	81	71	73	71	97	56[f]	92	72[e]	80	76
Drink or eat light foods every hour	97	100	100	90[e]	100	92[d]	95	95	95	97	98	100
Woman and helpers wash hands before and during labor and hand protection (clean latex gloves)	69	100[c]	91	91	76	92[a]	79	97[a]	86	94	80	96[a]
Change positions during labor: walk, sit, lie on side, rest	94	72[e]	91	69[f]	83	63[e]	92	95	92	83	93	93
Use safe birth practices: feel/look for baby's head before pushing	92	92	84	71	75	79	77	77	83	78	87	73
Use good pushing positions	75	72	86	45[f]	81	49[f]	72	74	82	74	84	80
Woman squat or pass urine before and after baby is born	81	78	97	69[f]	79	62[d]	74	95[b]	85	88	91	91
Do *not* give oxytocin before baby born	33	19	62	31[f]	52	27[e]	23	79[c]	58	51	36	58
Do *not* push on woman's belly	42	25	48	38	46	32	21	51[b]	43	55	47	58
Do *not* put anything in birth canal before or after baby is born	31	39	57	33[e]	30	29	23	38	32	37	18	40[a]
TOTAL	76	71	83	64[f]	74	63[f]	70	78[a]	80	79	76	79

Abbreviations: CHDA, community health development agent; HEW, health extension worker; TBA, traditional birth attendant.

The 18-month posttest result is significantly *higher* than the posttraining posttest results [a] P < .05, [b] P < .01, [c] P < .001.

The 18-month posttraining posttest result is significantly *lower* than the posttraining posttest results [d] P < .05, [e] P < .01, [f] P < .001.

scores ($P < .01$). In contrast, a significant difference was not noted in post training and 18-month posttest results for "storing misoprostol at home or know birth attendant with it" among health workers in Oromiya.

However, knowledge retention was low among community health development agents and TBAs in Amhara in 8 of 14 care steps. Most notably, statistically significant lower 18-month posttest scores—as compared to posttraining posttest scores—were noted ($P < .01$) for the steps, "store misoprostol at home or know birth attendant with it," "change position during labor," "use good pushing position," "squat and pass urine," "do *not* give oxytocin," and "do *not* put anything in the birth canal."

Prevent Problems After Baby Is Born

On average, health extension workers in both regions and community health development agents and TBAs in Oromiya retained the knowledge gained in CMNH training related to the prevention of problems after birth, while knowledge retention was less consistent among community health development agents and TBAs in the Amhara region (Table 2 and Table 3).

Detailed results of posttraining and 18-month posttests can be found in Table 3 for the topic Prevent Problems After Baby Is Born. Three skills were retained across all 3 cadres in both Amhara and Oromiya, including "wipe baby's face and dry baby as soon as baby is born," "wrap baby in a dry blanket," and "breastfeed within one hour."

Knowledge was retained among health extension workers in the Amhara region for all care elements and for 14 of 16 care steps among health extension worker in the Oromiya region. Of note, significantly higher 18-month posttest scores, compared to posttraining posttest scores, were observed among health extension worker in Amhara for "immediate breastfeeding" and "advise exclusive breastfeeding," and in Oromiya for "checking baby for good color," "*not* pulling on cord," and "rubbing the womb after the placenta is delivered" ($P < .05$).

Eighteen-month posttest scores were significantly lower than posttraining posttest scores among community health development agents and/or TBAs in the Amhara region among the care steps, "check baby for good color, breathing, and activity," "give misoprostol if a trained health worker and there is no second baby," and "safe delivery of placenta: Woman squats and passes urine," "safe delivery of placenta: Semisit," "do not pull on cord," "rub womb after placenta is delivered," "watch for danger signs," "advise woman/family on nutrition, rest, and cleanliness," "advise exclusive breastfeeding for at least 6 months," "good breastfeeding position. Feed every 2 to 3 hours," and "advise woman to rest with baby under bed net for at least 12 days."

In contrast, community health development agents and TBAs in Oromiya retained knowledge in all care steps, excluding "checking baby for good color" among community health development agents. Overall performance scores of community health development agents and TBAs in the Amhara region were noted to be lower compared to community health development agents and TBAs in the Oromiya region.

Factors Influencing Maternal and Newborn Health Training Test Results

Regression analysis results for Prevent Problems Before Baby Is Born revealed that health workers who had more years of education had significantly higher 18-month posttest scores compared to their health worker counterparts with less education ($P = .002$). Conversely, health workers as a whole who live in the Amhara region were significantly less likely to score as high as health workers who live in the Oromiya region ($P < .001$). The remaining independent variables (age, cadre type, marital status, experience attending births, number of births attended, and number of referrals) were not significant predictors of performance on Prevent Problem Before Baby Is Born.

The results for Prevent Problems After Baby Is Born revealed that being a community health development agent and being older were associated with lower 18-month posttest score ($P = .005$ and $P = .009$, respectively). Attending more births was also associated with lower 18-month posttest scores ($P = .001$). Being a TBA, experience with referral, and having more years of education were not significant predictors of performance on the topic Prevent Problems After Baby Is Born (Table 4).

DISCUSSION

Our results revealed that the majority of health workers retained the knowledge gained in maternal and newborn health training. In 18-month posttesting, substantial knowledge retention was noted in 12 of 14 care steps and 13 of 14 care steps of Prevent Problems Before Baby Is Born among health extension workers in the Amhara and Oromiya regions, respectively. Moreover, knowledge retention was also high for Prevent Problems After Baby Is Born among health extension workers in the Amhara (16 of 16 care steps) and Oromiya (14 of 16 care steps) regions. These findings complement prior work in other contexts such as Bangladesh, India, Liberia, and southern Ethiopia where the HBLSS training approach has been successful in transferring knowledge[21,22,27,28] and behavior change[29] among health workers, women, and family caregivers.

The results also highlighted areas for improvement across regions and cadres. Most notably, health workers scored lower on steps that used verbal cues. Select action steps, for example, were accomplished by reminding the family care team about what *not* to do during and after birth (eg, *do not* give oxytocin) rather than using a physical action to show the family what they should do (eg, rub the womb). These steps can be particularly difficult to remember to include in the CMNH meeting because they do not involve a physical action. This finding supports results from prior programmatic research that nonaction steps are the most challenging steps for health workers to remember in posttraining and 18-month posttests.[21] Development of novel strategies to improve knowledge transfer and retention of these low-scoring areas are important points for future intervention.

The findings demonstrate that regardless of sociodemographic characteristics, maternal and newborn health service experience, and involvement in voluntary activities, all types of cadres (health extension worker, TBA, and community health development agent) have the ability to

Table 3. Comparison of Health Worker Posttraining Posttest (January 2011) and 18-Month Posttest Results (June-July 2012) for Prevent Problems After Baby Is Born Among Only Health Workers, Assessed at Both Testing Periods (n = 306)

Percentage Who Correctly Demonstrated the Skill (%) Prevent Problems After Baby Is Born	Amhara HEW Posttraining posttest n = 36	Amhara HEW 18-month posttest n = 36	Amhara CHDA Posttraining posttest n = 58	Amhara CHDA 18-month posttest n = 58	Amhara TBA Posttraining posttest n = 63	Amhara TBA 18-month posttest n = 63	Oromiya HEW Posttraining posttest n = 39	Oromiya HEW 18-month posttest n = 39	Oromiya CHDA Posttraining posttest n = 65	Oromiya CHDA 18-month posttest n = 65	Oromiya TBA Posttraining posttest n = 45	Oromiya TBA 18-month posttest n = 45
Wipe baby's face and dry baby as soon as baby is born	100	100	100	98	97	94	95	100	100	95	98	100
Wrap all of baby in dry blanket	89	97	100	91	97	92	87	92	92	95	96	96
Check baby for good color, breathing, activity	44	50	71	17[f]	43	16[f]	49	74[b]	63	35[f]	60	58
Give misoprostol (Cytotec) if trained person and no second baby	97	94	98	72[f]	86	57[f]	85	90	75	95[c]	73	89
Tie and cut cord using clean cord practices	100	100	100	98	98	94	92	100	98	98	98	100
Safe delivery of placenta: woman squats and passes urine	83	83	88	47[f]	78	49[f]	90	92	85	86	76	80
Safe delivery of placenta: semi-sit	89	69	93	52[f]	87	67[d]	92	77[d]	83	77	73	80
Breastfeed within one hour	86	100[a]	100	98	92	94	92	97	86	98[b]	89	100[a]
Do *not* pull on cord	92	78	100	83[d]	94	79[d]	67	87[a]	91	78	93	82
Rubs womb after placenta is delivered	81	72	71	40[f]	59	60	64	92[c]	54	69	53	67
Safe disposal of placenta	97	100	100	98	89	100[b]	92	97	91	98	91	96
Watch for danger signs	89	89	79	60[d]	68	43[f]	95	79[d]	69	66	67	64
Advise woman/family on nutrition, rest, and cleanliness	100	97	100	93[d]	97	98	90	92	97	92	87	96
Advise exclusive breastfeeding for at least 6 months	72	92[a]	99	71[f]	78	65	82	92	91	91	76	84
Good breastfeeding position, feed every 2-3 hours	89	89	97	81[d]	79	70	79	77	66	68	76	67
Advise woman to rest with baby under bed net for at least 12 days	94	92	86	66[d]	87	62[f]	82	72	72	62	67	53
Total	88	88	94	73[d]	83	71[f]	84	88[a]	82	82	80	82

Abbreviations: CHDA, community health development agent; HEW, health extension worker; TBA, traditional birth attendant.

The 18-month posttest result is significantly *higher* than the posttraining posttest results [a] P < .05; [b] P < .01; [c] P < .001.

The 18-month posttest result is significantly *lower* than the posttraining posttest results [d] P < .05; [e] P < .01; [f] P < .001.

Table 4. Sociodemographic and Professional Experience Characteristics Associated with 18-Month Posttest Results for Prevent Problems Before and After Baby Is Born

Variable	Prevent Problem Before Baby Is Born			Prevent Problem After Baby Is Born		
	Parameter Estimates (SE)	t Statistic	P Value	Parameter Estimates (SE)	t Statistics	P Value
Demography						
Age	−0.001 (0.001)	−1.02	0.310	−0.003 (0.001)	−2.83	0.005
Education	0.012 (0.004)	3.13	0.002	0.002 (0.003)	0.81	0.417
Marital Status	0.039 (0.022)	1.82	0.070	0.021 (0.017)	1.25	0.212
Cadre Type						
CHDA	0.022 (0.034)	0.64	0.520	−0.07 (0.027)	−2.63	0.009
TBA	0.067 (0.045)	1.51	0.133	−0.05 (0.035)	−1.42	0.155
MNH Service						
Experience	0.002 (0.001)	1.37	0.172	0.002 (0.001)	1.94	0.053
Births	0.000 (0.000)	−1.53	0.126	−0.001 (0.000)	−3.52	0.001
Referral	0.006 (0.004)	1.43	0.155	0.001 (0.003)	0.31	0.753
Region						
Amhara	−0.119 (0.034)	−3.53	<.001	0.019 (0.027)	0.72	0.471
Woreda						
Degem	−0.118 (0.033)	−3.63	<.001	−0.037 (0.026)	−1.44	0.151
Kuyu	0.142 (0.033)	4.32	<.001	0.097 (0.026)	3.74	<.001
Mecha	−0.004 (0.029)	−0.14	0.887	−0.019 (0.023)	−0.83	0.410
South Achefer	0.013 (0.032)	0.41	0.680	−0.162 (0.025)	−6.38	<.001

Note: Health extension workers and 2 *woredas* (third-level administrative divisions of Ethiopia managed by local government and composed of *kebeles* [district]) were omitted from analyses due to collinearity.
Abbreviations: CHDA, community health development agent; HEW, health extension worker; MNH, maternal and newborn health; SE, standard error; TBA, traditional birth attendant.

learn and practice lifesaving maternal and newborn health skills. The 3 health worker cadres varied significantly by key sociodemographic characteristics. For example, health workers had varied levels of experience, and significant differences were noted by age and marital status across the 3 health worker cadres. Furthermore, more than 90% of health extension workers and TBAs reported attending at least one birth since the posttraining posttest, and the majority of community health development agents and TBAs reported engagement in voluntary activities.

Regional variations were also observed related to birth attendance and referrals. For example, health extension workers and TBAs in Amhara attended a significantly higher number of births compared to health extension workers and TBAs in Oromiya. Moreover, TBAs in the Amhara region referred a significantly higher number of cases than did TBAs in the Oromiya region. These results complement findings that significantly more women in Amhara received birth care from a skilled provider or health extension worker compared to women in Oromiya.[30]

Regional and cadre differences were also observed in the retention of knowledge and skills for the prevention of problems before and after birth. For example, the average 18-month posttest score for misoprostol storage at home was significantly lower among all cadres in the Amhara as compared to cadres in Oromiya. This finding may be accounted for by regional differences in misoprostol distribution and utilization.[31] Specifically, Oromiya permits health extension workers, as well as well-trained TBAs and community health development agents, to keep and provide misoprostol. Amhara permits only health extension workers to keep and provide it.

Overall, the demonstrated knowledge and skills of the care steps was less consistent among community health development agents and TBAs in Amhara compared to community health development agents and TBAs in Oromiya. This finding is surprising given the level of engagement in CMNH family meetings among community health development agents and TBAs in the Amhara region (93% and 82%, respectively) compared to community health development agents and TBAs in the Oromiya region (43% and 49%, respectively).[32] Far fewer community health development agents and TBAs in Amhara, however, were members of MaNHEP quality improvement teams than were community health development agents and TBAs in Oromiya (Community Health Development Agent 28% vs 46%, TBA 10% vs 51%, respectively).[31] Quality improvement teams composed of community leaders and health workers meet regularly to discuss practical community-based solutions to maternal and newborn health problems. It is possible that engagement in these teams reinforces CMNH content. Future work is needed to better discern the possible reasons for these conflicting patterns (eg, disparities in level of support following training, differences in performance scoring practices between regions).

Regression analyses demonstrated that having more years of education is associated with significantly higher 18-month posttest scores for Prevent Problems Before Baby Is Born.

Other variables such as age, cadre type, marital status, birth experience, and number of referrals had no effect on 18-month posttest scores. This finding suggests that, regardless of prior maternal and newborn health service experience and sociodemographic characteristics, community-based health workers from all cadres are able to learn and provide maternal and newborn health services.

For the topic of Prevent Problems After Baby Is Born, we noted that health workers who attended more births and who were older scored lower compared to younger health workers and those who attended fewer births. While these findings were surprising, they may simply reflect the influence of Traditional birth attendants in the analysis. Traditional birth attendents are older, on average, than other cadres and report the highest overall number of attended births, yet TBAs scored as low or lower on the topic than did community health development agents and health extension workers.

The maternal and newborn health training program has important implications for countries such as Ethiopia where the majority of the population lives in rural areas and has low literacy. The training program emphasizes building the capacity of health workers, who are closest to pregnant women and their families, and demonstrates an effective way to deliver maternal and newborn health education and services at the community level. In addition, the CMNH program that the health workers provide utilizes pictorial presentation, storytelling, discussion, experience sharing and demonstrations, thereby eliminating the barrier that low literacy can at times pose. Furthermore, the training cascade approach enables health workers to continuously practice the steps involved in maternal and newborn health care and increase their confidence. The training also provides an opportunity to build team spirit among diverse health worker groups who may not otherwise interact.

Some limitations are inherent to this type of performance assessment study. First, it is possible that different maternal and newborn health specialists scored the posttraining and 18-month posttests for individual trainees, making a comparability of scores less reliable. We minimized this potential bias by providing training to maternal and newborn health specialists, using co-scoring with consultants until scoring was consistent, and by using a similar checklist at pretesting before training, posttraining posttesting, and 18-month posttesting. Another limitation is that 3 care steps in Prevention Problems Before Baby Is Born and 5 steps in Prevention Problems After Baby Is Born involved more than a single action. For example, "wipe baby's face and dry baby as soon as baby is born" involves 2 separate steps, although it was worth only one point in testing. Trainees were only given credit for the step if they completed all substeps, which may have resulted in lower performance scores overall. In the future, care steps with more than one action should be divided into multiple steps so that respondents can receive credit for the skills they have retained.

CONCLUSION

Results demonstrated an overall strong retention of knowledge and skills. Although retention levels differ, less educated cadres and volunteers have acquired the knowledge and skills to provide a package of maternal and newborn health care to the community. Furthermore, intercadre variations in retained skills were also observed, largely reflecting the extent to which members of each cadre are directly involved in the actual provision of maternal and newborn health care, especially during the critical birth-to-48-hours period, and in their role of CMNH training to the community. Refresher training, mentoring, increased involvement in CMNH family meetings, and a development of strategies to improve knowledge retention of low-performing steps are recommended.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

REFERENCES

1. Hill K, Thomas K, AbouZahr C, et al. Estimates of maternal mortality worldwide between 1990 and 2005: an assessment of available data. *Lancet*. 2007;370(9595):1311-1319.

2. Central Statistical Agency [Ethiopia] & ICF International. *Ethiopia Demographic and Health Survey 2011*. Addis Ababa, Ethiopia: Central Statistical Agency and ICF International; 2012.

3. Darmstadt GL, Bhutta ZA, Cousens S, Adam T, Walker N, de Bernis L. Evidence-based, cost-effective interventions: how many newborn babies can we save? *Lancet*. 2005;365:977-986. Retrieved from http://www.thelancet.com/series/neonatal-survival.

4. Thaddeus S, Maine D. Too far to walk: Maternal mortality in context. *Soc Sci Med*. 1994;38(8):1091-1110.

5. Byrne A, Morgan A. How the integration of traditional birth attendants with formal health systems can increase skilled birth attendance. *Int J Gynaecol Obstet*. 2011; 115(2):127-134.

6. World Health Organization. *WHO Recommendations: Optimizing Health Worker Roles to Improve Access to Key Maternal and Newborn Health Interventions Through Task Shifting*. Geneva, Switzerland: World Health Organization; 2012.

7. Bhutta ZA, Soofi S, Cousens S, et al, Improvement of perinatal and newborn care in rural Pakistan through community-based strategies: A cluster-randomized effectiveness trial. *Lancet*. 2011;377:403-412.

8. Miller PC, Rashida G, Tasneem Z, Haque Mu. The effect of traditional birth attendant training on maternal and neonatal care. *Int J of Gynaecol Obstet*. 2012;117(2):148-152.

9. Darmstadt GL, Lee AC, Cousens S, et al, 60 million non-facility births: Who can deliver in community settings to reduce intrapartum-related deaths? *Int J Gynaecol Obstet*. 2009;107(Suppl 1):S89-112. doi:10.1016/j.ijgo.2009.07.010.

10. Gill CJ, Phiri-Mazala G, Guerina NG, et al. Effect of training traditional birth attendants on neonatal mortality (Lufwanyama Neonatal Survival Project): Randomized controlled study. *BMJ*. 2011;3(342):d346. doi: 10.1136/bmj/d346

11. Rowe KA, Onikpo F, Lama M, et al, A multifaceted intervention to improve health worker adherence to integrated management of childhood illness guidelines in Benin. *Am J of Public Health*. 2009;99(5):837-846.

12. Sibley LM, Sipe TA, Barry D. Traditional birth attendant training for improving health behaviours and pregnancy outcomes. *Cochrane Database of Syst Rev*. 2012; 15(8):CD005460. doi: 10.1002/14651858.CD005460.pub3.

13. Gogia S, Ramji S, Gupta P, et al. Community based newborn care: a systematic review and meta-analysis of evidence: UNICEF-PHFI series on newborn and child health, India. *Indian Pediatr*. 2011;48(7):537-546.

14. Lewin S, Munabi-Babigumira S, Glenton C, et al. Lay health workers in primary and community health care for maternal and child health and the management of infectious diseases. *Cochrane Database Syst Rev*. 2010;17(3):CD004015. doi: 10.1002/14651858.CD004015.pub3

15. Carlo WA, Goudar SS, Jehan I, et al. Newborn-care training and perinatal mortality in developing countries. *N Engl J Med*. 2010;362(7):614-623.

16. Prata N, Mbaruku G, Campbell M, Potts M, Vahidnia F. Controlling postpartum hemorrhage after home births in Tanzania. *Int J of Gynaecol Obstet*. 2005;90(1):51-55.

17. Baqui AH, Arifeen SE, Rosen HE, et al. Community-based validation of assessment of newborn illnesses by trained community health workers in Sylhet district of Bangladesh. *Trop Med Int Health*. 2009;14(12):1448-1456. doi:10.1111/j.1365-3156.2009.02397.x.

18. Bang AT, Reddy HM, Deshmukh MD, Baitule SB, Bang RA. Neonatal and infant mortality in the ten Years (1993 to 2003) of the Gadchiroli field trial: Effect of home-based neonatal care. *J Perinatol*. 2005;25(S1):S92-S107.

19. Buffington ST, Sibley LM, Beck D, Armbruster D. *Home Based Lifesaving Skills* (2nd ed). Silver Spring, MD: American College of Nurse-Midwives; 2010.

20. Nelson BD, Ahn R, Fehling M, et al. Evaluation of a novel training package among frontline maternal, newborn, and child health workers in South Sudan. *Int J of Gynaecol Obstet*. 2012;119(2):130-135.

21. Dynes M, Rahman A, Beck D, et al. Home-based life saving skills in Matlab, Bangladesh: A process evaluation of a community-based maternal child health programme. *Midwifery*. 2011;27(1):15-22.

22. Lori JR, Majszak CM, Martyn KK. Home-based life-saving skills in Liberia: Acquisition and retention of skills and knowledge. *J Midwifery Womens Health*. 2010;55(4):370-377.

23. Federal Ministry of Health of Ethiopia. Health Service Extension Program Implementation Guideline. January 2005.

24. Dynes, M, Buffington S, Carpenter M, et al. Strengthening maternal and newborn health in rural Ethiopia: Early results from frontline health worker community maternal and newborn health training. *Midwifery*. 2013;29:251-259.

25. IBM Corp. *IBM SPSS Statistics for Windows*, Version 20.0. Armonk, NY: IBM Corp;2011.

26. StataCorp. *Stata Statistical Software: Release 11*. College Station, TX: StataCorp LP;2009.

27. Fullerton JT, Killian R, Gass PM. Outcomes of a community- and home-based intervention for safe motherhood and newborn care. *Health Care Women Int*. 2005;26(7):561-576.

28. Sibley L, Buffington ST, Tedessa L Sr, McNatt K. Home-based life saving skills in Ethiopia: An update on the second phase of field testing. *J Midwifery Womens Health*. 2006;51(4):284-291.

29. Lori JR, Amable EE, Mertz SG, Moriarty K. Behavior change following implementation of home-based life-saving skills in Liberia, West Africa. *J Midwifery Womens Health*. 2012;57(5):495-501.

30. Barry D, Frew AH, Mohammed H, Desta BF, Tadesse L, Aklilu Y, et al. The effect of Community Maternal and Newborn Health (CMNH) Family Meetings on skilled birth attendance and quality and completeness of care received by mothers and newborns in rural Ethiopia. *J Midwifery Womens Health*. 2014;59:S44-S54.

31. Sibley LM, Spangler SA, Barry D, Tesfaye S, Desta BF, Gobezayehu AG. A regional comparison of distribution strategies and women's awareness, receipt, and use of misoprostol to prevent postpartum hemorrhage in rural Amhara and Oromiya Regions of Ethiopia. *J Midwifery Womens Health*. 2014;59:S73-S82.

32. Sibley, LM, Abebe, ST, Desta, BF, et al. Improving maternal and newborn health care delivery in rural Amhara and Oromiya regions of Ethiopia through the Maternal and Newborn Health in Ethiopia Partnership. *J Midwifery Womens Health*. 2014;59:S6-S20.