International Journal of Africa Nursing Sciences 20 (2024) 100729

Contents lists available at ScienceDirect

International Journal of Africa Nursing Sciences

journal homepage: www.elsevier.com/locate/ijans

The effect of emergency obstetric and newborn care training interventions on knowledge and skills of midwifery students prior to graduation in Kenya: A quasi-experimental study using a non-randomised controlled study design

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ARTICLE INFO

Keywords:
Emergency obstetrics and newborn care
Knowledge and skills
Midwifery
Pre-service
Students
Kenya

ABSTRACT

Introduction: Improving access to emergency obstetric and newborn care (EmONC) improves maternal and newborn health. However, there is evidence that the pre-service midwifery training curriculum is deficient in developing countries.

Purpose: This study measured the effectiveness of pre-service Emergency obstetric care training intervention package on the knowledge and skills of final year midwifery students in Kenya.

Methods: The study was a quasi-experimental controlled trial (ISRCTN 74563398) with one control and two intervention arms (full and partial), involving 12 Kenya Medical Training Colleges (KMTCs) and 381 final year midwifery students. Intervention arms' KMTCs received EmONC skills training equipment, training of lecturers on teaching methods, EmONC and clinical supervision skills, (and 12 months of mentoring for full intervention arm). Control arm KMTCs had no intervention. Students' knowledge and practical skills scores 12 months after the bundle of interventions were analysed using mixed effects linear models.

Results: A statistically significant difference was detected between the study arms for the practical skills test ($p < 0.001$) but not for the knowledge test ($p = 0.23$). The odds of achieving scores of 80 % or higher in the knowledge test was significantly higher in the full intervention group A compared to the control group OR 3.2 (1.1 – 9.8), $p < 0.05$. The scores in the skills tests were significantly higher in the intervention groups A and B compared to the control group 14.5 (4.2 – 24.9), $p < 0.001$ and 24.9 (14.5–35.2) respectively.

Conclusion: The pre-service EmONC intervention package was effective in improving the knowledge and skills of final year midwifery students.

1. Introduction

Every day, 800 women die from complications relating to pregnancy and childbirth; 7,000 newborn babies die and another 5,000 are stillborn (UNICEF & World Health Organization, 2024; World Health Organization, 2023b). Most of these maternal deaths (99 %), newborn deaths (77 %) and stillbirths (98 %) occurred in low- and middle-income countries (Blencowe et al., 2016; UN Inter-agency Group for Child Mortality Estimation (UN-IGME), 2019; World Health Organization, 2023b). Sub-Saharan Africa (545) alone accounted for approximately 70 percent of global maternal deaths in 2020. The majority of these deaths occurred around the time of childbirth (Chou et al., 2015). Kenya, a middle-income country in sub-Saharan Africa, continues to experience a high burden of maternal and newborn deaths, with WHO statistics estimating a maternal mortality ratio (MMR) of 530/100,000 live births in 2020 (World Health Organization, 2023b) and a neonatal mortality rate of 21/1,000 live births in 2019 (UNICEF, 2020). These mortality rates are beyond the sustainable development goal (SDG)

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https://doi.org/10.1016/j.ijans.2024.100729
Received 27 October 2023; Received in revised form 23 May 2024; Accepted 30 May 2024
Available online 31 May 2024

targets of less than 140/100,000 live births for maternal mortality (for Kenya) and 12/1,000 live births for neonatal mortality by 2030 (United Nations, 2015).

Improving access to family planning, emergency obstetric and newborn care (EmONC) and skilled attendance at birth, are key strategies for improving maternal and newborn health, and preventing 83 % of all maternal deaths, stillbirths and neonatal deaths (ten Hoope-Bender et al., 2014). These strategies have been prioritised in the global Ending Preventable Maternal Mortality and Every Newborn Action Plan (World Health Organization, 2023a) and Kenya Health Sector Strategic Plan (KHSSP) July 2018–June 2023 (Ministry of Health, 2020). Globally, the proportion of births attended by a skilled health personnel (SHP) has increased from 61 % to 86 % in the last two decades although only 70 per cent of births are attended by a SHP in sub-Saharan Africa, indicating regional discrepancies in the coverage of skilled birth attendance (UNICEF, 2022). If current coverage of births by SHP stays the same, UNICEF estimates that approximately 141 million births in sub-Saharan Africa will occur without the assistance of SHP between 2022 and 2030. This calls for more resources to increase intervention coverage levels and provide skilled care to women and their newborns during childbirth. Although there is increased coverage of maternal and newborn health services, quality of care remains the key challenge to achieving the maternal and newborn health SDG targets (Chou et al., 2019). This calls for investments in quality pre-service midwifery education and continuous professional development for in-service educators/faculty, adequate supplies and equipment.

In Kenya, the proportion of births attended by SHP improved from 41 % in 2003 to 89 % in 2022, although other studies have shown that health workers lack the knowledge and skills to provide good quality care (Harvey et al., 2007; KNBS and ICF, 2023). The first Kenya confidential enquiry into maternal deaths (CEMD) report (2017) showed that sub-standard care was identified in 9 out of 10 maternal deaths with health workforce factors including inadequate clinical skills (emergency obstetrics and newborn care skills), inadequate monitoring and delay in starting treatment accounting for 75 % of the maternal deaths (MOH (Kenya), 2017).

Midwifery is the cornerstone for improving quality of maternal and newborn health and health outcomes (World Health Organization, 2023a). Nurses and midwives are the main frontline skilled health personnel providing maternity care services globally. When educated, trained and regulated to national and international standards, midwives can provide 90 % of the needed essential care for women and newborns (United Nations Population Fund et al., 2021). Investing in midwifery education through legislation, regulation and licensing of midwives ensures the delivery of high-quality care and therefore the protection of women's health, representing a "best buy" in primary health care. The State of the World Midwifery 2021 report estimated that the world's sexual, reproductive, maternal, newborn and adolescent health (SRMNAH) workforce could meet 75 % of the world's need for essential SRMNAH care with African and Eastern Mediterranean WHO regions meeting the lowest need. Further the report estimates that even though there are shortages of all types of SRMNAH workers, the largest shortage (900,000) is of midwives and the wider midwifery workforce (World Health Organization et al., 2021). As a result, investment in a responsive health system and its health workforce is needed to ensure effective coverage, i.e., women can obtain the care they want and need in relation to SRMNH services, that is available, accessible, acceptable and of high quality.

As skilled health personnel, midwives working in an enabling environment should perform (as part of a team) all signal functions of emergency maternal and newborn care (basic and comprehensive emergency obstetric and newborn care) to optimize women and their newborn's health and well-being (World Health Organization, 2018). The seven basic emergency obstetrics and newborn care (EmONC) signal functions are: (1) antibiotics to prevent puerperal infection; (2) anticonvulsants for treatment of eclampsia and pre-eclampsia; (3) uterotonic drugs (e.g. oxytoxics) administered for postpartum haemorrhage; (4) manual removal of the placenta; (5) assisted or instrumental vaginal delivery; (6) removal of retained products of conception; and (7) neonatal resuscitation. The comprehensive EmONC signal functions comprise of the seven basic functions plus surgery (caesarean section) and blood transfusion (WHO et al., 2009). International Confederation of Midwives (ICM) recommends that midwifery educators should structure curriculum and develop learning activities that enable midwifery graduates to learn the knowledge and develop skills and behaviours – competencies that promote the role of the midwife to assess, diagnose, act, intervene, consult and refer as necessary, including providing EmONC interventions. These competencies include the general competencies that apply to all aspects of a midwife's practice, and competencies that are specific to care during pre-pregnancy, antenatal, labour, birth and the postnatal period (International Confederation of Midwives, 2019). Evidence suggests that pre-service training curricula may be deficient in low- and middle- income countries (Adegoke et al., 2013). Skills-and-drills competency-based training in skilled birth attendance and EmONC is an approach that is successful in improving knowledge and skills, both for trained health care professionals, and at pre-service level, for midwifery and medical students (Ameh & van den Broek, 2015). Despite this evidence, few studies have formally evaluated the impact of EmONC training interventions at pre-service (undergraduate) level, prior to graduation (Fan et al., 2015; Kerdijk et al., 2013; Succar et al., 2017; Wu et al., 2014). Previous studies have predominantly focused on the training of medical and nursing students in high income settings (Fan et al., 2015; Kerdijk et al., 2013; Succar et al., 2017; Wu et al., 2014) with limited evidence in low resource settings (Homaifar et al., 2013). The benefit of competency-based training, including improved knowledge and skill outcomes and clinical practice behaviours, has been clearly demonstrated (Fan et al., 2015; Frank et al., 2009; Homaifar et al., 2013; Kerdijk et al., 2013; Pandit et al., 2019; Saud & Chen, 2018; Succar et al., 2017; Wu et al., 2014). However, a lack of robust methodologies and small sample sizes limit the generalisation of the results.

To date, there are no known controlled trials of EmONC enhanced pre-service training curriculum focused with primary outcome of change in midwifery students' knowledge and skills compared to the standard curriculum. The objective of this Pre-service EmONC Training Intervention study was to measure the effectiveness of a pre-service EmONC training intervention package on the knowledge and skills of their final year midwifery students.

2. Methods

2.1. Study design

A quasi-experimental study, involving a multicentre, non-randomised, cluster-controlled design was used. Our hypothesis was that the intervention was more effective than the standard training curriculum in a large sample of student population from multiple, geographically dispersed sites.

Two intervention arms and one control arm were used to evaluate the effectiveness of an EmONC training intervention package for midwifery lecturers on the knowledge and skills of final year midwifery students in EmONC skills, prior to graduation.

All nursing educators in the colleges teach nursing and midwifery modules. In this study, nursing educators who participated in the teaching, clinical supervision and assessment of midwifery modules were included. Those who participated in teaching non-midwifery modules were excluded.

2.2. Study setting

This study was conducted in the KMTCs which are responsible for educating over 80 % of hospital healthcare workers including nurses and

midwives from 71 campuses nationwide. In 2018, during the intervention period, a total of 36 KMTCs offering nursing and midwifery training with a graduation cohort of students were available for selection. The institution has a student population of over 41,000; 2,200 members of staff and more than 12,000 graduates every year (Kenya Medical Training College, 2020). Each KMTC had approximately 60 final year midwifery students.

2.3. Pre-service EmONC training interventions

The pre-service competency-based EmONC training intervention package had four components: (a) EmONC training for midwifery lecturers using the Liverpool School of Tropical Medicine (LSTM) 5-day EmONC course (Ameh & van den Broek, 2015), (b) Nursing/midwifery lecturers were trained to use evidence based EmONC training methods and content. Active and participatory methods used to train and deliver the content were: short lectures, simulation-based education using low-fidelity mannequins and equipment, role plays, plenary/small group discussions, videos, scenarios and skill drills. The content covered is summarised in the table below (Table 1) (c) Supply of EmONC training equipment for skills laboratories and technical support to set-up and use the skills laboratories, and (d) Mentorship: 3-monthly visits to supported KMTCs to support the use of evidence based EmONC training methods and content for 12 months.

The phases of the project included joint review of the national EmONC guidelines with the Ministry of Health, assessment of capacity of pre-service institutions, procurement processes for the EmONC equipment and supply to the colleges. Due to the bureaucratic nature of the Ministry of Health-led projects, the early phases of the project required more time as they involved multiple stakeholders led by the Ministry of Health (Fig. 1).

Due to funding limitations, not all KMTCs received all the interventions. Of the 25 KMTCs in the intervention arms, 14 received all the interventions (Group A, full intervention) whilst 11 only received components a, b and c (they did not receive the mentoring – partial intervention) (Group B). The 11 KMTCs in the control arm (Group C) received none of the EmONC training interventions (Fig. 2). Intervention colleges received the EmONC training and support between 2014 and 2017, while the control colleges received no interventions during the same period. Before selecting KMTCs for inclusion in the trial, each KMTC was screened to determine the availability of a final year cohort of students in 2018 who could be used to assess the potential impact of the EmONC interventions provided to their lecturers.

Table 1
EmONC training content covered for midwifery educators.

Days	Topics covered
1	Communication; respectful maternity care; infection prevention and control; normal pregnancy; antenatal care (ANC) – Booking ANC, Obstetric Examination, Rapid ANC Tests and Documentation in MCH booklet
2	Preparation for Delivery; vaginal examination in Labour; Normal Delivery & Immediate Care; Newborn Examination; Maternal Resuscitation – Airway Management, cardio-pulmonary resuscitation (CPR), Blood Transfusion, Venous Cut- Down; Newborn Resuscitation; Managing Shock and the Unconscious patient
3	Active Management of 3rd Stage; Obstetric Hemorrhage; Severe pre-eclampsia/eclampsia; Neonatal Sepsis; Sepsis &Malaria in pregnancy; Prevention of mother-to-child transmission of HIV (PMTCT); Female Genital Mutilation; Preventing Obstructed Labour (Partograph Use)
4	Assisted Vaginal Delivery; Shoulder Dystocia; Breech birth; Cord Prolapse; Twin Delivery; Other obstetric emergencies; Surgical Skills – Manual Removal of Placenta, Pre-operative Caesarean Section (CS): Indications and consent (+antibiotic use), Difficulties at CS + peri op care, Perineal Repair
5	Obstetric Fistula: Prevention of Fistula; Recognition, early Management & Referral; Post-abortion Care (PAC): Manual Vacuum Aspiration: Procedure; PAC: Diagnosis and pre-procedure assessment; Assessment and treatment of Complications and care of equipment; PAC: Components of PAC; Postnatal Care of Mother & Baby, Routine Care of the Newborn; Puerperal Sepsis; Newborn Drills: Danger signs, Postnatal; Special Cases and Newborn Sepsis

After excluding KMTCs without final midwifery cohorts, the colleges were placed into the three arms, based on the predefined study characteristics (see intervention and control groups section above), this formed the sampling frame for each study arm. Four KMTCs were randomly selected from each of the three-study arm sampling frames to determine clusters included in the study.

2.4. Sample size calculation

The unit of analysis was a cluster, defined as one KMTC. The numbers of clusters of size 60 that would be needed to detect a range of differences for inter cluster correlation (ICCs) ranging in value between 0.1 and 0.3 were calculated using a formula provided by Donner and Klar and the standard deviation of responses was assumed to be 10 % (Donner & Klar, 2000). A sample size of four Colleges per arm was selected; this would give 90 % power to detect a difference of 10 % for an ICC at 0.1. Study sites were not randomly allocated to receive the intervention, however, of the KMTCs in each arm of the study, the four included sites were randomly selected. The research team were blinded to the study arm allocation of each KMTC during the data collection process. The study KMTCs included a mix of rural and urban settings and were randomly selected from all those eligible in each arm of the study.

2.5. Study participant recruitment and consent

All participants in this trial were final year KMTC midwifery students. This year group was selected as they had completed all their midwifery clinical placements and were preparing for their final exams. Students were randomly selected from all those available in the KMTC on the day of data collection, by drawing lots.

Participation was entirely voluntary for each college and eligible student. Consent was obtained at both institution and individual participant levels. Institutional consent was obtained from the KMTC Principal, four weeks before data collection. Participants received the study information sheet one week before the data collection and informed consent was obtained on the day of assessment. Before the start of each knowledge and skills assessment, the participants were asked if they had read the information sheet and were given an opportunity to ask any questions they may have had. They were then asked to indicate their willingness to participate and sign two copies of the consent form (one for the participant and one for the study records). At registration prior to the assessment, each study participant was given a unique identification number that consisted of the institutional code and the participant number. This unique identification number was used on both knowledge and skills assessment sheets to ensure participant anonymity.

2.6. Data collection

Study data was collected in May 2018. Data collection was performed by three research teams, with allocation of data collection sites based on geographical distribution of the institutions and region of residence of Kenya research team members. The teams were led by Kenya and Liverpool based researchers experienced in organising and coordinating LSTM EmONC courses, supported by an administrative assistant and eight assessors, who were Kenya based EmONC master trainers. All teams received a two-day training on the study protocol prior to data collection by FD and HA. The teams collected data from KMTCs included from any of the three groups within regions allocated to that team. The data collectors were blinded to the study arm allocation of each cluster and were assigned to KMTCs in a region other than the region they were resident in.

The data collection was conducted in the KMTCs. Midwifery lecturers in KMTCs were not involved in data collection and apart from initial introductions were excluded from the data collection process.

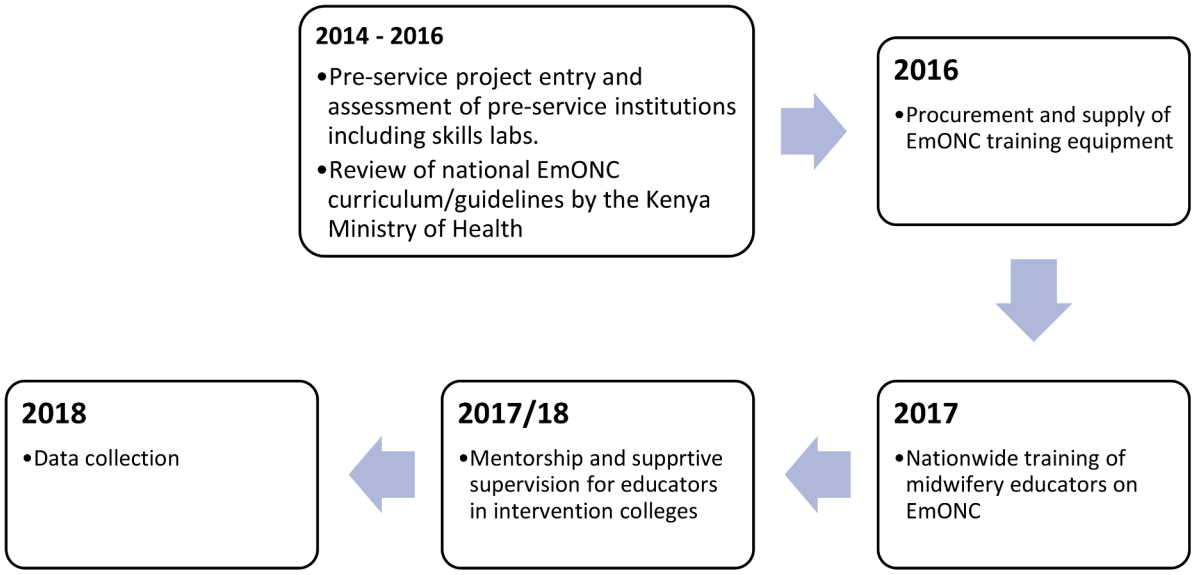

Fig. 1. Summary of project and study milestones.

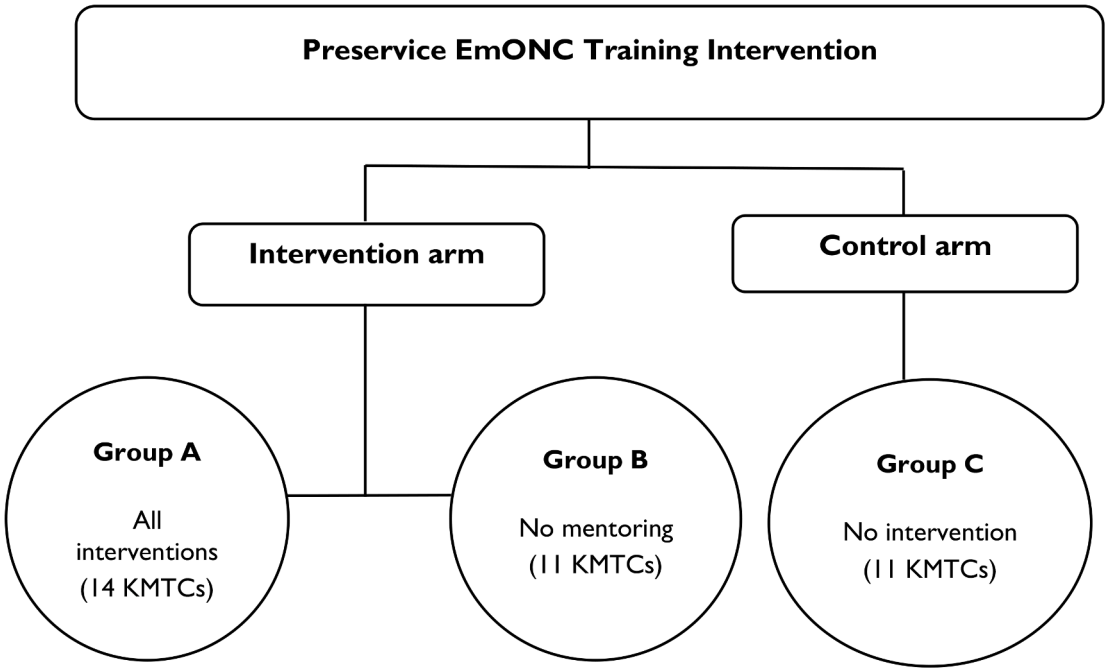

Fig. 2. Summary study design.

2.7. Assessments

The assessment process incorporated two types of testing, a knowledge test with 40 true/false questions; and four Objective Structured Clinical Examinations (OSCE) stations using obstetric and newborn models to assess practical skills – maternal resuscitation, shoulder dystocia, breech delivery and newborn resuscitation using specific EmONC training guidelines skills checklists. The knowledge evaluation lasted 30 min. Participants were then divided into 4 groups (each with 6 – 8 students) and rotated round 4 'stations' lasting about 20 min each. Stations consisted of the four practical skills tests with each student lasting about 5 min per skill. Each student was assessed in all the four practical OSCE skills at each of the four OSCE skill stations. Each skill assessment was completed by one assessor (who were all experienced master EmONC trainers) using a predetermined OSCE checklist. The checklists used were developed and reviewed by the LSTM EmONC trainers and experts based on key aspects of the EmONC training course by Liverpool School of Tropical Medicine (Ameh & van den Broek, 2015).

The maximum score in the knowledge test was 40 while the maximum score in the practical skills test was 80. Percentage scores were calculated for both assessments. Data collection at each cluster lasted half a day and all sites were completed in one week. Non personal feedback was provided to all students at the end of the last skill assessment by the assessors.

Within 3 months of data collection, all final year students and their lecturers in the control sites were trained in EmONC.

2.8. Data management

All data was managed in accordance with the LSTM internal data management policy and protocols. Knowledge and skills scores were calculated by one of the assessors and this was cross checked by another assessor. Data was entered into a database using optical character recognition software (Formic) and cross checked to ensure accuracy. Only the study team had access to the final dataset that was stored on a password protected, networked drive.

2.9. Data analysis

The primary outcomes were student knowledge and skill assessment scores. Data analysis was performed using STATA version 14.2 (Stata Statistical Software: Release 14. College Station, TX: StataCorp LP). The primary outcome data (final assessment score for each student) was analysed using a mixed effects linear model, with random effects for student, nested in cluster (KMTC), and a fixed effect for study arm (Group A – Full EmONC intervention, Group B – partial EmONC intervention and Group C – control). Summary statistics of knowledge test and practical skills test scores are reported, by study arm. These include the proportion of test scores of 80 % or higher and failure rates in 2018 of students at the colleges for use as a possible explanatory variable.

Scores for the knowledge test and practical skills test were each analysed using mixed effects linear models, with random effect for cluster (KMTC). Fixed effects considered were study arm, the interaction of study arm and failure rates of the Colleges.

Likelihood ratio tests were used to compare models, to test the significance of the fixed effects. Likelihood ratio test statistics and p-values of the tests are reported. Fitted estimates of the significant fixed effects are reported with 95 % confidence intervals.

Mixed effects logistic regression models were also used to assess the binary outcome variables of a score of 80 % or more for each test, with random effect for cluster (KMTC) and fixed effects as described above. Similarly, likelihood ratio tests were used to compare models and likelihood ratio test statistics and p-values of the tests are reported. Fitted estimates of the significant fixed effects are reported with 95 % confidence intervals. Odds ratios of scores of 80 % or more score for each of Groups A and B compared with C were derived.

3. Results

Summary statistics of test scores are provided in Table 1, stratified by study arm. These include average test scores and the proportion of test scores of 80 % (n_{80}) or higher. The maximum score in the knowledge test was 40 while the maximum score in the practical skills test was 80. In the knowledge test, the mean scores of students were high for Group C at 31.3 (±3), 28.8 (±3.6) for Group A and 28.2 (±3.6) for Group B. Group C had the highest proportion of students (45 %) who scored 80 % or more with Group B the lowest at 17 %.

For practical skills test, the mean scores were highest in Group B at (38.9 (±12.8) and lowest for Group C at 23.2 (±6.4). Only one student (1 %) in Group B had a score of 80 % or more in the practical skills test with none from either Group A or Group C (Table 2).

3.1. Linear regression for test scores

A statistically significant difference was detected between the study arms for the practical skills test (d.f. = 2, X^2 = 14.20, $p < 0.001$). However, no statistically significant difference was detected between the study arms for the knowledge test ($p = 0.23$). Additionally, there were no statistically significant differences between failure rates for both knowledge and practical skills tests ($p > 0.05$) (Table 4).

Practical scores for study arm A were estimated to be on average 14.53 times (95 % CI: 4.21 – 24.85) higher than for study arm C. Practical scores for study arm B were estimated to be on average 24.87 times (95 % CI: 14.54 – 35.19) times higher than for study arm C (Table 5).

Table 2
Summary statistics of test scores by study arm.

Study arm	N (n)	Mean (SD)	n_{80} (%)
Knowledge test			
A	4 (127)	28.8 (3.9)	28 (22 %)
B	4 (127)	28.2 (3.6)	21 (17 %)
C	4 (127)	31.1 (3)	57 (45 %)
Practical skills test			
A	4 (126)	28.3 (10.8)	0 (0 %)
B	4 (121)	38.9 (12.8)	1 (1 %)
C	4 (127)	23.2 (6.4)	0 (0 %)

N = number of colleges; n = number of students; n_{80} = number of students with a high score of > 80 % The failure rate in knowledge test was 23 % in Group C compared to 10 % in group A (Table 3).

Table 3
Failure rate stratified by study arm.

Study arm	N (n)	Failure rate (%)
A	4 (173)	18 (10 %)
B	4 (180)	28 (16 %)
C	4 (169)	39 (23 %)

Table 4
Likelihood ratio tests for linear regression models of test scores.

Effect	Knowledge test			Practical skills		
	D.f.	X^2	p-value	D.f.	X^2	p-value
June 2018 Failure rate	1	1.17	0.28	1	0.05	0.82
Study arm	2	2.91	0.23	2	14.20	<0.001

3.2. Estimates of effects of study arms on knowledge test scores in logistic regression

Only one student achieved 80 % or more in the practical skills test (Table 1). Therefore, the practical skills tests were not included in these estimates of effects in logistic regression models of test scores analysis.

The odds of achieving scores of 80 % or higher in the knowledge test was significantly higher in the full intervention group compared to the control group (OR 3.17, 95 % CI: 1.1 – 9.83). However, the difference between the partial intervention and control group for knowledge scores of 80 % and above was not statistically significant (OR 0.84, 95 % CI: 0.29 – 2.43) (Table 6).

4. Discussion

This study aimed to evaluate the effectiveness of a pre-service EmONC training intervention package on the knowledge and practical skills of final year midwifery students. The intervention significantly improved knowledge and practical skills of final year midwifery students. Students in the full intervention group were three times more likely compared to students in the control group to score 80 % or more in

Table 5
Estimates of effects in linear models of test scores, with 95% confidence intervals.

	Intercept (Study arm C)	Study arm A v C	Study arm B v C
Knowledge test	31.23 (30.74 – 31.7)		
Practical skills	23.22 (17.71 – 28.73)	14.53 (4.21 – 24.85)	24.87 (14.54 – 35.19)

Table 6
Estimates of effects in logistic regression models of test scores, with 95% confidence intervals.

	Intercept (Study arm C)	Study arm A v C	Study arm B v C
Knowledge test	0.81 (0.5–1.29)	3.17 (1.10–9.83)	0.84 (0.29–2.43)

the knowledge test. Also, students in intervention colleges, either full or partial, had statistically significant higher scores in practical skills compared to the control group. Evidence from multi-country studies among healthcare workers and medical students shows that exposure to EmONC training results in improved knowledge as well as retention of EmONC knowledge and skills (Ameh et al., 2018; Homaifar et al., 2013; Tang et al., 2016). These findings provide a pathway to educating improving the competency of healthcare providers to provide essential care for women and newborns consistent with the new SHP definition, MNH quality of care standards and the State of the World's Midwifery 2021 report (World Health Organization, 2018; World Health Organization et al., 2021).

The EmONC capacity building interventions should improve the content and quality of teaching EmONC within the institutions. Potentially colleges that were supported with EmONC capacity building interventions are likely to have implemented these within their training programmes. Importantly, implementing all four EmONC training intervention components is required for optimum improvement in the quality of EmONC teaching in these colleges. Mentorship/supportive supervision platforms complement the theoretical teaching strategies by upskilling lecturers in overall application of competence-based teaching strategies and resources to improve the quality of care, training and development of the workforce (Anatole et al., 2013; Maphalala, 2013; Schwerdtle et al., 2017). This is critical in contributing to the achievement of the universal health coverage goals and Midwifery 2030 targets, through practical skills training and continuous professional development for reduction of preventable maternal and newborn mortality by reviewing midwifery training standards, policies and regulations (WHO, 2014).

Likelihood ratio tests showed no statistically significant differences between study arms in knowledge tests even though there were statistically significant differences in the practical skills tests. Knowledge can be acquired through reading, simple recall or recognition of facts, and forms the lowest level of cognitive learning as described in the levels of Bloom's taxonomy. Therefore, students easily exhibit memory of previously learned material by recalling facts, terms, basic concepts, and answers (Krathwohl et al., 1964). However, practical skills form the psychomotor domain that involves higher-order thinking skills and go beyond basic observation of facts and memorization (Wass et al., 2001).

Although the effectiveness of EmONC has been evaluated, evidence in pre-service midwifery education is lacking. As part of WHO, ICM and UNFPA's seven-step action plan to strengthen quality midwifery education, strengthening the capacity of training institutions with EmONC equipment, faculty to deliver the EmONC content and updated training guidelines is critical to enhance midwifery competencies for practice (World Health Organization, 2019). To the best of our knowledge, this was the first study in Kenya to assess the impact of an EmONC pre-service training intervention on the knowledge and skills of final year midwifery students. Results from this study triggered a detailed review of nursing/midwifery training syllabi and curricula for competent SHP graduates. It is intended that the new curricula will ensure that newly qualified nurse/midwives are confident and competent to provide EmONC, good quality and respectful care with less supervision and dependence on in-service EmONC training. This study resulted in a radical shift in the approach to midwifery education incorporating improved content and learning approach. The resulting curriculum blends a theoretical and skills-based approach for competency-based pre-service midwifery training improving the previous, overly didactic training. It is expected that this approach will improve the availability of competent skilled health personnel, an essential strategy to achieve universal health coverage and reduce preventable maternal and newborn mortality.

Our study was strongly powered and therefore these findings are generalizable to other similar settings. Effectiveness of the pre-service EmONC should be monitored and scale-up to improve practice. A robust methodology was used to minimise contamination, data collectors were blinded from the allocation of each cluster, the clusters were unblinded only after analysis. A limitation of the study was that the sites benefiting from the original interventions were not randomly selected but included in the larger EmONC programme, that focused on regions with relatively worse maternal and newborn outcomes. Even though this was the case, the random selection from the pool of intervention sites and ensuring that colleges with similar baseline characteristics (including number and training of lecturers and clinical supervisors received and availability of training equipment) were selected mitigated against selection bias.

5. Conclusion

We investigated the effectiveness of a EmONC enhanced midwifery training curriculum on the basis of the global strategy of skilled health personnel to improve maternal and newborn health. The intervention package was effective in improving the knowledge and skills of final year midwifery students. Midwifery training programmes in low resource settings should be updated, midwifery faculty trained and supported to implement the updated curriculum and an enabling environment provided (mannequins) to facilitate skills teaching. However, more work needs to be done to evaluate the impact of such improved curricula on the quality of care/service delivery, including health outcomes.

Funding

This PETI study was part of the larger 4-year Making it Happen II program in Kenya funded by the UK government (UKaid).

Consent for publication

Not applicable

CRediT authorship contribution statement

Duncan N. Shikuku: Writing – review & editing, Writing – original draft, Methodology, Data curation. **Fiona Dickinson:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation. **Helen Allott:** Writing – review & editing, Methodology, Investigation, Data curation. **Sarah White:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Sarah Bar-Zeev:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Charles Ameh:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The study data is available from the corresponding author on reasonable request.

Acknowledgements

The authors specially acknowledge the Kenya Medical Training College Headquarters and the respective colleges' lecturers for the kind participation as collaborators and the final year midwifery students who participated in the whole study. The Kenya Ministry of Health through the Division of Reproductive and Maternal Health are acknowledged for the overall program implementation support. Authors also acknowledge the team of EmONC faculty who supported with the students' assessments across the country in the pre-service training institutions. Katie Fahy (Department of Public Health, Policy, and Systems, University of Liverpool) is acknowledged for her unreserved contribution with the statistical analysis. The LSTM Kenya technical and operations teams are acknowledged for their logistical planning and support with the assessments and data collection across the country.

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