UNIJERPS
Unizik Journal of Educational Research and Policy Studies VOL.22 (1);
July-December, 2026 https://unijerps.org
2023 Impact Factor: 6.834; 2022 *Impact Factor*: 5.156; *2021 Impact Factor: 5.641;*
2020 Impact Factor: 5.355. Indexing and Impact Factor URL: http://sjifactor.com/passport.php?id=21363

EFFECT OF A STRUCTURED EDUCATIONAL INTERVENTION ON MIDWIVES' KNOWLEDGE OF THE WHO SAFE CHILDBIRTH CHECKLIST IN SECONDARY HEALTH FACILITIES IN KADUNA STATE, NIGERIA: A QUASI-EXPERIMENTAL MIXED-METHODS STUDY

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ABSTRACT

Background: *The World Health Organization Safe Childbirth Checklist (WHO-SCC) is a 29-item cognitive aid organised around four pause points that targets the leading causes of maternal and intrapartum-related perinatal death. Its benefit depends on birth attendants knowing the tool, yet Nigerian studies consistently report very low awareness of the WHO-SCC among midwives, and interventional evidence from secondary health facilities is scarce. This study evaluated the effect of a structured educational intervention (SEI) on midwives' knowledge of the WHO-SCC in secondary health facilities in Kaduna State, Nigeria.* ***Methods:*** *A sequential explanatory mixed-methods design was used, comprising a non-randomised pre-test/post-test control-group study followed by focus group discussions (FGDs). Eight state-owned secondary health facilities in the Northern and Central senatorial zones were randomly allocated to intervention (n = 4) or control (n = 4). All eligible, consenting midwives in the labour and postnatal wards were enrolled by total enumeration (intervention n = 39; control n = 36). Intervention midwives received a multimodal training programme (lectures, demonstrations, role-play, supervised checklist use) followed by 12 weeks of supported implementation with monthly follow-up visits. Knowledge was measured with a 13-item validated instrument (Cronbach's α = 0.757) before and after the intervention. Data were analysed with descriptive statistics, independent-samples t-tests, Cohen's d and analysis of covariance (ANCOVA) adjusting for baseline knowledge, years of experience and educational level. Four FGDs were analysed thematically.* ***Results:*** *At baseline, no midwife in either group answered any knowledge item correctly (mean 0.00 ± 0.00), confirming a universal knowledge gap and complete pre-intervention equivalence. After the intervention, all 39 intervention midwives answered all 13 items correctly (13.00 ± 0.00; 100%), compared with a mean of 4.25 ± 1.65 (32.7%) in the control group (t (35.0) = 31.79, p < 0.001; Cohen's d = 7.65). ANCOVA confirmed the SEI as an independent predictor of post-intervention knowledge (F (1,67) = 4.05, p = 0.048) with no significant main or interaction effects of years of experience or educational level. Midwives described the training as the source of their confidence and competence in using the checklist and called for periodic retraining.* ***Conclusion:*** *A brief, multimodal structured educational intervention produced complete knowledge acquisition among midwives who had no prior exposure to the WHO-SCC, irrespective of experience or*

qualification. Low checklist knowledge in Nigerian secondary facilities reflects the absence of training rather than a deficit in learners. WHO-SCC training should be institutionalised as mandatory in-service education and embedded in pre-service midwifery curricula.

Keywords: WHO Safe Childbirth Checklist; knowledge; midwives; structured educational intervention; in-service training; secondary health facilities; Nigeria.

Introduction

Maternal and neonatal mortality remain among the most pressing public health challenges in sub-Saharan Africa. Globally, an estimated 287,000 women died during pregnancy and childbirth in 2020, with about 95% of these deaths occurring in low- and middle-income countries (World Health Organisation [WHO], 2023). Nigeria carries a disproportionate share of this burden, with a maternal mortality ratio of approximately 512 per 100,000 live births and a neonatal mortality rate of 38 per 1,000 live births (National Population Commission [NPC] & ICF, 2019; WHO, 2019a). Within Nigeria, Kaduna State is estimated to have a maternal mortality ratio of about 1,025 per 100,000 live births, roughly double the national average (Federal Ministry of Health [FMoH], 2022; Ibrahim, Musa & Danladi, 2021). A substantial share of these deaths is attributable not only to limited access to care but to gaps in the quality of intrapartum care, including delays in recognising complications and inconsistent adherence to evidence-based practices (Tukur et al., 2022; Ajide et al, 2026).

The WHO Safe Childbirth Checklist (WHO-SCC) was developed to address precisely this quality gap. Updated in 2015, it groups 29 evidence-based essential birth practices into four pause points on admission, just before pushing (or caesarean section), soon after birth and before discharge so that critical actions targeting haemorrhage, hypertensive disorders, infection, obstructed labour and birth asphyxia are prompted at the moment they matter (WHO, 2015; Perry, Singh & Koblinsky, 2017). Early pilot work in India demonstrated large improvements in adherence to essential practices (Spector et al., 2012), and subsequent pre–post and quasi-experimental studies in Bangladesh, Ethiopia, Rwanda, Cameroon, Burkina Faso and Côte d'Ivoire reported improved delivery of essential practices following checklist introduction (Nababan et al., 2017; Tuyishime et al., 2018; Kourouma et al., 2020; Abawollo et al., 2021; Dohbit et al., 2021, Babalola et al, 2026). Systematic reviews conclude that the checklist improves process quality, although effects on mortality depend heavily on the intensity of implementation support (Varghese et al., 2019; Tolu, Jeldu & Feyissa, 2020; Fernández-Elorriaga et al., 2025). The large BetterBirth trial in Uttar Pradesh is instructive: coaching-based implementation improved adherence to essential practices without reducing mortality, underscoring that the checklist is a vehicle for behaviour change whose effect depends on how well birth attendants know and use it (Semrau et al., 2017).

Knowledge is the entry point to that behaviour change. Within the Theory of Planned Behaviour, beliefs about a tool its purpose, structure and expected benefits shape attitudes, perceived norms and perceived behavioural control, which in

turn determine intention and action (Ajzen, 1991). Within the Kirkpatrick training evaluation model, learning (Level 2) is the necessary precursor to behaviour (Level 3) and results (Level 4) (Kirkpatrick & Kirkpatrick, 2006). A midwife who has never encountered the WHO-SCC cannot form favourable beliefs about it, cannot be expected to use it, and cannot contribute to the outcome gains the checklist is designed to deliver. The Nigerian evidence base suggests that this entry point is often missing (Lanre-Ogungbile et al, 2020). Cross-sectional surveys report that only 27.6% of midwives in Imo State were aware of the WHO-SCC and just 4.8% used it consistently, with lack of understanding (45.5%) and insufficient training (22.1%) the most frequently cited barriers (Ibrahim, Amadi & Ogaji, 2023).

In Rivers State, 80% of nurses and midwives in tertiary hospitals had no prior knowledge of the tool (Jeremiah, 2023), and in Ibadan only 13.1% of nurses and midwives were aware of the checklist before structured training (Onianwa et al., 2024). Similar gaps have been documented in Anambra and Enugu States and at national level (Ugochukwu, Adirieje & Okonkwo, 2020; Ekholuenetale et al., 2021; Okonkwo, Aniebue & Aguwa, 2022). Where training has been evaluated in Nigeria, it has produced substantial knowledge gains among midwives in primary health care facilities (Odetola, Ogu & Ntoimo, 2021; Agbojo et al, 2026) and improved competence in quasi-experimental studies (Olaniyan, Okafor & Bello, 2022; Sotunsa, Oduwole & Odusoga, 2022). However, most Nigerian studies remain descriptive, few include a control group, and none, to our knowledge, has evaluated a structured educational intervention on WHO-SCC knowledge among midwives in the state-owned secondary health facilities that handle the bulk of facility-based deliveries in northern Nigeria (Popoola et al, 2026). This study therefore assessed the effect of a structured educational intervention (SEI) on midwives' knowledge of the WHO-SCC in secondary health facilities in Kaduna State, Nigeria, and examined whether the effect varied by years of professional experience and educational level. We hypothesised that there would be no statistically significant difference in post-intervention knowledge scores between intervention and control midwives after adjusting for baseline knowledge, years of experience and educational level (H_{01}).

Methods

Study design

A sequential explanatory mixed-methods design was adopted, anchored in a pragmatic paradigm (Creswell & Plano Clark, 2018). Phase I was a non-randomised pre-test/post-test control-group (quasi-experimental) study quantifying the effect of the SEI. Phase II used focus group discussions (FGDs) with intervention midwives to explain and contextualise the quantitative findings. This paper reports the knowledge outcome; perception, implementation and maternal–fetal outcomes from the parent study are reported separately.

Setting

The study was conducted in Kaduna State, North-West Nigeria, which has a projected population of approximately 8.5 million across 23 local government areas and three senatorial zones. The state operates 29 secondary health care facilities (general hospitals, rural hospitals and designated

maternal health centres) employing about 1,686 nurses and midwives, of whom 123 are deployed to obstetric units. Eight facilities were selected: four from the Northern and four from the Central senatorial zones. The Southern zone was excluded because of prevailing security concerns.

Participants and sampling

The target population was midwives deployed to the labour and postnatal wards of the selected facilities (206 across the three zones according to the State Ministry of Health, 2023). Multi-stage sampling was used. First, the Northern and Central senatorial zones were selected. Second, four secondary facilities were selected from each zone by simple random sampling (balloting), and the eight facilities were then randomly assigned to intervention (General Hospital Kawo, General Hospital Kakuri, General Hospital Hunkuyi and Hajiya Gambo Sawaba General Hospital Zaria) or control (Yusuf Dantsoho Memorial Hospital Tudun Wada, General Hospital Giwa, General Hospital Miba and General Hospital Makarfi). Third, all midwives in the labour and postnatal wards of the selected facilities who consented were recruited through total enumeration. Midwives on sick, maternity or extended leave during data collection were excluded. The minimum sample size was estimated with the formula for comparing two independent proportions (Charan & Biswas, 2013), using a baseline WHO-SCC use proportion of 4.8% (Ibrahim et al., 2023), an expected post-intervention proportion of 15.2% (Abawollo et al., 2021), $\alpha = 0.05$, power = 80%, a design effect of 2 for facility clustering and 10% allowance for attrition, giving 78 midwives. Seventy-five eligible midwives were available and consented (intervention n = 39; control n = 36), a shortfall of 3.8% that was judged unlikely to compromise power given the magnitude of effect anticipated. For the qualitative phase, intervention midwives who had completed the training and were directly involved in labour care were purposively selected.

Intervention

The SEI was developed for this study and delivered exclusively at the four intervention facilities by the principal investigator, on separate days at each site. It consisted of two sessions of approximately two hours each. Session 1 gave an overview of the WHO-SCC its structure, purpose, evidence base and significance for reducing preventable maternal and neonatal deaths and was evaluated with a pre/post-session quiz, group question-and-answer and a feedback form. Session 2 covered a detailed explanation and practical demonstration of every checklist item at each pause point, correct documentation, barriers to use and strategies to overcome them, and communication and teamwork; it was evaluated through practical demonstration, a post-training quiz and a checklist-scoring exercise. Teaching methods combined didactic lectures, practical demonstrations, interactive group discussion and role-play simulation, and every participant received printed WHO-SCC materials. Printed checklists were displayed in the labour and delivery rooms of all intervention facilities for a 12-week supported implementation period, during which the researcher made monthly follow-up visits to observe practice, reinforce checklist use and address emerging challenges. Control facilities continued routine practice with no training or materials.

Instrument

A structured, self-administered questionnaire was developed from the WHO-SCC implementation guide (WHO, 2015) and the study objectives. Section A captured socio-demographic and professional characteristics. Section B, the knowledge scale reported here, comprised 13 dichotomous items covering awareness of the checklist, its recommended users, its key components, the four pause points and their timing, the need for supervision and coaching, the inclusion of magnesium sulphate and the partograph, the requirement for formal training, essential equipment and supplies, documentation procedures and the checklist's intended outcomes. Correct responses were scored 1 and incorrect or "not sure" responses 0, giving a total score of 0–13; scores were also expressed as percentages and categorised as poor (< 50%), moderate (50–60%) or good (> 60%) knowledge. Face and content validity were established by a panel of experts in midwifery, obstetrics and public health. The instrument was pre-tested among midwives in a secondary facility outside the study area, ambiguities were revised, and internal consistency was acceptable (Cronbach's $\alpha = 0.757$) (Nunnally & Bernstein, 1994). A semi-structured FGD guide explored perceived benefits of the checklist, challenges encountered during implementation, and enablers of and suggestions for sustaining its use. Trustworthiness was pursued through triangulation, member checking, an audit trail, reflexive journaling, peer debriefing and thick description (Lincoln & Guba, 1985).

Data collection

Data were collected between July and September 2024. After institutional permissions were obtained from each facility's Medical Director and Chief Nursing Officer, the study was explained to midwives individually and written informed consent was obtained. Baseline questionnaires were administered individually under supervision (15–20 minutes) and checked for completeness on collection. Following delivery of the SEI, an identical post-test questionnaire was administered to both groups. Four FGDs (one per intervention facility; 45–60 minutes each) were then conducted in English in a quiet room within the facility, moderated by the principal investigator with a trained note-taker, and audio-recorded with consent. All 75 midwives completed both assessments (100% response).

Data analysis

Quantitative data were analysed in SPSS version 22. Frequencies, percentages, means and standard deviations summarised participant characteristics and item-level knowledge. Independent-samples t-tests (Welch-adjusted where variances were unequal) compared post-intervention knowledge scores between groups, and Cohen's d quantified effect size. A univariate ANCOVA was fitted with post-intervention knowledge score as the dependent variable, group (intervention vs control), years of experience and educational level as factors, baseline knowledge as covariate, and all two- and three-way interactions, with partial eta squared (ηp^2) as the effect-size measure; Scheffé post-hoc tests examined pairwise differences across experience categories. Significance was set at $p < 0.05$. FGD

transcripts were analysed thematically in NVivo 12 using Braun and Clarke's (2006) six-phase approach; participants are identified by focus group and midwife number (e.g., FGD2, M10). Quantitative and qualitative findings were integrated at the interpretation stage.

Ethical considerations

Ethical approval was obtained from the Kaduna State Ministry of Health Ethics Committee, following an introductory letter from the Department of Nursing Science, Ahmadu Bello University, Zaria. Participation was voluntary, written informed consent was obtained, and participants could withdraw at any time without consequence. Data were anonymised with unique identifiers, stored securely, and audio recordings were deleted after transcription.

Results

Participant characteristics

All 75 midwives were female. The mean age was 32 years in the control group and 35 years in the intervention group, with mean professional experience of 7.25 and 8.82 years respectively. Most held a diploma in midwifery (control 66.7%; intervention 61.5%), roughly a third held a bachelor's degree (33.3% vs 35.9%), and one intervention midwife (2.6%) held a master's degree. Most midwives attended between five and ten births per week in both groups (Table 1). The groups were comparable on all measured characteristics.

Table 1. Socio-demographic and professional characteristics of participating midwives (N = 75)

Characteristic	Control (n = 36)	Intervention (n = 39)
Sex: female, n (%)	36 (100.0)	39 (100.0)
Age, mean (years)	32	35
Years of experience as a midwife, mean	7.25	8.82
Highest qualification, n (%)		
Diploma	24 (66.7)	24 (61.5)
Bachelor's degree	12 (33.3)	14 (35.9)
Master's degree	0 (0.0)	1 (2.6)
Years attending births, n (%)		
1	1 (2.8)	1 (2.6)
2–4	10 (27.8)	9 (23.1)
5–7	15 (41.7)	9 (23.1)
8–10	6 (16.7)	8 (20.5)
> 10	4 (11.1)	12 (30.8)
Births attended per week, 5–10, n (%)	31 (86.1)	33 (84.6)

Baseline knowledge of the WHO-SCC

Before the intervention, no midwife in either group answered any of the 13 knowledge items correctly (Table 2). None reported awareness of the checklist, its four pause points, the inclusion of magnesium sulphate or the partograph, or the need for training, supervision or coaching. Baseline

mean scores were therefore 0.00 ± 0.00 (0%) in both groups, indicating a universal pre-intervention knowledge gap and complete equivalence between groups on the outcome.

Post-intervention knowledge of the WHO-SCC

After the intervention, all 39 midwives in the intervention group (100%) answered every one of the 13 items correctly, yielding a mean of 13.00 ± 0.00 (100%; "good" knowledge). In the control group, correct responses ranged from 19.4% (formal training is required before implementing the checklist) to 55.6% (awareness of the checklist's existence), with an aggregate correct response of 32.7% and a mean score of 4.25 ± 1.65 ("poor" knowledge). Knowledge of the operational details of the tool supervision and coaching (22.2%), timing of the pause points (27.8%), documentation (25.0%) and the magnesium sulphate item (25.0%) remained particularly low among control midwives (Table 2).

Table 2. Item-level knowledge of the WHO Safe Childbirth Checklist before and after the intervention, by group (N = 75)

Knowledge item (correct response)	Intervention (n = 39)		Control (n = 36)	
	Before n (%)	After n (%)	Before n (%)	After n (%)
1. Aware of the WHO Safe Childbirth Checklist	0 (0.0)	39 (100.0)	0 (0.0)	20 (55.6)
2. WHO-SCC is recommended for all health workers involved in childbirth care	0 (0.0)	39 (100.0)	0 (0.0)	18 (50.0)
3. Can identify the key components of the WHO-SCC	0 (0.0)	39 (100.0)	0 (0.0)	12 (33.3)
4. WHO-SCC is structured around four pause points	0 (0.0)	39 (100.0)	0 (0.0)	14 (38.9)
5. Pause points occur on admission, before pushing, soon after birth and before discharge	0 (0.0)	39 (100.0)	0 (0.0)	10 (27.8)
6. Health workers should receive supervision and coaching during implementation	0 (0.0)	39 (100.0)	0 (0.0)	8 (22.2)
7. Magnesium sulphate is the anticonvulsant assessed at the first three pause points	0 (0.0)	39 (100.0)	0 (0.0)	9 (25.0)
8. Formal training is required before implementing the WHO-SCC	0 (0.0)	39 (100.0)	0 (0.0)	7 (19.4)
9. Partograph use is an item under the first pause point	0 (0.0)	39 (100.0)	0 (0.0)	11 (30.6)
10. Knows the recommended timing of each pause point	0 (0.0)	39 (100.0)	0 (0.0)	10 (27.8)
11. Knows the essential equipment and supplies for effective checklist use	0 (0.0)	39 (100.0)	0 (0.0)	12 (33.3)
12. Knows the correct procedure for documenting each pause point	0 (0.0)	39 (100.0)	0 (0.0)	9 (25.0)
13. WHO-SCC is designed to improve both maternal and neonatal outcomes	0 (0.0)	39 (100.0)	0 (0.0)	13 (36.1)
Aggregate correct response (%)	**0.0**	**100.0**	**0.0**	**32.7**

Correct = item answered correctly; Incorrect = "No" or "Not sure". Knowledge level: < 50% poor; 50–60% moderate; > 60% good.

Effect of the intervention on knowledge scores

Table 3 summarises the knowledge scores. The between-group difference in post-intervention scores was large and statistically significant (mean difference 8.75 of 13 points; $t(35.0) = 31.79$, $p < 0.001$), with an exceptionally large effect size (Cohen's $d = 7.65$). Within the intervention group the change from baseline was 13.00 points; within the control group it was 4.25 points, a modest but statistically significant rise ($p < 0.001$) in the absence of any training. The null hypothesis of no difference in post-intervention knowledge between groups was therefore rejected.

Table 3. Knowledge scores (0–13) before and after the intervention, by group

Group	n	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Mean change	Post %
Intervention	39	0.00 ± 0.00	13.00 ± 0.00	13.00	100.0
Control	36	0.00 ± 0.00	4.25 ± 1.65	4.25	32.7
Between-group comparison (post): t(35.0) = 31.79, p < 0.001; Cohen's d = 7.65					

Welch's t-test used because of unequal variances. Cohen's d computed from post-intervention means and pooled SD.

Influence of experience and educational level

The ANCOVA model was statistically significant, $F(7,67) = 5.46$, $p < 0.001$, explaining 36.3% of the variance in post-intervention knowledge ($R^2 = 0.363$; adjusted $R^2 = 0.297$). The SEI had a significant independent effect on post-intervention knowledge ($F(1,67) = 4.05$, $p = 0.048$; $\eta p^2 = 0.057$). Neither years of experience ($F(1,67) = 0.42$, $p = 0.520$) nor educational level ($F(1,67) = 0.41$, $p = 0.524$) had a significant main effect, and none of the two- or three-way interactions was significant (all $p > 0.38$), indicating that the knowledge gain was consistent across experience and qualification categories (Table 4). Scheffé post-hoc comparisons across experience categories (0–10, 11–20 and 21–30 years) showed no significant pairwise differences (mean differences −2.27 to 2.27; all $p \geq 0.115$; all 95% confidence intervals included zero).

Table 4. ANCOVA of post-intervention knowledge scores by intervention, years of experience and educational level, adjusting for baseline knowledge

Source	Type III SS	df	Mean square	F	p	ηp^2
Corrected model	196.774	7	28.111	5.456	< 0.001	0.363
Intercept	678.311	1	678.311	131.664	< 0.001	0.663
Baseline knowledge (covariate)	123.903	1	123.903	24.050	< 0.001	0.264
Intervention	20.863	1	20.863	4.050	0.048	0.057

Source	Type III SS	df	Mean square	F	p	ηp²
Years of experience	2.158	1	2.158	0.419	0.520	0.006
Educational level	2.110	1	2.110	0.410	0.524	0.006
Intervention × experience	0.158	1	0.158	0.031	0.861	0.000
Intervention × education	4.010	1	4.010	0.778	0.381	0.011
Experience × education	1.656	1	1.656	0.321	0.573	0.005
Intervention × experience × education	0.024	1	0.021	0.027	0.899	0.004
Error	345.173	67	5.152			
Corrected total	541.947	74				

Dependent variable: post-intervention knowledge score. $R^2 = 0.363$ (adjusted $R^2 = 0.297$).

Qualitative findings: training as the source of knowledge and confidence

Thematic analysis of the four FGDs generated five themes in the parent study (perceived benefits of the WHO-SCC, training and motivation, policy and institutionalisation, implementation challenges, and enablers). The theme of training and motivation speaks most directly to the knowledge outcome. Midwives consistently attributed their ability to use the checklist to the structured training, describing it as the step that made the tool intelligible and usable:

> *"The pre-training is very helpful because it guides us in the use of the checklist. It also guides us on how to fill it properly despite that it was written in English language. All the four phases are okay by us so far."* (FGD2, M10)

> *"The training boosts our confidence to implement the checklist… training itself actually motivates and goes down to your nursing instinct to save a life."* (FGD3, M11)

Participants also linked specific knowledge gained such as the drugs prompted at each pause point to changes in what they did at the bedside, and repeatedly asked for periodic retraining to consolidate what they had learned:

> *"This checklist guided us to know what to give in terms of drugs like antibiotics and magnesium sulphate."* (FGD2, M7)

> *"For every successful training, there is always room for retraining. It will significantly improve if there is more training because the training itself actually motivated us to use the checklist."* (FGD2, M3)

These accounts corroborate the quantitative finding that structured training, rather than experience or prior qualification, was the mechanism through which knowledge of the WHO-SCC was acquired, and they identify continuing education as the condition midwives themselves regard as necessary for retaining it.

Discussion

This study set out to determine whether a structured educational intervention

improves midwives' knowledge of the WHO Safe Childbirth Checklist in Nigerian secondary health facilities. Three findings stand out. First, at baseline not one of the 75 midwives had any knowledge of the WHO-SCC. Second, a brief multimodal training programme brought every intervention midwife to full marks on all 13 items, a between-group effect of exceptional magnitude. Third, this gain was unrelated to years of experience or educational level.

The complete absence of baseline knowledge is the most sobering of these findings. It is more extreme than, but directionally consistent with, previous Nigerian reports of 27.6% awareness in Imo State (Ibrahim et al., 2023), 20% awareness in Rivers State (Jeremiah, 2023) and 13.1% awareness in Ibadan (Onianwa et al., 2024), all of which were conducted in tertiary or mixed settings where exposure to guidelines is likely to be higher than in state-owned secondary facilities. Nine years after the WHO published the revised checklist and implementation guide (WHO, 2015), midwives responsible for the majority of facility deliveries in one of Nigeria's highest-burden states had not been introduced to it. This reflects a systemic failure to integrate the WHO-SCC into pre-service midwifery curricula and in-service education rather than any deficit in the midwives themselves, a point reinforced by how readily and completely they learned once taught. It also has implications for how earlier Nigerian utilisation data should be read: the very low rates of consistent checklist use reported by Ibrahim et al. (2023) and Okafor, Ugwu and Arinze-Onyia (2020) are unsurprising where the tool is unknown.

The magnitude of the post-intervention gain exceeds that reported in comparable studies. Odetola et al. (2021) reported an increase of about 45% in knowledge scores among midwives in Nigerian primary health care facilities; Kourouma et al. (2020) documented significant knowledge gains and an increase in checklist implementation from 21% to 68% after tailored training in Burkina Faso and Côte d'Ivoire; and Ethiopian studies reported improved knowledge and utilisation following structured training (Mengistu, Sitotaw & Engida, 2019; Kara, Habte & Adamu, 2019). Several features of the present intervention plausibly account for the ceiling-level attainment observed here. The training combined didactic content with demonstration, role-play and supervised use of the printed checklist, an approach that engages multiple learning modalities and is consistent with evidence that multimodal, practice-based education outperforms lectures alone in changing health-worker performance (Rowe et al., 2018). Session 2 walked through every item at every pause point, directly mapping onto the content of the knowledge instrument. The post-test was administered soon after training, when recall is maximal. And the instrument, though valid and reliable, assessed factual and structural knowledge of the checklist rather than deeper clinical reasoning, so a well-taught cohort could reasonably reach the ceiling. The 100% attainment should therefore be interpreted as evidence that the training delivered its intended content completely, not as evidence that midwives had achieved mastery of every clinical competency the checklist prompts.

The modest rise in control-group knowledge (from 0 to a mean of 4.25) in the

absence of any training merits comment. Midwives in control facilities were most likely to have learned that the checklist exists and is recommended for all birth attendants, and least likely to know its operational details. This pattern is consistent with incidental learning: exposure to the baseline questionnaire itself, informal communication among midwives across facilities in the same state health system, and curiosity aroused by participation a Hawthorne-type effect acknowledged in other checklist studies (Semrau et al., 2017). The fact that the control group nevertheless remained at a "poor" level after three months underlines that informal exposure does not substitute for structured teaching. The ANCOVA finding that neither years of experience nor educational level moderated the effect of training is important for both equity and policy. Ibrahim et al. (2023) found awareness and use to be higher among more experienced midwives and those in teaching or administrative roles, suggesting that knowledge of the checklist diffuses unevenly through the workforce when it depends on opportunity rather than design. Our results show that when training is provided deliberately, diploma-prepared and degree-prepared midwives, and newly qualified and long-serving midwives, learn equally well.

Within the Kirkpatrick framework, the intervention achieved uniform learning (Level 2) across the cohort (Kirkpatrick & Kirkpatrick, 2006); within the Theory of Planned Behaviour, it supplied the beliefs and perceived behavioural control on which favourable attitudes and intention to use the checklist depend (Ajzen, 1991). Programmes need not be stratified by cadre or seniority, which simplifies scale-up. It should be noted, however, that the ANCOVA effect for the intervention, while significant, was smaller ($\eta p^2 = 0.057$) than the raw between-group difference would suggest, because the model was fitted with multiple factors and interaction terms in a sample of 75, and the statistical significance of the baseline-knowledge covariate must be interpreted with caution given its near-zero variance in this sample. The qualitative data add an explanatory layer. Midwives did not describe the training merely as information transfer; they described it as the source of confidence, the thing that made a document written in English intelligible in practice, and a motivator that reconnected them with their professional purpose. They also spontaneously identified retraining as necessary. This aligns with evidence that knowledge gained from one-off training decays and that coaching, supervision and refresher sessions are required to sustain checklist behaviours (Hirschhorn et al., 2015; Semrau, Maina & Gawande, 2020; De Leo, Lippke & Knoll, 2019), and with Nigerian qualitative work showing that lack of training and institutional support are the dominant barriers to checklist use (Amadi, Okorie & Iwuoha, 2023; Ekholuenetale et al., 2021).

Implications for practice, education and policy

Three implications follow. First, WHO-SCC training should be institutionalised as mandatory in-service education for all midwives in Kaduna State's secondary health facilities, with the content, format and duration used here offering a replicable model that facility nursing leadership can deliver. Second, the checklist should be integrated into pre-service nursing and midwifery curricula so that graduates enter

practice already familiar with it, addressing the root cause of the knowledge gap. Third, because knowledge acquisition was complete but midwives themselves anticipated decay, in-service training should be scheduled periodically and paired with supportive supervision and audit of checklist completion, consistent with the WHO implementation guide (WHO, 2015). Knowledge is necessary but not sufficient: the parent study found that staffing, supplies and institutional mandates shaped whether knowledge translated into sustained use, so educational investment should be coupled with health-system strengthening.

Strengths and limitations

Strengths include a controlled design with a multi-site sample across eight facilities, complete pre-intervention equivalence on the outcome, a 100% response rate at both time points, adjustment for baseline knowledge, experience and educational level, and integration of qualitative data that explain the quantitative results. The study also has limitations. Facilities, not midwives, were randomised, and the design was quasi-experimental; unmeasured facility-level confounders cannot be excluded, and the analysis did not formally account for clustering within facilities. The post-test was administered soon after training, so the durability of the knowledge gain is unknown; a follow-up assessment at six or twelve months is needed. The knowledge instrument measured factual knowledge of the checklist and produced a ceiling effect in the intervention group, which constrains variance and limits what can be inferred about higher-order competence. Self-report may have introduced social desirability bias, although the dichotomous factual format of the knowledge items limits this concern. Finally, the Southern senatorial zone was excluded for security reasons, restricting generalisability within the state, and the sample of 75 fell slightly short of the calculated minimum of 78.

Conclusion

Midwives in secondary health facilities in Kaduna State had no knowledge of the WHO Safe Childbirth Checklist before this study. A brief, multimodal structured educational intervention produced complete knowledge acquisition among every trained midwife, with an exceptionally large effect relative to untrained controls, and the effect did not depend on years of experience or educational qualification. Low knowledge of the checklist in this setting is a problem of missing training rather than of learner capacity, and it is readily remediable. Institutionalising WHO-SCC training in in-service and pre-service midwifery education, reinforced by periodic retraining and supportive supervision, is a feasible and high-yield step towards improving the quality of intrapartum care in Nigeria and comparable settings.

Declarations

Ethics approval and consent to participate: Approved by the Kaduna State Ministry of Health Ethics Committee. Written informed consent was obtained from all participants.

Availability of data: The datasets generated and analysed during the study are available from the corresponding author on reasonable request.

Competing interests: The authors declare no competing interests.

Funding: No external funding was received.

Authors' contributions: [OEO conceived and designed the study, delivered the intervention, collected and analysed the data and drafted the manuscript; co-authors supervised the study and critically revised the manuscript. All authors approved the final version.]

Acknowledgements: The authors thank the Kaduna State Ministry of Health, the management of the participating facilities, and the midwives who took part in the study.

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