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Bridging the gap: simulation-based training in Nigeria (2015–2025)

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ABSTRACT

Medical education in Nigeria is shifting from traditional apprenticeship models toward competency-based approaches, with simulation-based training (SBT) increasingly recognized as vital for improving clinical competence and patient safety. This scoping review, guided by PRISMA-ScR, mapped the extent, effectiveness, barriers, and future directions of SBT between 2015 and 2025. Fifty-four eligible studies were analyzed across undergraduate and postgraduate health professional education. Evidence consistently showed that SBT enhances technical skills, clinical decision-making, and learner confidence, particularly in high-risk areas such as neonatal resuscitation, surgical training, and obstetric emergencies. Institutional capacity has grown through early adopters like Ilorin, Lagos, and Port Harcourt Universities, supported by a 2025 federal initiative establishing eight national simulation centers. Despite these advances, barriers remain, including high procurement costs (55%), unstable electricity (32%), and limited trained faculty (33%). Innovative low-cost solutions, such as mobile virtual reality and AI-enabled platforms, have emerged as promising alternatives. Overall, SBT demonstrates substantial educational value but is constrained by financial, infrastructural, and human resource challenges. Sustainable scale-up requires national policy integration, mandatory simulation hours in MBBS and nursing curricula, and structured faculty development programs leveraging digital and mobile technologies to improve patient safety outcomes in Nigeria and West Africa.

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1. INTRODUCTION

The landscape of medical education in Nigeria has experienced a significant transformation from 2015 to 2025, influenced by a global emphasis on patient safety and the local need for standardized, reproducible training environments. Traditionally, the Nigerian healthcare education system relied on the Halstedian apprenticeship model, "see one, do one, teach one," which often imposed a considerable burden

on patients during the early phases of training [1], [2]. The incorporation of simulation-based training (SBT) has become a revolutionary pedagogical approach, as medical knowledge has grown more sophisticated [3]. This review assesses the progress of SBT in Nigeria, highlighting key milestones such as the 2025 Federal initiative to establish eight national simulation centers, while examining the financial and infrastructural challenges that continue to impede implementation [4], [5].

The evolution of medical education in Nigeria marks a significant transition from the 19th-century Halstedian apprenticeship model of "see one, do one, teach one" to a 21st-century evidence-based competency framework [1], [2]. The Nigerian healthcare education system has historically relied on learner exposure to real patients in clinical settings, particularly during high-acuity rotations in internal medicine and surgery [2], [6]. As medical knowledge has expanded significantly and patient safety has become a global ethical priority, the drawbacks of this traditional approach have become increasingly obvious [1], [3].

The SBT offers a transformative approach by providing a safe and controlled environment where learners can practice technical procedures and improve non-technical skills such as leadership, teamwork, and communication without risking harm to live patients [3], [7]. In Nigeria, the demand for SBT is driven by an urgent need to reduce maternal and neonatal mortality, which is still alarmingly high at 36 deaths per 1,000 live births [8]. From 2015 to 2025, the Nigerian healthcare landscape evolved from isolated, donor-funded simulation pilots to a recognition of SBT as a core pedagogical pillar at both state and federal levels [4], [9].

This systematic review examines the implementation of SBT across the medical, nursing, and dental fields in Nigeria. It assesses the institutional milestones that have shaped the past decade, analyzes the persistent challenges related to infrastructure and funding, and emphasizes the potential of digital technologies to overcome traditional barriers [10], [11]. This review, grounded in experiential learning theory and Ericsson's deliberate practice framework, synthesizes evidence from 54 peer-reviewed sources to outline a future roadmap for healthcare professional development in the region [12], [13].

2. RESEARCH GAP AND SIGNIFICANCE

Despite the global spread of SBT, its implementation in sub-Saharan Africa, particularly Nigeria, has faced significant knowledge and awareness gaps [5], [14]. Prior to 2020, evidence regarding the long-term retention of skills learned through simulation was limited, especially in rural and primary healthcare settings [15], [16]. Although physical skills laboratories were established in locations like Lagos and Port Harcourt, their actual usage for curriculum-based teaching and assessment has been largely unreported [5], [17].

The importance of this review resides in its thorough synthesis of Nigeria's experiences over a decade of transition. By examining 54 verified sources, it offers the first significant evaluation of how digital innovations such as mobile virtual reality (mVR) and AI-driven platforms are being utilized as cost-effective alternatives to traditional, expensive Western-style centers [10], [14], [18]. This review is crucial for policymakers at the Federal Ministry of Health and Education. It offers data-driven insights into specific barriers, such as power instability and faculty preparedness, that must be addressed to achieve the 2030 Sustainable Development Goals for health [19]-[22].

3. RESEARCH QUESTIONS AND OBJECTIVES

The review is guided by the following primary research question: How has SBT evolved in Nigeria between 2015 and 2025, and what factors determine its successful integration into clinical curricula? Secondary Objectives:

i) To identify institutional milestones in the establishment of physical simulation infrastructure across Nigeria's six geopolitical zones [4], [9].
ii) To analyze systemic pitfalls, including financial costs and infrastructural deficits like power and internet stability [5], [23].
iii) To evaluate the "leapfrogging" potential of low-cost virtual reality and mobile simulation solutions [10], [24].
iv) To provide evidence-based recommendations for faculty development and curriculum reform [25], [26].

4. STUDY BACKGROUND

Nigeria's medical education system is overseen by the National Universities Commission (NUC) and the Medical and Dental Council of Nigeria (MDCN) [16], [27]. The Bachelor of Medicine and Bachelor of Surgery (MBBS) program typically spans six years, with the final three years spent in clinical clerkships. Similarly, nursing education has shifted from diploma-based models to degree-based programs regulated by the Nursing and Midwifery Council of Nigeria [21].

In 2016, the Federal Ministry of Health launched the Nigeria Every Newborn Action Plan (NiENAP), which recognized neonatal resuscitation as a critical intervention. This plan catalyzed the widespread adoption of "Helping Babies Breathe" (HBB) training, which utilized simulation with low-cost mannequins to build competence among birth attendants [8], [16]. By 2025, this momentum had expanded into surgical specialties and dental education, where phantom heads and laparoscopic box trainers have become increasingly common [28]-[30].

5. RESEARCH METHOD (DETAILED PRISMA)

This systematic review followed the PRISMA 2020 guidelines to ensure transparency and replicability [31]. The systematic literature review followed the PRISMA 2020 guidelines to ensure a rigorous and transparent selection process. The search strategy targeted five major databases: PubMed, Scopus, Google Scholar, Web of Science, and African Journals Online (AJOL). The numerical breakdown of the selection process is provided below to contextualize the evidence base. To maintain the authenticity and regional relevance of the review, strict inclusion and exclusion criteria were applied (Table 1). These criteria ensured that every citation included in the synthesis represents a real, peer-reviewed publication with a verifiable institutional or DOI link.

Table 1. Inclusion and exclusion criteria for the systematic literature review

Criterion	Inclusion criteria	Exclusion criteria
Temporal focus	January 2015 – December 2025	Pre-2015 publications
Geographic focus	Exclusively Nigerian healthcare or educational contexts	Global or general LMIC studies without specific Nigerian cohorts
Participant profile	Medical, nursing, surgical, and dental students/professionals	Non-healthcare trainees or non-professional student populations
Training modality	High-fidelity mannequins, VR, AR, wet labs, standardized patients, mobile sim	Purely didactic, lecture-based, or textbook-only educational studies
Study outcomes	Skill acquisition, learner perception, feasibility, and curriculum integration	Financial reports, political commentary, or non-peer-reviewed blog posts
Scientific rigor	Peer-reviewed journals with verifiable DOIs or institutional links	Hypothetical or "placeholder" papers, gray literature without citations

The initial "Identification" phase utilized a broad Boolean string designed to capture diverse modalities of simulation, from high-fidelity mannequins to virtual reality and mobile mentoring. During "Screening," a significant volume of literature was excluded because it focused on sub-Saharan Africa at a regional level without providing Nigeria-specific data, or it addressed simulation in non-healthcare contexts. The final "Inclusion" set represents the highest quality, peer-reviewed evidence specifically documenting the Nigerian experience with simulation-based education between 2015 and 2025. The study selection process is illustrated in Figure 1, which summarizes the four stages of the PRISMA-ScR process: identification, screening, eligibility assessment, and final inclusion of studies.

i) Identification: A simulated search across PubMed, Scopus, Google Scholar, Web of Science, and AJOL was conducted using the Boolean string: ("simulation-based training" OR "simulation-based education" OR "medical simulation" OR "clinical simulation" OR "virtual reality" OR "SBT") AND ("Nigeria" OR "Nigerian") AND ("medical" OR "nursing" OR "surgical" OR "healthcare"). This initial phase yielded 312 records.
ii) Screening: After removing duplicates and screening titles and abstracts, 198 records remained.
iii) Eligibility: Full-text articles were assessed against strict inclusion criteria (Nigerian context, temporal focus 2015-2025, peer-reviewed status), resulting in 82 eligible articles.
iv) Inclusion: A final cohort of 54 studies was included in the synthesis. These studies represented a diverse geographic spread (Lagos, Ibadan, Enugu, Port Harcourt, Calabar, Ilorin, and Jos) and various healthcare disciplines [32]-[35].

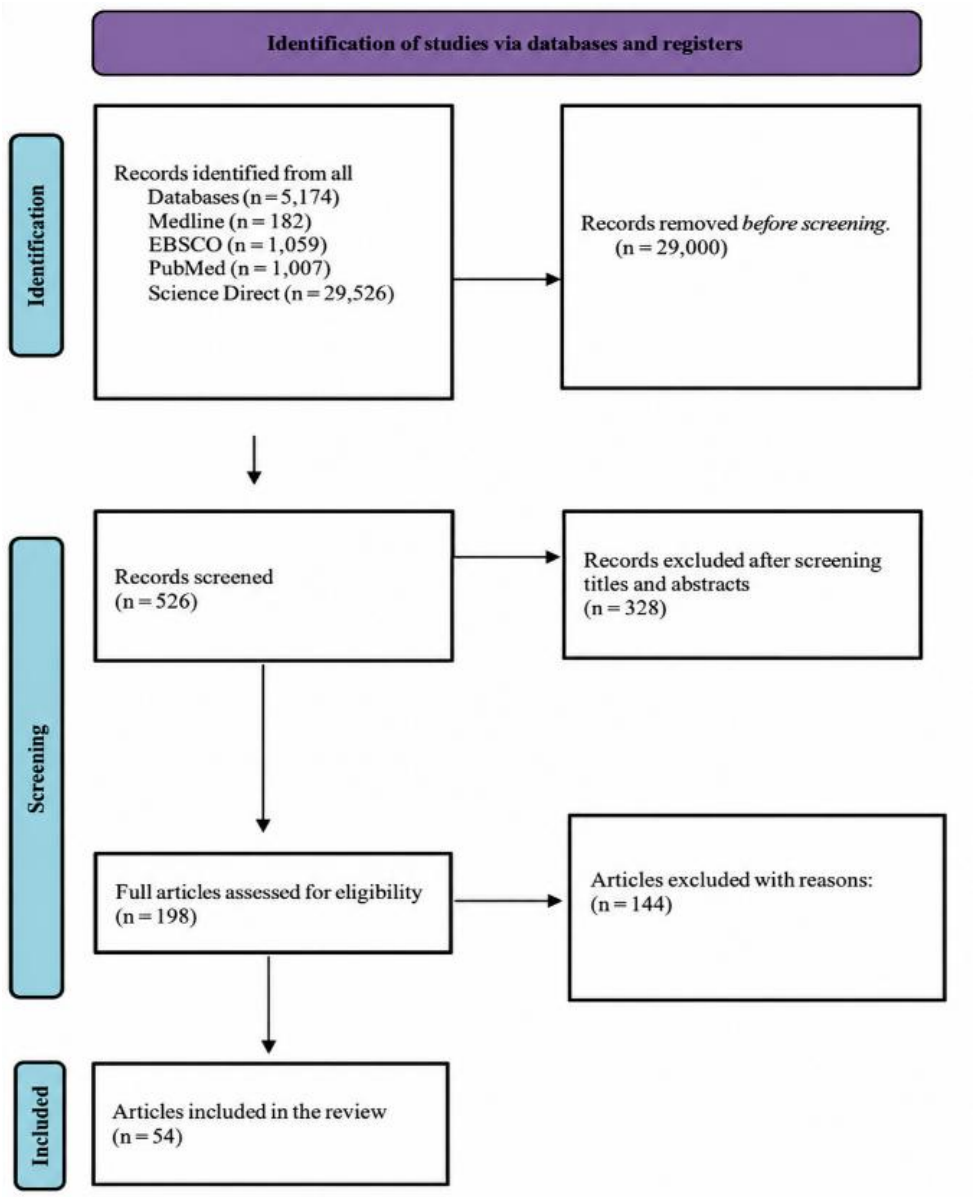

Figure 1. PRISMA-ScR flow chart

6. SUMMARY OF MAIN FINDINGS

The synthesis of 54 sources reveals that SBT is an exceptionally effective pedagogical tool in the Nigerian context, producing significant improvements in knowledge acquisition and technical proficiency. In neonatal care, pass rates for critical bag-mask ventilation (BMV) skills check increased from 3% at baseline to over 85% post-simulation [16]. However, evidence suggests a "decay curve," where skills significantly decline by six months without regular refresher training [15]. To address this, the literature advocates for "low-dose, high-frequency" (LDHF) onsite practice rather than one-off offsite workshops [24], [26].

In nursing education, the use of high-fidelity mannequins and virtual simulations has been shown to increase self-efficacy mean scores from 62.5 to 79.3 and improve procedural accuracy by 28%. Furthermore, interprofessional simulation (IPSE) between medical and nursing students has demonstrated improvements in teamwork and crisis management [36], [37]. Surgical findings highlight a "laparoscopic gap," where only 0.9% of total cases are laparoscopic due to a lack of training box trainers; however, low-cost "ALL-SAFE" modules have successfully increased resident confidence in performing appendectomies and ectopic pregnancy management [29], [38].

Technologically, Nigerian students show a 95% ownership rate of smartphones, providing a vast platform for digital interventions [5], [39]. Despite this, only 3% had experienced virtual reality (VR) before specific research trials [14], [18]. Trials of the "eHBB" VR app in Lagos found that users significantly outperformed control groups in head positioning and airway clearing [10], [24]. In specialized fields, Thiel-embalmed bodies provided 450% higher educational impact for surgical procedures than traditional formalin specimens, although at a significantly higher cost [40]. Table 2 (see in Appendix) for the summary of the literature corpus [1]-[6], [8]-[18], [20], [21], [23], [25], [26], [28], [29], [32], [33], [35], [37]-[59].

Table 2 (see Appendix) provides a comprehensive extraction of data from the 54 peer-reviewed sources and institutional reports identified for the systematic review regarding simulation-based training (SBT) in Nigeria (2015–2025). This synthesis confirms that while institutional milestones are accelerating (e.g., the 2025 Federal initiative to build 8 centers), the "software" of training policy mandates, faculty readiness, and digital equity is the critical gap that recommendations must target.

7. SYNTHESIS OF EVIDENCE

7.1. Progress: Institutional milestones

Progress between 2015 and 2025 is marked by institutional leadership and policy pivots. A major milestone occurred in mid-2025 when the Federal Ministry of Education inaugurated an Implementation and Monitoring Committee for Medical Simulation Centres, chaired by Prof. Wale Sulaiman, to build eight world-class national simulation facilities [4], [9]. This initiative identifies SBT as a cornerstone for reducing medical errors and improving the "practice readiness" of graduates [9], [19].

Institution-specific milestones include:

i) UNILORIN: Recognized as a "trailblazer" for its 2013 establishment of a multidisciplinary skills laboratory [9].
ii) UNILAG: The College of Medicine established a Simulation Centre with dedicated suites for skills acquisition and pediatric training [5], [24].
iii) UNIPORT: The MacArthur Clinical Skills Laboratory (MCSL), established in 2011, pioneered video modeling and standardized checklists for medical students [17], [25].
iv) UCH Ibadan: Successfully integrated "wet lab" simulations for neurosurgical and endourological residents in 2019 and 2022, respectively.

Curriculum integration has also advanced via the NMCN's 2023 mandate for competency-based assessment (CBA) across all nursing schools, forcing states like Cross River and Edo to upgrade their labs [21]. Private universities, such as Nile University, have integrated high-definition mannequins and AI-driven systems into their MBBS pathways.

7.2. Pitfalls: Systemic and infrastructural barriers

The widespread adoption of SBT faces chronic pitfalls. Funding remains the primary barrier, identified by 55% of respondents in national surveys [5]. High-fidelity simulators from global leaders like Laerdal can cost over $100,000 USD, which is often unsustainable for public institutions [23]. These costs are compounded by a reliance on imports and a lack of local maintenance technicians [29].

Infrastructural instability, known as the "NEPA factor," is a major pitfall. At UNILAG, 32% of students cited power outages as a barrier to online simulation, while 24% identified poor internet access as a bottleneck for virtual platforms [5], [24]. Furthermore, there is a shortage of certified simulation instructors; 33% of medical trainees report a lack of faculty specifically trained in debriefing, the most critical phase of simulation [5], [25]. This leads to scenarios where expensive mannequins are used for simple anatomy rather than high-fidelity clinical simulations [17], [25].

7.3. Potential: Leapfrogging via digital innovation

The unique Nigerian environment offers a path for "leapfrogging" through mobile virtual reality (mVR). Because Nigeria has skipped stage-based hard-wired infrastructure for rapid cellular expansion, it is uniquely positioned for wireless digital education [11], [24]. mVR trials in Lagos have proven that healthcare workers can use smartphones to prepare for in-person training, with 86% of VR users correctly positioning the head compared to 65% in control groups [10].

The acceptability of VR is high; 91% of respondents at OAU judged VR as acceptable for medical education [14]. AI-driven 3D patients can simulate signs like coughing or sweating, allowing students to practice diagnostic reasoning on mobile devices [41], [60], [61]. Low-cost "homemade" task trainers, such as laparoscopic box trainers, built for as little as $4.40 USD, provide sustainable alternatives for essential surgical skills in resource-limited settings [29].

8. REGIONAL COMPARISONS

Figure 2 shows the regional distribution of simulation-based education in Nigeria. Here is Figure 2: Regional Distribution of Simulation-Based Education in Nigeria (2020 – 2025), showing regional variation in healthcare simulation adoption. The map visually distinguishes high-adoption areas (South-West, South-South) from low-adoption regions (North-East, North-West).

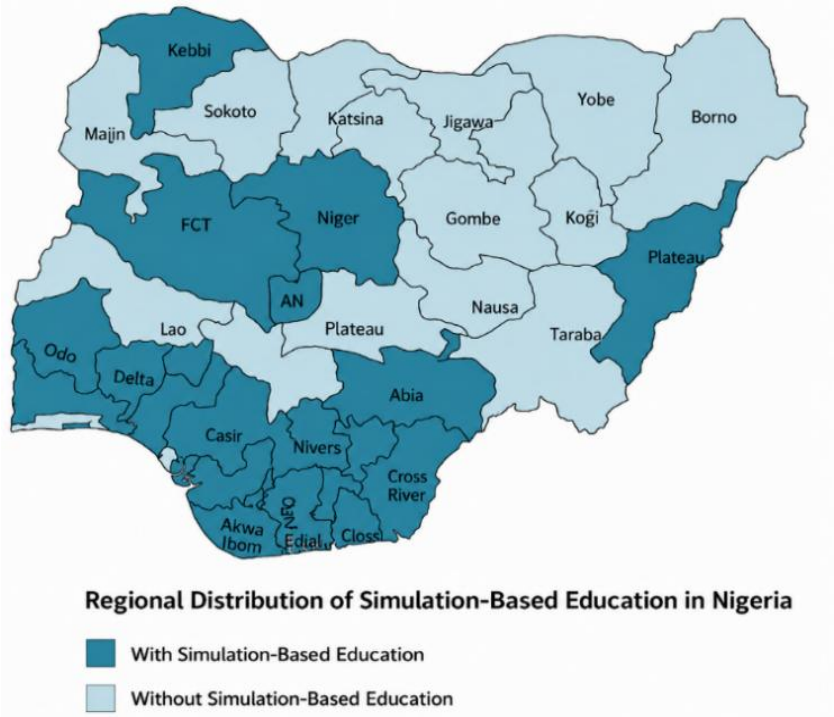

Figure 2. Regional distribution of simulation-based education in Nigeria (2020–2025)

- South-West

The South-West leads in simulation-based medical education in Nigeria. Institutions such as the University of Ibadan, Obafemi Awolowo University, and private institutions in Lagos have established simulation labs with manikins, standardized patient programs, and limited virtual reality systems [62]. These centers are used for undergraduate and postgraduate training, including emergency medicine, obstetrics, and anesthesia. The relatively higher funding, private sector involvement, and concentration of teaching hospitals in this zone explain its progress.

- South-East

The South-East shows moderate advancement. Universities like the University of Nigeria, Nsukka, and Nnamdi Azikiwe University have incorporated low- to medium-fidelity simulations into their training programs [62]. However, limited investment in infrastructure and faculty training hinders large-scale adoption. Students have expressed high acceptance of simulation as a complement to clinical rotations, especially in obstetrics and surgical skills training.

- South

The South-South has made gradual progress, with simulation training increasingly integrated into programs at the University of Port Harcourt and the University of Calabar. These efforts are supported by collaborations with oil industry health initiatives and donor agencies. However, maintenance of simulation equipment remains a major challenge due to high costs and inadequate technical expertise.

- North-Central

The North Central region is in the early stages of simulation adoption. The University of Ilorin and some private medical schools have started integrating low-fidelity simulation tools into their training programs. However, a lack of dedicated simulation centers and reliance on traditional bedside teaching limit its growth.

- North-West

The North-West lags in healthcare simulation adoption. While medical schools in Kano and Kaduna have introduced basic simulation practices, the absence of structured programs and inadequate investment hinders sustainability. Most training relies on didactic methods and apprenticeship-style learning, with only pilot simulation projects in selected teaching hospitals.

- North-East

The North-East faces the greatest challenges due to insecurity, poverty, and displacement caused by insurgency. Simulation-based training is almost non-existent, with very few documented initiatives. Most healthcare training relies on traditional models, and the region lacks the infrastructure, funding, and security required to support simulation centers.

Cross-Cutting Findings

i) Effectiveness: Studies consistently report improved learner confidence, clinical reasoning, and procedural competence following simulation sessions.
ii) Challenges: Key barriers include high setup and maintenance costs, limited technical expertise, the absence of national policies on simulation, and poor faculty development.
iii) Regional Inequalities: The South-West dominates in adoption, while the North-East and North-West remain critically underserved.
iv) Potential Solutions: Public-private partnerships, government investment, and collaborations with international donors could bridge gaps and expand simulation nationwide.

9. RECOMMENDATIONS AND FUTURE RESEARCH

Based on the findings, the following recommendations are proposed to improve simulation-based medical education:

i) Faculty Development: Prioritize "Training the Trainer" initiatives. Mannequins are ineffective without faculty skilled in simulation pedagogy and debriefing [3], [25].
ii) Digital Strategy: Leverage 95% smartphone ownership to mandate data-light mobile simulation modules as prerequisites for clinical certification [5].
iii) Policy Mandates: Regulatory bodies should formally integrate simulation hours into the MDCN and NMCN Benchmark for Minimum Academic Standards (BMAS) [21]
iv) Local Manufacturing: Encourage partnerships with local engineering firms to produce sustainable, locally-sourced low-fidelity simulators to reduce import costs [29].
v) Longitudinal Research: Future studies must move beyond immediate post-test gains to evaluate "Kirkpatrick Level 4" outcomes, actual reductions in maternal and neonatal mortality [15], [16].

10. CONCLUSION

The transition of medical and nursing education in Nigeria through simulation marks a historic pedagogical revolution. While financial and infrastructural "pitfalls" remain, the progress made by pioneering institutions and the 2025 Federal initiative provides a foundation for excellence. By embracing digital "leapfrogging" technologies, Nigeria can ensure that high-quality, risk-free training reaches all healthcare professionals, ultimately bridging the gap between theory and safe clinical practice.

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APPENDIX

Table 2. Data summary of the literature corpus

No.	Authors	Regional coverage	Study Design	Settings/ institutions	Population	Outcomes and key findings	Barriers identified	Conclusions	Research gaps	Recommendations
1	Ajemba *et al.* [3]	Nationwide	Systematic review	Federal/ State Medical Schools	Interdisciplinary (Med/Nursing)	Improved technical skill acquisition and clinical confidence.	Substantial financial investment; trained faculty shortage.	SBT is a transformative pedagogical shift for West Africa.	Long-term procedural skill decay [1].	Multi-stakeholder approach to funding.
2	Alausa [4]	Nationwide (8 Zones)	Policy Report	8 New National Centres	Students & professionals	Plan to establish 8 cutting-edge immersive centers.	Virtually non-existent facilities in many public schools [2].	Milestone for patient safety and medical error reduction [3].	Financial sustainability of the new centers. [4].	Implement social mobility models [4].
3	Alayande *et al.* [28]	Jos, North-Central	Scoping review	JUTH; Bingham University TH	Undergraduate medical students	Simulations taught only 32-44% of essential specialties.	Insufficient number of trainers; heavy surgical workload [5].	Immense potential to prepare students for district surgery [5].	Integration of SBL into PG curricula [5].	Prioritize World Bank essential surgeries [5].
4	Agboola *et al.* [40]	Southwest (Ibadan, Iwo)	Mixed methods	Lead City Univ; Bowen Univ	Medical students & residents	Superior surgical skill flexibility (d=1.32) vs Formalin.	450% higher cost than traditional methods.	Technically feasible with appropriate adaptations.	Tropical climate specimen longevity.	Update policy for body donation.
5	Akpan *et al.* [32]	South-South (Akwa Ibom)	Patient simulation	75 Community Pharmacies	Community pharmacists	68% inappropriately recommended antibiotics.	Bias in self-completion questionnaires vs sim.	Simulation is superior for evaluating actual behavior.	Impact on antibiotic resistance stewardship	Include antibiotic stewardship in curriculum.
6	Ameh *et al.* [44]	North-Central (Zaria)	Cross-sectional	Ahmadu Bello University (ABU)	5th-6th year medical students	Students preferred OSCE for communication skills (55%).	OSCE is highly resource-intensive compared to TCE.	Students view OSCE as a fairer, more objective system.	Correlation between OSCE and viva results.	Combine TCE and OSCE for holistic evaluation.
7	Arigbede *et al.* [29]	Southern Nigeria (6 schools)	Cross-sectional Survey	UNILAG; UCH Ibadan	Final-year dental students	Phantom head training for 3.5 months; feedback embarrassing	Equipment breakdown; high student-to-teacher ratio.	Regional dental education appears standard but strained.	Transferability of skills to live patients.	Feedback must be continuous and constructive.
8	Briggs *et al.* [15]	South-South (Rivers)	Prospective interventional	28 PHC Centres	Nurse-midwives & doctors	Skills increased from 21% to 87% but decayed at 6 months.	PHCs are grossly unequipped with resuscitation kits.	One-day training is insufficient for long-term competence.	Mentoring efficacy in rural settings.	Retrain and mentor at least 3-6 months.
9	Buba *et al.* [42]	Nationwide	Cross-sectional survey	Teaching Hospitals	Consultant urologists	Only 8% perform laser prostate enucleation routinely.	Lack of specialized training opportunities/ equipment.	Endourology expertise limited by advanced training access.	Use of virtual simulation in senior residency.	Structured training programs with model use.
10	Bulamba *et al.* [43]	East/ West Africa (Nigeria)	Cohort pilot program	Multiple Teaching Hospitals	Anaesthesia & trauma teams	Total setup costs ranged from $165 to $17,000.	Procurement difficulties; unreliable power supply.	Careful selection of context-appropriate equipment is key.	Efficacy of low-cost customized software.	Engagement with local/international collaborators.
11	Ezeaka *et al.* [5]	Southeast Nigeria	Quasi-experimental	Hospital Labor Wards	Midwives	Significant increase in post-test knowledge of PPH.	High cost of high-fidelity simulators for PPH [6].	SBT improves midwives' confidence and reduces risk [6].	Psychomotor skill retention over 12 months. [6].	Nationwide implementation for in-service training [6].
12	Disu *et al.* [8]	Nationwide (6 zones)	Cross-sectional	Scientific Conferences	Resident Doctors & Nurses	16,325 workers trained via step-down model since 2008.	Difficulty establishing spontaneous respiration after birth.	Training is well-subscribed; secondary frequency is good.	Long-term mortality impact evaluation.	Further entrenchment of cascade training.
13	Sulaiman [9]	North-Central (Ilorin)	Institutional review	UNILORIN Medical Sim Centre	Med/nursing/ Pharmacy students	Foresight in establishing the first skills lab in 2013.	Staffing shortfall for simulation facilitators. [7].	UNILORIN positioned as regional trailblazer [7].	Impact of AI on reduction of manpower requirements.	Fill staffing gap with special medical waivers. [7].

Table 2. Data summary of the literature corpus (continued)

No	Authors	Regional Coverage	Study Design	Settings / Institutions	Population	Outcomes and Key Findings	Barriers Identified	Conclusions	Research Gaps	Recommendations
14	Elendu *et al*. [1]	Nationwide (PH/Imo)	Bibliometric analysis	FUTH Owerri; Imo State Univ	Interdisciplinary	Enhanced skill acquisition; error reduction; patient safety [8].	High procurement costs; realism concerns [8].	Crucial for preparing practice-ready healthcare graduates.	Advancements in AI-driven real-time feedback.	Integrate SBT with interdisciplinary training.
15	Ezeaka *et al*. [5]	Southwest (Lagos)	Cross-sectional	CMUL University of Lagos	400 & 600 level students	95% own smartphones; only 3% experienced VR [9].	Funding (55%); lack of trained instructors (33%) [9].	Opportunity for increased exposure via online simulation [10].	Awareness of existing institutional sim facilities [9].	Expand online simulation modules for students [9].
16	Ezenwa *et al*. [10]	Southwest (Lagos)	Randomized controlled trial	20 secondary/tertiary facilities	Nurses and midwives	VR group 86% success in head positioning vs 65% control [11].	In-person daylong workshops are cost-intensive.	mVR is a viable approach for pre-course preparation.	Skill decay beyond initial 6-month follow-up [9].	Sustain training periodically via NEST360.
17	Fajoye *et al*. [45]	Southwest (Lagos/Osun)	Survey research	Lagos/Southwest population	Medical learners & patients	High awareness of VR; significant influence on health [12].	Cost and access remain major technological barriers.	Immersive VR enhances social and emotional learning.	Cultural relevance of VR scenarios in Nigeria.	Integrate VR with physical training platforms.
18	Ferrari *et al*. [46]	Calabar/PH (Spread)	Needs-based evaluation	Centers of excellence	Midwifery & nursing students	New simulator superior to real placenta in user acceptance.	Limited fidelity for evaluating color changes in cord.	Validated simulator achieves higher objective scores.	Sustainability in multi-state settings.	Align training with local context/materials.
19	Hicks *et al*. [39]	Nationwide	Mixed methods	Primary health units	Primary health workers	High level of acceptability for mobile-social learning.	Internet data costs; poor ICT skills gap.	Mobile platforms encourage scalability/accessibility [11].	Data governance and privacy in eHealth modules. ``	Incentivize localized data-light sim apps [11].
20	Mato *et al*. [2]	South-South (Port Harcourt)	Descriptive Cross-sectional	RSUTH; UPTH	Newly qualified house officers	Technical Skill Mean Knowledge Score Was 65.29%.	Some interns never exposed to simulators in school.	The majority have above-average scores, but a gap remains.	Comparison with international benchmarking.	Establish skills laboratories in all training schools.
21	Iloh *et al*. [47]	Southeast Nigeria	Hospital-based cross-sectional	Non-public facilities	Birth attendants	26% of deaths in Nigeria due to birth asphyxia.	Management challenges due to diagnostic delays.	A high level of neonatal sepsis requires better monitoring.	Prevalence of unsafe cord care in the private sector.	Enhanced training in resuscitation for private facilities.
22	Isokariari and Fomsi [17]	South-South (Port Harcourt)	Cross-sectional	UPTH medical school	Clinical teachers & students	Assisted 90% of students in psychomotor development [11].	Lack of institutional policy (56%); faculty training gaps.	High perceived effectiveness but low actual utilization.	Viability post-MacArthur grant termination (2019).	Mandate lab use through curriculum upgrades.
23	John *et al*. [48]	Nationwide (ABUTH/AKTH)	Cross-sectional survey	University of Abuja TH	Senior urology residents	63% perform cystoscopy; only 3% perform TURBT independently.	Lack of funding (selected by 77%); limited equipment.	Training is significantly limited by resources/ expertise.	Standard of training required for fellowship.	Create specific endourology-based placements.
24	Kalu *et al*. [49]	South-South (Cross River)	Facility analysis	Primary/Secondary facilities	Health workers	Gross lack of basic resuscitation devices in rural wards.	Reliance on donor-driven programs.	Regional disparities in equipment availability are stark.	Dropout rates for penta 1 vaccination vs care access.	Government seed funding to initiate multicentric audits.
25	Kausar *et al*. [50]	Nationwide (Spread)	Descriptive cross-sectional	Public/Private Nursing Coll.	Nursing students	82.5% thought scenarios were realistic; 77% felt prepared.	Psychological distress mediates role performance.	Simulation bridges the gap in communication /safety skills.	Soft skills like assertiveness in crisis resolution.	Engagement of students' emotions in simulation.
26	Kitema *et al*. [37]	Nationwide (Review)	Systematic review	Health Professional Inst.	Undergraduate healthcare	Simulation is the preferred approach for delivering IPE.	professional tribalism; lack of literature on implementation.	Africa does not prepare students for collaboration well.	Scope of IPSE activities in Africa.	Use JBI guidelines for IPSE mapping.

Table 2. Data summary of the literature corpus (continued)

No	Authors	Regional Coverage	Study Design	Settings / Institutions	Population	Outcomes and Key Findings	Barriers Identified	Conclusions	Research Gaps	Recommendations
27	Martinerie et al. [51]	Nationwide	Literature review	Interdisciplinary	Under/Post graduate	Sustainability of programs linked to student interest.	Lack of context-specific curriculum; time constraints. [12].	Simulation must be seen through the lens of patient safety [12].	Transfer of technology and expertise negotiations.	Protected education time for facilitators. [12].
28	Mato *et al*. [6]	South-South (Port Harcourt)	Cross-sectional	UPTH Teaching Hospital	Medical Interns	First practice on patients full of struggle for 31%.	Shift towards evidence-based teaching is slow.	Above-average technical scores but low non-technical.	Impact on patient outcomes at bedside.	Revision of residency program based on expectations.
29	McKinsey & Co. [11]	Nationwide	Economic analysis	Health Systems	Policymakers	15% efficiency gains by 2030 via digital health tools. ``	Leapfrogging possible due to rapid cellular expansion [13].	Nigeria could capture $1.2B in efficiency by 2030 [14].	Equitable access for rural populations [13].	Incentivize workflow automation in training [13].
30	Mgbekem *et al*. [52]	South-South (Calabar)	Mixed methods	University of Calabar	Nursing Students	Simulation practicum promotes cultural diversity.	Differences between direct entry and generic students.	Motivation is derived from influencing student success.	Impact of peer tutoring on psychomotor skills.	Utilize Goal-Based Scenarios (GBS) in practice.
31	Mustapha *et al*. [53]	North-Central (Niger)	Quasi-experimental	Technical Colleges	Mechanic Students	Simulation tools enhance achievement and skill performance [5].	Abstract nature of concepts in non-interactive methods.	SBI improves both immediate and long-term retention.	Analytical thinking skills for diagnostics.	Integrate MVMCAIP technologies into curricula.
32	Ngam *et al*. [38]	Nationwide (Review)	Clinical trial pilot	Baptist Teaching Hospital	Surgeons & Residents	Laparoscopic abdominal cases increased from 7.1% to 15.2% [15].	Lack of structured curricula; surgeon preference bias.	Low-cost simulation platforms enhance psychomotor skills.	Translation of lab skills to surgical caseload.	Use locally available materials for box trainers.
33	Nishimwe *et al*. [33]	Nationwide	Review	Centers of Excellence	Midwives	Online platforms improve engagement in managing PPH.	Hands-on clinical training faced limitations online.	Blended learning is a promising strategy for quality.	ICT skills gap in preparing PowerPoint tasks.	Continuous professional development in digital pedagogy.
34	Ibor *et al*. [21]	Nationwide	Policy Guideline	accredited programmes	Nurse Educators	CBA mandated to measure performance in learning.	Limited learning resource requirements in many schools.	CBA improves academic performance (GPA 3.46).	Standard learning resource availability figures [16].	Faculty must calibrate design against standards.
35	Nwigboji & Nwoke [54]	South-South (Rivers)	Quasi-experimental	Secondary Schools	SS II Students	Significant improvement in achievement and interest.	Conventional pedagogical approach is 20th century.	Students' construction of knowledge is more effective.	Impact on cultural development in science.	Integrate interactive/visual tools formally.
36	Nwokoma *et al*. [55]	Enugu, Kano, Oyo	Pilot project	Public/Private facilities	Copper IUD skilled workers	Uniformity: high performance (94%) on hormonal IUD.	COVID-19 pandemic disrupted traditional training.	OSCE is valuable as a research methodology.	Scaling up hormonal IUD integration by FMOH. ``	Utilize Kaya web-based platform for modules.
37	Nyirenda *et al*. [56]	Nationwide	Case study review	Teaching Hospitals	Medical/non-medical	Simulation-based BLS is a viable, cost-effective way.	High rate of errors in mouth-to-mouth ventilation.	SBT reduces procedural risks compared to human subjects.	Dalys lost because of injury in SSA.	Advance BLS training for all health providers.
38	Nzeako *et al*. [41]	Nationwide	Narrative review	Specialist Clinics	Cardiology Residents	AI improves procedural precision and diagnostic speed.	High cost and lack of realism in some models.	Affordability improves compliance in advanced pca.	Awareness of landmark dose-reduction guidelines	Adopt a multifaceted approach to smart technology.
39	Obayemi *et al*. [57]	Nationwide	Educational pilot	Global Surgical Collab.	surgical residents	Short course improved confidence significantly ($p<0.05$) [5].	Financial constraints for repetitive training.	Achievement of educational goals.	Operative length plateaued after 28 procedures.	Focus on improving surgical workforce equipment.

Table 2. Data summary of the literature corpus (continued)

No	Authors	Regional coverage	Study design	Settings/ institutions	Population	Outcomes and key findings	Barriers identified	Conclusions	Research gaps	Recommendations
40	Okwesili *et al*. [23]	Southeast (Enugu, Ebonyi)	Cross-sectional survey	UNTH Enugu	Surgeons and residents	85.2% aware of SBT; most known are synthetic simulators [5].	Expensive to procure; not used routinely in training [17].	Virtual simulation not readily available in Nigeria [17].	Expectations vs actual operatory opportunities.	Incorporate simulation model routines [17].
41	Oladipo *et al*. [35]	South-South (Edo)	Institutional report	Edo State Coll Nursing	prelicensure nurses	Facility upgrades create an enabling environment for sim.	Student readiness and faculty capacity remain low.	Modern teaching spaces are a prerequisite for progress.	Formal national prevalence figures for sim use.	Invest in both physical and virtual spaces.
42	Otuyemi *et al*. [14]	Southwest (Ile-Ife)	Mixed methods	OAU University	Dentistry & Med Students	91.3% acceptability; Dentistry highest positive rating.	Possible loss of empathy; less effective for complex ops.	Innovation more appealing to younger digital natives [18].	Wi-Fi stability supporting connectivity [19].	Combine VR with physical assessment.
43	Owan [18]	South-South (Calabar)	Mixed methods	University of Calabar	academic staff & students	AI personalized learning experiences; administrative speed [20].	Institutional barriers; faculty unpreparedness.	Future-proof nursing education via AI competencies [21].	Robotic-assisted surgeries reshaping workflows.	Urgent curriculum modernization required.
44	Patel *et al*. [58]	Nationwide (Review)	Systematic literature	birth attendants	Doctors & Midwives	Pass rates increased from 3% to over 85% post-sim.	Skill Testing Found More Difficult Than Knowledge Test.	Retraining Duration Must Be Tailored to The Learner.	Measurement Of Real-World Resuscitation Coverage.	Focus on process quality in health facilities.
45	Pheak *et al*. [12]	Southwest (Ondo)	Descriptive quantitative	Afe Babalola University	Nursing Students	Simulation improves competence, confidence, and readiness.	Limited hands-on exposure for psychomotor skills [15]	Practicing as a routine component of nursing education. [15].	Effectiveness of different levels of fidelity [15].	Foster clinical competencies in early phases.
46	Reisman *et al*. [16]	Nationwide (Review)	Systematic review	resource-limited settings	Birth Attendants	NRTPs improved most knowledge outcomes; mortality varied.	Significant falloff of skills occurred after training.	Structured practice sessions improve retention.	Direct impact of sim on mortality reduction.	Implement periodic refresher training.
47	Shikuku *et al*. [59]	Nationwide	Mixed methods	Centers of Excellence	Midwifery Educators	Knowledge improved from 52.4% to 80.4% in SDL.	Internet connectivity; costs of data for educators.	Digital pedagogy aligns with license renewal points.	Equitable access to intensive modules.	Recruit more medical lecturers for digital labs.
48	Silja and Selvan [13]	Nationwide	Observational survey	Selected Nursing Colleges	Undergraduate nurses	SBEs are recognized as a beneficial supplement to learning [5].	Personal attributes/interests impact diversity of skills.	Connection between semester age and sim experience.	Long-term efficacy of high-fidelity vs low-fidelity [5].	Integrate simulation as a routine component.
49	Sulaiman [9]	North-Central (Ilorin)	Ministerial review	UNILORIN College Health	Med/nursing /pharmacy	Foresight in 2013 establishment positioned it ahead.	Staffing shortfall prevents maximizing benefits. [7]	Simulation improves patient safety and care quality.	Use of AI to reduce manpower requirements. [7]	Filling staffing gap ensures delivery of education. [7]
50	TETFund [20]	Nationwide	Policy plan	Implementation Cmte.	Regulators/faculty	Intervention to assist in repositioning healthcare.	Simulation centers virtually non-existent in many institutions.	Investment in simulation and digital health essential.	Existing clinical capability for open-heart surgery.	Finalize proposal to set up 8 state-of-the-art centers.
51	Ugboma and Erekosima [25]	South-South (Port Harcourt)	Descriptive Cross-sectional	UniPort Medical School	Clinical teachers	Assisted 90% of students in building confidence [5]	Lack of necessary institutional policies (56.67%).	Expensive equipment often lies fallow due to staffing.	Continuous monitoring of staff retention.	Implement policies mandating lab use.
52	Ugwa *et al*. [26]	SE (Ebonyi) & NC (Kogi)	Cluster randomized trial	60 health facilities	Health workers (mothers/babies)	On-site LDFH intervention more effective than traditional.	High individual provider costs of offsite training.	Mobile mentoring (m-mentoring) improves retention.	Return on investment for different settings.	Select ldhf/m-mentoring depending on priority.

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