

# Use of Virtual Simulation as a Tool in Surgical Training: Survey of Surgeons in South-Eastern Nigeria

OR Okwesili, UC Mba<sup>1</sup>, UU Nnadozie<sup>2</sup>, LO Okwesili<sup>3</sup>, EO Ugwu<sup>4</sup>, JC Igwe, CC Maduba<sup>2</sup>, II Nnabugwu

Departments of Surgery and <sup>3</sup>Ophthalmology, University of Nigeria Teaching Hospital (UNTH), Enugu, <sup>1</sup>Department of Surgery, Enugu State University of Science and Technology (ESUT), Enugu, <sup>4</sup>Department of Obstetrics & Gynaecology, University of Nigeria, Nsukka, Enugu State, <sup>2</sup>Department of Surgery, Alex Ekwueme Federal University Teaching Hospital, Abakiliki, Ebonyi State, Nigeria

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ABSTRACT

**Background:** Surgical training in developing climes is predominantly based on the apprenticeship model. The number of surgical residents has increased worldwide. Surgical residents now have limited clinical exposure and decreased operation opportunities. This challenge is overcome by the incorporation of simulation models in surgical training. It is necessary to evaluate the extent of utilization of simulation-based surgical training in this digital era. **Aim:** The objective of this study was to evaluate the knowledge and exposure to use of simulation-based surgical training among surgeons in Southeastern Nigeria. **Methods:** The study was conducted among surgical residents and consultants in three teaching Hospitals in South-eastern Nigeria. It was a descriptive cross-sectional survey, and the calculated sample size was 213. A survey questionnaire was administered to 216 respondents, and data collected were analysed. **Results:** The majority of the respondents (75.9%) were males, and 52.3% of them were between 31 and 40 years. The respondents that have heard about any simulation-based training were 85.2%, and the most known modality of simulation was synthetic simulators (37.04%), followed by animal-derived simulators (26.45%) and cadaver-derived simulators (23.81%). The majority of the respondents (53.7%) said that simulation was not used routinely in surgical training in Nigeria, but only used during workshops, courses, and conferences (56.1%). Only 27 respondents were aware of any hospital where virtual simulation was used in training. The lack of relevant equipment and its high cost were the major limitations of using simulation in surgical training. **Conclusion:** Virtual simulation is not readily available for surgical training in Nigeria mainly because it is expensive to procure. Other forms of simulation are used for training residents, but they are not used routinely.

**KEYWORDS:** *Simulation-based surgical training, surgical simulation, surgical training, residency training, virtual simulation*

## INTRODUCTION

Surgical training of resident doctors in developing climes is predominantly based on the traditional model based on apprenticeship, and this was the only system used by all surgical trainers in the past, but the trend is changing<sup>[1,2]</sup> The number of surgical residents has increased worldwide, and there are many hospitals that conduct surgeries but do not train residents. The disadvantages of the continued operation of the traditional model are the worsening situation of surgical residents having limited clinical exposure and decreased operation opportunities.<sup>[1]</sup> With this apprenticeship

model, the assessment of surgical training is usually based on duration of training but the time spent does not always translate to having enough learning opportunities. It is essential to have an assessment of surgical training that is competency-based and not duration-based. This can be effectively done by incorporating the use

**Address for correspondence:** Dr. OR Okwesili, Department of Surgery, University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu State, Nigeria. E-mail: obiokwesili@gmail.com

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of simulation in surgical training, especially virtual simulation, in filling the gap that has developed in the apprenticeship model. Simulation objectively assesses surgical competency of trainees and without the risk of complications.<sup>[2]</sup> It would help in standardizing surgical programs across the globe.<sup>[2]</sup>

Simulation models used in training include human and animal cadavers (especially soft-embalmed cadavers),<sup>[1,3]</sup> synthetic simulators,<sup>[4]</sup> virtual reality, and augmented reality.<sup>[5]</sup> Virtual reality is one of the most recent of these modalities, and it is used to simulate a surgical environment or a procedure. It is considered as the “most cost-effective and efficient method” for training surgery residents.<sup>[6]</sup> Training using virtual simulation continues even in the absence of patients. In this regard, virtual simulation and other digital technologies have been proven to be quite useful in delivering safe and efficient surgical training,<sup>[6,7]</sup> even when there was need to maintain social distance as indicated during COVID-19 pandemic.

Utilization of virtual simulation and other digital technologies is the ultimate destination of surgical training with the rise in medical litigations worldwide. There are surgeons that insist that patients should not be used for learning.<sup>[8,9]</sup> It is therefore necessary to evaluate the extent of utilization of virtual resources and other surgical simulation in a developing economy like Nigeria and to explore ways of enhancing it.

## MATERIALS AND METHODS

The study was conducted among resident doctors and consultants in specialties or subspecialties that carry out surgical procedures in three teaching Hospitals in South-eastern Nigeria. These comprise doctors in departments of surgery (general surgery, plastic surgery, neurosurgery, cardiothoracic surgery, urology, and paediatric surgery), orthopaedic surgery, ophthalmology, otorhinolaryngology, or oromaxillofacial surgery and the department of obstetrics and gynaecology.

This is a descriptive cross-sectional survey that was conducted among residents and consultants working in the selected hospitals to determine the extent of their knowledge, their exposure and the utilization of virtual resources, and other simulations in surgical training in Nigeria. Ethical approval was obtained from the Health Research and Ethical Committee of the three institutions and their reference numbers are NHREC/05/01/2008B-FWA00002458-1RB00002323, NHREC/16/05/22/266, and ESUTHplc-MAC/RA/034/144

The research was done using a predesigned survey questionnaire in hard copies. The data obtained include the demographics, knowledge on simulation-based

training of surgery residents in Nigeria, and the exploration of the exposure and experience of the respondents of such training, especially training using virtual simulation. A stratified random sampling method was used. The three tertiary hospitals were randomly chosen from tertiary hospitals in Southeast Nigeria. The total population of residents and consultants in the tertiary hospitals was approximately 460 at the time of the study. The sample size was calculated using Yamane’s formula:<sup>[10]</sup>

$$n = N/[1 + N (e)^2]$$

where  $n$  is sample size,  $N$  is population size (460), and  $e$  is the level of precision which is 5 percent (0.05). A confidence level is also 95% is also assumed for this formula.

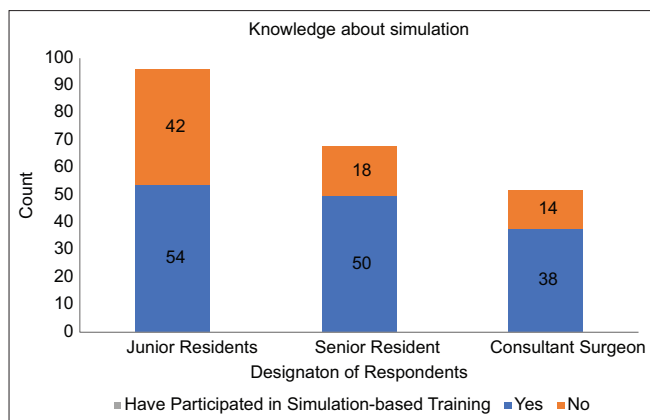
$$n = 460/[1 + 460 (0.05)^2] = 213 \text{ respondents}$$

A sample size of 213 respondents was used. The survey questionnaire was administered on paper to a minimum sample size of 213 residents/consultants, with a proportionate number from each of the three target institutions. A total of 275 of questionnaires were shared, but only 216 completed ones were returned. The questionnaires were shared through representatives in each of three institutions. The majority of the questionnaires were shared during the weekly clinical conferences of the specialties, although a few were shared in the surgeons’ rooms in the theatres and in the clinics. The research participants were told the purpose of the study. They were also assured of maintenance of their privacy and anonymity and were free to participate, and those who consented to the study were included after they signed consent form. The study was carried out over 6 months. The data collected were entered, and descriptive analysis was done using Statistical Package for the Social Sciences (SPSS, IBM Version 25 for Windows). Data were presented in percentages and proportions.

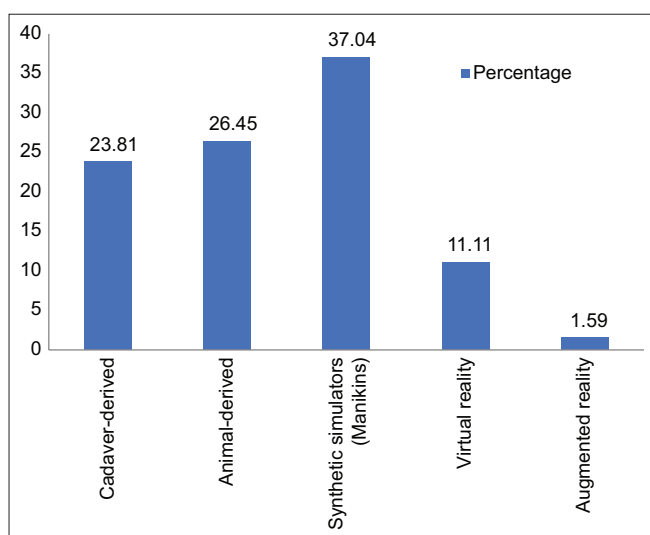
## RESULTS

### Demographics

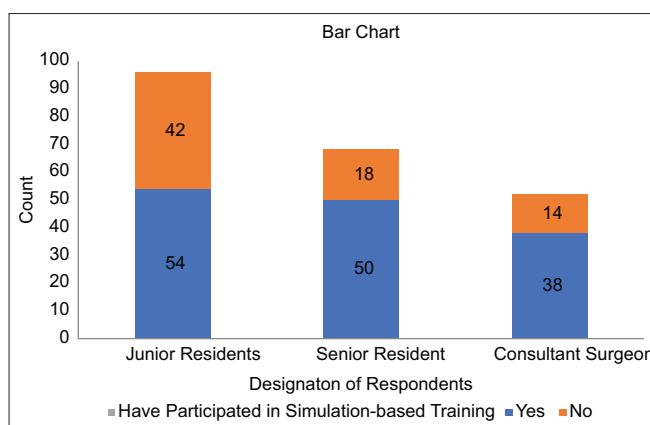
Out of 275 questionnaires that were shared among surgeons, a total of 216 were returned, giving a response rate of 78.54%. The majority of the 216 respondents (75.9%) were males [Table 1]. Over half of the respondents were aged between 31 and 40 years (52.3), while 29.6% of them were within the 41 to 50 years age group [Table 1] The proportion of females in each age group was less than 50% [Figure 1]. The majority of respondents were Junior residents (44.4%), as shown in Table 1.



**Figure 1:** Response to whether the surgeons have participated in simulation-based surgical training



**Figure 2:** Modalities of simulation used in training surgical residents in Nigeria



**Figure 3:** Respondents that have participated in simulation-based surgical training

### Use of diverse simulation-based trainings in surgical practice in Nigeria

The proportion of respondents who have heard about any simulation-based training for learning a surgical

**Table 1: Demographics of respondents**

Variable	n	%
<b>Sex</b>		
Male	164	75.9
Female	52	24.1
Total	216	100.0
<b>Age</b>		
21-30yrs	23	10.6
31-40yrs	113	52.3
41-40yrs	64	29.6
51-60yrs	15	6.9
61-70yrs	1	0.5
Total	216	100.0
<b>Designation of respondents</b>		
Junior Residents	96	44.4
Senior Resident	68	31.5
Consultant Surgeon	52	24.1
Total	216	100.0

**Table 2: Responses on use of simulation-based training routinely or only during events like workshops, courses, and conferences**

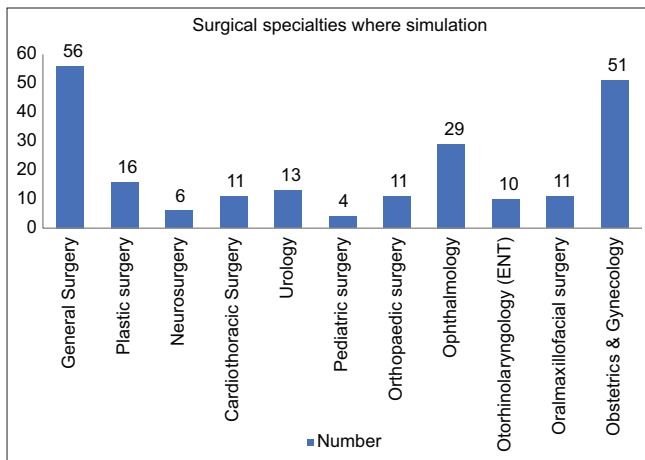
Response	Number	Percent
<b>Was simulation used routinely as part of the curriculum for training residents?</b>		
Yes	72	33.3
No	116	53.7
No answer given	28	13.0
<b>Was it used only during a workshop, course, or conference?</b>		
Yes	121	56.1
No	53	24.5
No answer given	42	19.4

**Table 3: Modalities of simulation respondents participated in**

	Number	Percent
Cadaver-derived	53	21.99
Animal-derived	57	23.65
Synthetic simulators (Manikins)	98	40.66
Virtual reality	28	11.61
Augmented reality	5	2.07
Total	241	100.00

procedure was 85.2%. Junior residents constitute more than 50% of those who have not heard about simulation-based surgical training [Figure 1]. There were still a few consultants who have not heard about it.

Those that responded to the issue of the modality of simulation used in surgical training in Nigeria were 123, although 48 of them gave multiple answers amounting to 189 responses. The most known modality of simulation among surgeons was the



**Figure 4:** Specialties where simulation-based surgical training was experienced

**Table 4: Use of virtual simulation in Nigeria and surgeons' attitude towards it**

Factors	Number	Percentage
Any Nigerian Centre using virtual simulation-based training?		
Yes	27	12.6%
No	188	87.4%
Would you like to use virtual simulation first before surgery on a patient?		
Yes	184	88.9%
No	11	5.3%
Not sure	12	5.8%
Would there be a surge in using virtual simulation if it was available?		
Yes	204	95.8%
No	9	4.2%

**Table 5: Procedures respondents experienced using virtual simulation**

Procedure	Number	Percent
Forceps Vaginal Delivery	4	14.8%
Spinal Anaesthesia	4	14.8%
Arthroscopy	2	7.4%
Endoscopic Surgeries	6	22.2%
Surgical Skills and Procedures	5	18.5%
Minimal Access Surgery	1	3.7%
Cataract	1	3.7%
Laparoscopy	2	7.4%
Visual Aid	2	7.4%
Total	27	100

**Table 6: The limitations of using virtual simulation for surgical training**

Limitations of virtual simulation-based surgical training	Number	Percent of responses	Percent of 216 respondents
Ignorance	76	15.17%	35.51%
Lack of expertise required for training	92	18.36%	42.59%
Lack of relevant equipment	154	30.74%	71.30%
High cost of the relevant equipment for facilities	125	24.95%	57.87%
Government policies	54	10.78%	25.00%

use of synthetic simulators (37.04%), followed by animal-derived simulators (26.45%) and cadaver-derived simulators (23.81%) [Figure 2]. The majority of the respondents (53.7%) said that simulation was not used routinely in the training of surgical residents in Nigeria, and a greater number of them (56.1%) noted that simulation in surgical training was only used during workshops, courses, and conferences [Table 2].

Junior residents had the highest number of those that have participated in simulation-based training. However, only 56.3% of them (54 out of 96) had participated in simulation-based training, compared with 73.5% (50 out of 68) of senior residents and 73.1% (38 out of 52) of consultants [Figure 3]. On the issue about modalities of simulation-based training, respondents have participated in, as shown in Table 3; there were 149 respondents (69% of all respondents), although 57 of them had experienced 2 or more modalities of simulation, and one of these 57 had experienced all the five modalities, making it a total of 241 responses. The majority of the respondents (40.66%) have experienced training using synthetic simulators or Manikins. Only 11.51% of them had experienced the use of virtual simulation.

General surgery (25.69%) was the specialty most known to use simulation in surgical training, followed by obstetrics and gynecology (23.39%) followed by ophthalmology specialty [Figure 4]. The respondents were 166, although 21 of them mentioned between 2 and 5 specialties in surgery, while 4 mentioned more than 5 specialties, making it a total of 218 responses.

#### Virtual simulation in surgical training in Nigeria

Only 27 respondents (12.6%) were aware of any hospital in Nigeria where virtual simulation was used in training of residents [Table 4]. The majority of the respondents (88.9%) would like to first use virtual simulation to learn and practice a procedure before carrying it out on a patient. The majority of the respondents (95.8%) believed there would be a surge in the use of virtual simulation in surgical training if it was readily available in the country, Nigeria. Most of the respondents (22.2%) who experienced virtual simulation used it to learn endoscopic surgeries [Table 5],

followed by those who used it for learning surgical skills and unspecified procedures (18.5%). The lack of relevant equipment (30.74%) and the high cost of these equipment (24.95%) are the most mentioned limitations of using virtual simulation in surgical training [Table 6].

## DISCUSSION

In the past, there were only few doctors who enroll for surgical training in developing climes like Nigeria, but this has changed drastically. With this comes the relative decrease in hands-on training opportunities. This situation was exacerbated during the recent pandemic. During the COVID-19 pandemic, several elective surgeries were cancelled or postponed and there was a general decrease in the number of procedures performed by surgery residents and their trainers as well globally.<sup>[6,11]</sup> In Nigeria, there was also a decline in the number procedures done by residents as reported in the South-west<sup>[12]</sup> and South East.<sup>[13]</sup> Surgical specialties had to introduce or increase the use of various modalities of simulation in their surgical skills training programs.<sup>[11,14,15]</sup> This was not feasible for many hospitals in developing countries like Nigeria because they did not have the setup for simulation, especially virtual simulation. The interest in simulation-based surgical training has increased after the COVID-19 pandemic. Virtual simulation is not only useful to novices in surgery in learning new procedures but also to expert surgeons who benefit from practicing complex surgeries and shortening their operation time.<sup>[9,16]</sup>

In the present survey of specialist and trainee surgeons, the majority of the respondents (85.2%) have heard about simulation-based surgical training [Figure 1]. However, as regards its use in Nigeria, the majority only knew more about the use of synthetic simulators (37.04%), animal-derived (26.45%), and cadaver-derived simulators (23.81%). This is similar to the findings of Umoren *et al.*<sup>[17]</sup> among pediatric healthcare providers in Nigeria, manikin-based training was the most frequently reported training. There are also many other synthetic simulators that are easy to procure, like skin substitutes used in practicing suturing.<sup>[4]</sup> The “Basic Surgical Skills” workshop organized periodically by the West African College of Surgeons at the University of Nigeria Teaching Hospital, Enugu, use porcine intestines for teaching intestinal anastomosis and the porcine chest for practice of chest intubation. Animal-model simulation, particularly porcine, is commonly used for learning thoracic procedures.<sup>[18]</sup> At the Aesthetic Surgery Workshop organized by plastic surgeons at University College Hospital, Ibadan, human cadaver is used in training residents about raising fasciocutaneous flaps,

muscle flaps, and other types of flaps. The vessels of rats were also used in learning microvascular anastomosis under the microscope or loupe.

Although some surgical trainees have been exposed to simulation-based surgical training, over half of the respondents pointed out that it was not used routinely for residency training in Nigeria, but rather used mostly during workshops, periodic training courses and conferences. This form of exposure is far from being adequate, and the ideal expectation is to have it incorporated into the curricula of the training bodies. This was also the opinion of over 90% of postgraduate doctors that participated in a survey that involved people from 25 countries with over 80% coming from African countries especially Uganda.<sup>[19]</sup>

The majority of the respondents got exposed to simulation-based surgical training in programs organized in general surgery (56), obstetrics and gynecology (51), and ophthalmology (29). This finding was also influenced by the greater proportions of respondents that came from these specialties. This also coupled with the fact that virtually all the residents in all the specialties spend diverse periods of time at some point in their training.

Virtual reality is the bedrock of current and future simulation-based surgical training and further advances on it is going on including robotic surgery.<sup>[20]</sup> Augmented reality presents a digital platform in the physical world that allows interaction with a virtual environment, and it is considered an alternative to the virtual reality.<sup>[9]</sup> Virtual simulation and augmented reality are not commonly used in low- and medium-income countries. Only 27 respondents (12.6%) in our survey have knowledge of any center in Nigeria where virtual reality was being used for surgical training, and most of them had their experiences in the practice of endoscopic procedures (22.2%). It is important to note that there are still a few residents in high-income countries that do not have access or have limited access to virtual simulation in surgical training.<sup>[20]</sup> In the present survey, the majority of all the respondents (88.9%) would like to practice a surgical procedure with virtual simulation before attempting the surgery on a real patient. Moreso, 95.8% of the respondents believed that there would be a surge in the use of virtual simulation if it was made available in the training institutions.

The availability of virtual reality for surgical training was limited by lack of relevant equipment (71.30% of respondents) and the high cost of equipment for it (57.87% of respondents), which makes it tasking for training institutions to procure them. This was similar to

the findings of a similar study of postgraduate doctors, where affordability was identified as the main barrier to the access of virtual reality by low- and medium-income countries.<sup>[19]</sup> Other researchers have also reported the disadvantages of it being expensive and using a fragile equipment.<sup>[8,21]</sup> It is not just that it is expensive to set up, but it also costs so much to provide the consumables and maintain the equipment.<sup>[21]</sup> The lack of the expertise required for training was also mentioned by 42.59% of respondents as an obstacle to making it readily available. It is however much easier to surmount this obstacle if the equipment was made available in several training centers.

It has been reported that the obstacle posed by lack of trainers with the expertise to the use of virtual reality in surgical training can be overcome by remote digital training via collaboration with experts working in centers in high income countries which has been tried out successfully.<sup>[19]</sup> Another way of bridging the gap between low- and medium-income countries and high-income countries is to develop phone applications that can simulate surgical procedures so that trainees can at least learn the steps of that procedure. This will serve as a cheap but weaker alternative. Many surgical procedures can be converted to game-like applications to introduce some procedures or consolidate knowledge of surgical procedures.

## CONCLUSION

Virtual simulation is not readily available for surgical training in Nigeria. The major challenge of making it available is the high cost of procuring it. Most surgeons would love to be able to use virtual simulation to learn a new procedure or to practice with it before a procedure. Other forms of simulation are used for training residents in the country, but they are not used routinely. The commonest among these is the synthetic simulators (manikins).

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## Conflicts of interest

There are no conflicts of interest.

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