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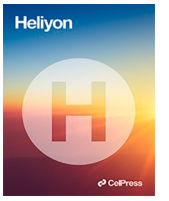

Train-the-trainers intervention for national capacity building in infection prevention and control for COVID-19 in Nigeria

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ABSTRACT

Background: The first case of COVID-19 in Nigeria was reported on February 27, 2020, and over time, spread across the country leading to many healthcare worker infections. The risk of transmission of COVID-19 within healthcare facilities makes it necessary to establish infection prevention and control measures. The World Health Organisation supported the Nigeria Centre for Disease Control to conduct a train-the-trainers workshop on infection prevention and control for key healthcare workers across Nigeria.

Aim/Objectives: This study aims to describe the process and results of train-the-trainers as an intervention for national capacity building in infection prevention and control for COVID-19 among healthcare workers in Nigeria.

Methods: Eight-hour sessions were held over three days with face-to-face instruction and practical hands-on experience in April 2020. A total of 61 healthcare workers participated across the six geographic zones of Nigeria: North Central, North East, North West, South West, South East, and South South. The training included slide presentations, case-based scenarios, and practical hands-on sessions with plenary discussions. Pre- and post-test assessments were used to evaluate knowledge of COVID-19, triage, and infection prevention and control among healthcare workers.

Finding/Results: 69 % (42) of the participants were male 31 % (19) were female, and the majority (67 %) were medical doctors. Others attending were nurses or health administrators. Of the 70 % (26) of the states with existing infection prevention and control structures within the COVID emergency response, only 40 % were functional. The average percentage of pre-test and post-test scores were 60.8 ± 13.4 and 67.8 ± 9 0.3 respectively, showing a statistically significant difference ($p > 0.001$) in trainee knowledge. Additionally, 70 % of participants evaluated the

List of Abbreviations: Antimicrobial resistance, (AMR); Centre for Disease Control, (CDC); Community Healthcare Workers, (HCWs); Infection Control African Network, (ICAN); Infection Prevention and Control, (IPC); Nigeria Centre for Disease Control, (NCDC); Nigeria Society for Infection Control, (NSIC); Personal Protective Equipment, (PPE); Primary healthcare, (PHC); Standard Deviation, (SD); Train-the-Trainers, (TOT); World Health Organization, (WHO).

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training workshop as "satisfactory" or higher in training format, relevance for daily clinical work, active participation, learning new concepts, and logistics.
Conclusion: Nationwide infection prevention and control training is feasible during a national health crisis. Infection prevention and control is cardinal in the containment of epidemic-prone diseases like COVID-19 and is invaluable in the prevention of healthcare-associated infections in healthcare settings.

1. Background

On December 31, 2019, the Wuhan Municipal Health Commission in China reported a cluster of cases of pneumonia that was discovered to be caused by a new coronavirus [1]. On 30 January 2020, the World Health Organization (WHO) declared the novel coronavirus outbreak a Public Health Emergency of International Concern (PHEIC), and on March 11, 2020, the WHO named it a pandemic [1]. COVID-19 is the disease caused by the betacoronavirus, SARS-CoV-2 [2]. Africa was the last continent to be affected by the COVID-19 pandemic. However, based on the Epidemic Preparedness Index, most African countries were deemed high-priority areas due to their vulnerability to epidemics [3]. The first case of COVID-19 in Africa was recorded on February 14, 2020, in Egypt while Nigeria, the most populous country in Africa reported its first case on February 27, 2020 [4,5]. As of May 2, 2023, there were over 8,900,000 cases and over 174,000 deaths in Africa, while in Nigeria there were about 260,000 cases and 3155 deaths [6].

The Nigerian healthcare system is structured into 3 tiers, the primary, secondary, and tertiary healthcare levels [7]. Primary healthcare (PHC) provides basic medical services to villages and districts managed by local government areas. This is predominantly where Community Healthcare Workers (CHWs) provide most of the care along with some nurses. The secondary level of healthcare receives referral from PHCs and provides diagnostic and enhanced medical care, this is managed by the respective state governments, and the tertiary level of care provides specialist and advanced care services rendered by teaching hospitals and specialist hospitals. There are clear inequalities in the distribution of HCWs in Nigeria. Although the rural areas constitute about half of the population in Nigeria, the populace only has access to about 12 % and 19 % of the total number of physicians and nurses, respectively [8]. This non-uniform distribution has resulted in significantly poorer health indices in rural areas than urban areas [9]. In the same manner training and retraining of HCWs tend to favor those in tertiary healthcare facilities.

The COVID-19 virus spreads from person to person through respiratory droplets and direct contact. Transmission may particularly occur in healthcare settings during aerosol-generating procedures and other patient care activities. Prevention is by respiratory hygiene and cough etiquette, physical distancing, hand hygiene, cleaning, and disinfecting frequently touched surfaces [10]. Healthcare facilities must institute infection prevention and control (IPC) measures to protect HCWs, patients, and visitors from acquiring healthcare-associated COVID-19 infection.

Infection prevention and control is a scientific approach and practical solution designed to prevent harm caused by infection to patients and HCWs [11]. Practicing IPCinfection prevention and control requires an understanding of infectious diseases, epidemiology, social science, and health system strengthening. Infection prevention and control is also a reflection of patient safety practices in a healthcare facility [12]. The WHO recommends that IPC should be implemented based on the following eight core components: IPC programs; IPC guidelines; IPC education and training; healthcare-associated infections surveillance; multimodal strategies; monitoring, auditing and feedback; workload, staffing and bed occupancy; and built environment, materials and equipment for IPC [13]. Although the basic principles of IPC apply globally, each country and individual healthcare facility needs to adapt and expand the core components based on their specific circumstances, differences in the patient population, infectious disease profiles, type of healthcare services delivered, and availability and distribution of healthcare workers.

At the global level, the current IPC gaps are: strengthening IPC visibility, advocacy, improving IPC knowledge development, fostering and promoting IPC as a marker of quality, building active networks and stronger communications, empowering IPC Leads to act, improving evidence-based presentation to leaders and helping people visualize how IPC programs can lead to antimicrobial resistance (AMR) risk reduction [14]. In West Africa, the results of a Centre for Disease Control (CDC) healthcare facility IPC assessment for Ebola revealed substantial gaps in IPC. These gaps included a lack of IPC oversight, poor waste management procedures, lack of triage and isolation protocols, frequent lack or misuse of personal protective equipment, and inadequate standard infection control precautions [15]. In a similar Ebola IPC gap assessment study carried out in Nigeria, involving two tertiary, twenty-four public secondary, and sixty-six private secondary healthcare facilities. Only one tertiary healthcare facility had an IPC committee with a focal officer in charge, only one hospital had an IPC policy that was not operational and none of the health facilities had a good score for both IPC materials availability and practice [16]. Analyses of these gaps using Ebola as a prototype outbreak response are important in the control of COVID-19 as well as future outbreaks.

National and international health organizations have stepped up efforts towards improving IPC practices among HCWs in the fight against COVID-19. This is achieved through the training and re-training of healthcare workers. Aside from pre-service education, the two principal means of HCWs' training are in-service training and continuous education [17]. During public health emergencies, similar continuous education focuses on the specific health emergency. Training of HCWs in Nigeria is largely suboptimal. In a study carried out by Okereke et al., only about a quarter of HCWs in the select northern and southern states of Nigeria have participated in in-service training and continuous education [17]. We set out to describe the process and results of a "Train-the-Trainers'' workshop delivered by the WHO in collaboration with the Nigeria Centre for Disease Control (NCDC) as an intervention for National Capacity Building in Infection Prevention and Control for COVID-19 for key healthcare workers in Nigeria.

2. Methodology

2.1. Overview of the train-the-trainers (TOT) workshop

The Infection Prevention and Control (IPC) Train-the-Trainers (TOT) intervention on COVID-19 in Nigeria was implemented in April 2020 as one of the key strategic objectives of the IPC pillar in the Nigerian National COVID-19 Response [18,19]. The policy guideline emphasized the need to develop the IPC capacity and skills of healthcare workers across all levels of care to safely render healthcare services in Nigeria.

2.2. Participants and setting

The trainees were the IPC focal persons or representatives identified by the Commissioners of Health from across 36 states and the Federal Capital Territory, Abuja Nigeria. All states were requested to send at least one representative, who would collaborate with other stakeholders (Partners, NCDC rapid response teams, and Ministries of Health) in their respective states to plan and deliver state-level IPC training for all HCW in COVID-19 treatment centers. The subsequent step-down training would involve IPC focal persons from across other public/private health facilities and other COVID-19 response staff at the state level. The TOT IPC training was conducted concurrently in each of the 6 geopolitical zones of Nigeria (Fig. 1).

2.3. Training design

Twenty-four (24) faculties were involved in the National TOT, comprised of NCDC staff; and IPC experts drawn from the Nigeria Society for Infection Control (NSIC), an affiliate of Infection Control African Network (ICAN) which consisted of clinical microbiologists, infectious disease physicians and public health practitioners.

The training was designed as a three-day, 8-h daily face-to-face with hands-on training. It was both didactic and participatory using a mixed methodology of slide presentations, case-based scenarios, and practical hands-on sessions with plenary discussions. Standard evaluative measures were deployed to assess knowledge and behavioral changes among the participants including program

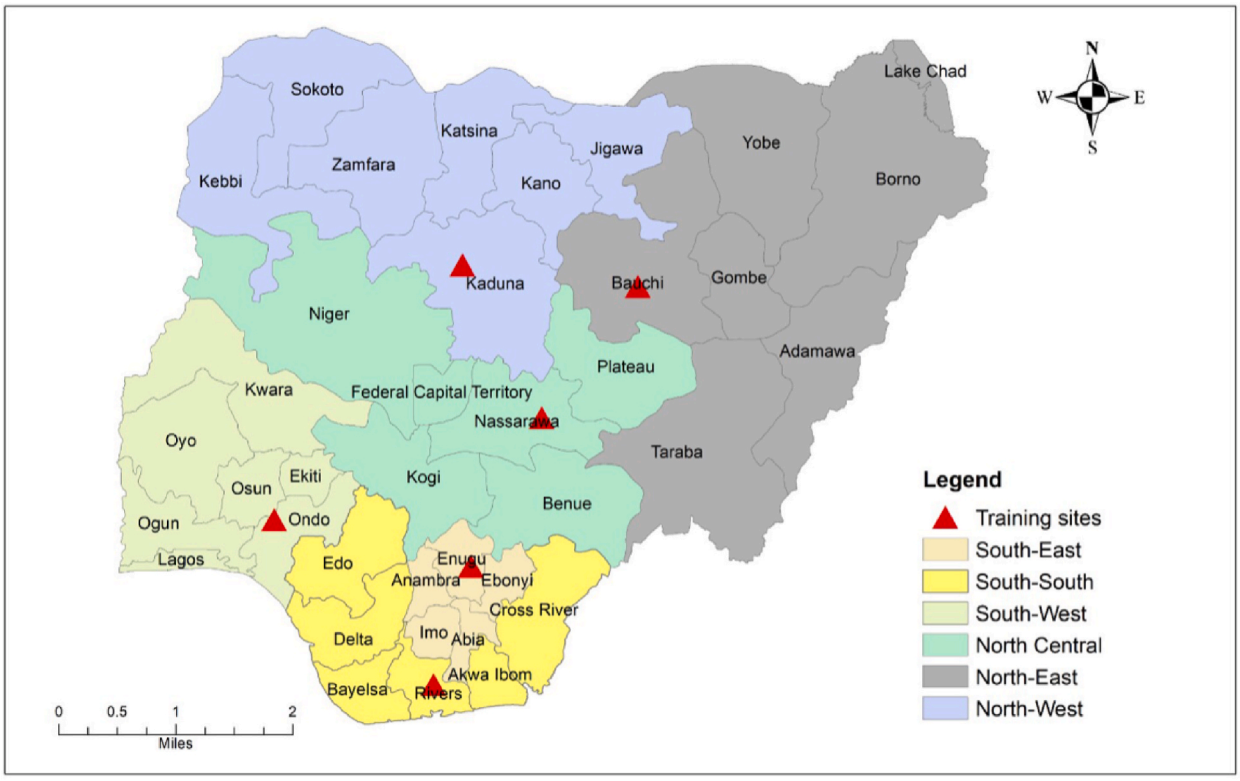

Fig. 1. Map of Nigeria showing the geopolitical zones and venues for the training.
A geographical map of Nigeria showing the 6 political/administrative sub-divisions of Nigeria highlighted in different colors as follows: North West, North East, North Central, South West South South, and South South. The red triangles indicate the respective sites in each geopolitical zone where the training was carried out.
Modified from Nigerian Center for Remote Sensing 2023 (NCRS, 2023) https://ncrsjos.wordpress.com/about/

evaluation. IPC training materials were developed jointly by staff of WHO and NCDC, pre-test, post-test, and training evaluation forms were adapted based on COVID-19 IPC guidelines published by the WHO [20].

The agenda encapsulated knowledge designed for IPC engagement, practical demonstrations to build IPC skills set for safe work practices, development of work plans and budgets as part of the next steps for the state-level IPC step-down training. The thematic focus of the training covered the following component areas: Basics of COVID-19, Coronaviruses, Understanding disease transmission using COVID-19-specific examples, Breaking transmission of infection using COVID-19-specific examples, IPC strategies, Preparedness and response. Other topics covered included: COVID-19 transmission dynamics, standard precautions, transmission-based precautions, donning and doffing of Personal Protective Equipment (PPE), hand hygiene, safe handling of COVID-19 dead bodies, cleaning and disinfection, healthcare waste management, establishing IPC programs at states and development of a step-down training plan.

The IPC training also introduced the IPC focal persons to some IPC tools for conducting rapid IPC needs and risk assessments across COVID-19 designated treatment facilities and other healthcare facilities using a standard quality control checklist. One such is the "Infection Prevention and Control (IPC) Assessment Framework"; a systematic tool that provides a baseline assessment of the IPC program and activities within a healthcare facility, as well as ongoing evaluations through repeated administration to document progress over time and facilitate improvement. These assessment tools target aspects of IPC practices including facility and administrative controls such as proper triage and isolation of high-risk patients, behavioral aspects such as handwashing, correct use of PPE, and identified areas for improvement. A pre-test and post-test were administered to all participants at the beginning and end of the training respectively. Training evaluation forms were filled out anonymously to obtain relevant feedback from participants. The pre-test and post-test tools were adapted from the African regional IPC TOT and WHO tools on COVID-19.

2.4. Data collection

Pre-test and post-test data were collected on paper forms and score data was entered into Microsoft Excel. Each participant's test form was uniquely identified to link the pre and post-test scores and the respective training sites. The data collection tools used include COVID-19 pre- and post-test tool and the training evaluation tool. The COVID-19 pre- and post-test forms comprised 10 questions with options on the basics of COVID-19, triage, and IPC. For each correct answer, a score of 1 was awarded, wrong answers were awarded 0 mark. Percentage scores were determined with maximum scores of 100 %. Scores of <45 % were considered poor; scores between 45 % and 55 % were fair, 56 % and 65 % good, and greater than 65 % as very good. The training evaluation tool comprised a 5-point Likert scale ranging from 1 (completely agree) to 5 (completely disagree) [21]. The following thematic areas were assessed: format and facilitation, logistics and organization, new IPC concepts, and applicability in daily practice. Additionally, open-ended questions and feedback on the training were obtained.

2.5. Statistical analysis

Data were analyzed using SPSS version 16.0 and descriptive analyses including proportions, percentages, means, and standard deviation (SD) were reported for categorical and continuous data. The Likert scores of training evaluation were analyzed using mean scores as previously described [22]. Paired Student's *t*-test was used for comparing pre-test and post-test scores. A two-sided p-value was used, with alpha defined at 0.05 considered statistically significant. Results were presented in figures and tables as appropriate.

Table 1
Characteristics of participants for COVID-19 IPC capacity development in Nigeria.
The table shows the descriptive statistics of the study participants by sex, profession, and geopolitical zone. Frequencies were provided with the respective percentages in brackets, and the sample size was 61.

Parameters	Frequency (%)
Sex:	
Male	42 (68.9 %)
Females	19 (31.1 %)
Profession	
Doctors	41 (67.3 %)
Nurses	9 (14.8 %)
Others	11 (18.0 %)
Geographical distribution	
North East	9 (15)
North West	11 (19)
North Central	9 (15)
South East	12 (20)
South West	12 (20)
South South	6 (10)

2.6. Ethics declaration

This study was reviewed and approved by the National Health Research Ethics of Nigeria, with the approval number: NHREC/01/01/2007-03/07/2020. All participants/patients (or their proxies/legal guardians) provided informed consent to participate in the study.

3. Results and discussion

A total of 61 IPC resource persons were trained between 28 and 30 April 2020. This was done simultaneously at a central venue in each of the 6 geopolitical zones of Nigeria. Sixty nine percent (42) of the participants were male, 31 % (19) were female, and the majority (67 %) were medical doctors. Others attending were nurses or health administrators. Of the 70 % (26) of the states with existing infection prevention and control structures within the COVID emergency response, only 40 % were functional. The characteristics and geographical distribution of the participants are shown in Table 1. The average percentage pre-test and post-test scores were 60.8 % (SD = 13.4) and 67.8 % (SD = 9.3) respectively, the difference was statistically significant ($p > 0.001$). The mean distribution of the pre- and post-test scores across the geopolitical zones is shown in Fig. 2. Additionally, 70 % of participants evaluated the training workshop as "satisfactory" or higher in training format, relevance for daily clinical work, active participation, learning of new concepts, and logistics, as shown in Table 2.

Implementing the IPC train-the-trainers for COVID-19 across the six geo-political zones of Nigeria was a critical intervention for National capacity building during the early phase of the COVID-19 pandemic. It has resulted in knowledge gain and established a framework for step-down training for all the healthcare workers in Nigeria. This is the first report of a comprehensive, decentralized, concurrent IPC training in Nigeria, especially undertaken during an ongoing National and global health crisis. The training strategy can be adopted to implement future training programs in resource-limited settings where there are challenges of resources and a paucity of trained, experienced, and specialized healthcare workers. The WHO has advocated the need for all countries to develop robust IPC structures that can reduce the burden of healthcare-associated infections [12]. This is acutely needful because of the transmissibility of COVID-19. Similar training on IPC was carried out in Guinea during an ongoing Ebola outbreak [23]. The daunting challenge that Africa potentially poses to the world is the lack of IPC structures and robust healthcare systems, and these factors were earlier envisaged to lead to a high burden of COVID-19 in the region.

Our research findings showed that about one-third of states did not have existing IPC structures. Amongst those that had, almost half were not functional. Similarly, other studies have clearly identified IPC gaps in Nigeria [16,24–27]. There is dire need of ensuring IPC structures are set up and made functional in the face of emerging and re-emerging infectious diseases. Training of healthcare workers on IPC needs to be strengthened in all healthcare settings. Generally, the vulnerability of healthcare workers to occupationally-acquired infections is real and quite challenging [28]. The Africa CDC in collaboration with the Infection Control Africa Network (ICAN) and other implementing partners has continued to hold trainings on IPC for healthcare workers as part of preparedness and response plans in Africa.

The trainees rated the training as being very good in terms of training format, relevance for daily clinical work, active participation, learning of new concepts, and other logistics. This is despite the challenges of travel restrictions, short planning period, and

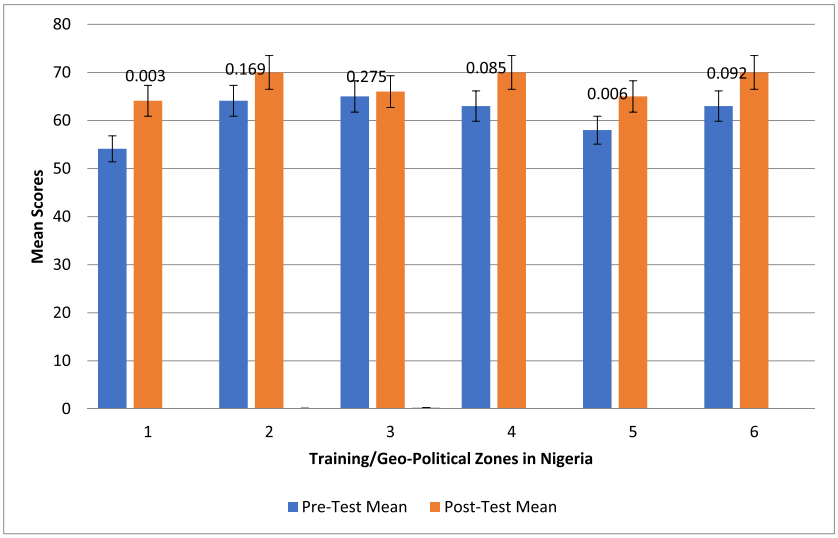

Fig. 2. Bar graph showing pre-test and post-test mean scores of COVID-19 IPC capacity development across geopolitical zones of Nigeria.
This shows the average pre-(blue) and post-test (orange) scores of participants in each of the six geopolitical zones of Nigeria with a sample size of 61, statistical differences using paired students' T-test comparing pre-and post-test for each geopolitical zone are shown on the respective bar graphs, and the P value was set at 0.05.

Table 2
Showing summary of Participant training evaluation for COVID-19 IPC capacity development in Nigeria.
The table shows the 61 participants' training evaluation based on their subjective assessment on a scale from 0 (worst to 10 (best), mean scores and standard deviation are provided for each evaluation parameter across the 6 geopolitical zones of Nigeria using simple descriptive statistics.

Evaluation Parameters	North West	South South	North East	South East	North Central	South West	Average (Standard Deviation)
Workshop format was appropriate	8	6	7	8	6	8	7.2 (±0.83)
Venue and room arrangement during sessions were adequate	9	8	8	9	7	7	8 (±0.76)
Time management during workshop was good	8	8	8	7	8	9	8 (±0.53)
Explanations were clear and easy to understand	9	9	9	9	9	9	9 (±0.00)
Working atmosphere was fruitful	8	8	9	9	8	9	8.5 (±0.46)
Time for active participation was sufficient	9	8	8	8	9	8	8.3 (±0.44)
Communication prior to event was good	5	5	5	5	5	5	5 (±0.00)
Travel logistics was appropriate	6	7	7	7	7	6	6.7 (±0.44)
Choice of hotel	10	10	10	10	10	10	10 (±0.00)
I reflected on something new related to IPC during this workshop	9	8	9	8	8	9	8.5 (±0.46)
What was discussed during this workshop is valuable for my daily work	10	10	10	10	10	10	10 (±0.00)

communication challenges. Communication prior to the training was rated low; timeliness of notification by the organizers was rather short. Despite some of these challenges, this experience has clearly demonstrated the feasibility of implementation of comprehensive training in resource-limited settings even during a public health emergency. The average mean of post-test scores was higher than the pre-test performance of the trainees and statistically significant, a pointer to comparable knowledge gain despite the decentralization of the training across the different geopolitical zones of Nigeria. This showed that the aim of the training was achieved with objective knowledge gain. Therefore, this training strategy can be adopted in future public health emergencies.

The training had other challenges: due to the national lockdown and restriction of movement, the interstate movement for the training was difficult. Therefore, participants arrived at the training venue late. Additionally, communication gaps were identified which was needed to implement future training. The limitation of this study is the lack of a clear sample size estimation strategy. However, since it was a strategic 'train-the-trainers' quality improvement training that would eventually be cascaded, it obviated the need for robust sample size estimation at this stage. Secondly, the relatively smaller number of stem questions in the pre-test and post-test may have limited comprehensive assessment. However, they were representative questions in the thematic areas of the training. Additionally, the best assessment to determine the application of knowledge is to conduct an audit of change in practice in the respective states, this was not undertaken in this study, and a follow-up study would be needed. Despite these limitations, the strength of this report lies in the nationwide coverage and structured concurrent training of key healthcare workers in resource-limited settings during the early phase of the National and global health crisis.

In conclusion, ensuring IPC structures are in place and functional in all healthcare settings should be prioritized. There is need for training and re-training of healthcare workers on IPC, this is more glaring in resource-constrained settings where IPC culture is abysmally low. It is needful to develop a monitoring mechanism to ensure IPC structures are functional in all healthcare settings. Undoubtedly, this would reduce the transmission of infections in healthcare settings.

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Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

Credit authorship contribution statement

N.Y. Shehu: Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **T. Okwor:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Funding acquisition, Conceptualization. **J. Dooga:** Writing – review & editing, Writing – original draft, Methodology, Data curation. **A.M. Wele:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Formal analysis, Data curation. **L. Cihambanya:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Funding acquisition. **I.I. Okonkon:** Writing – review & editing, Writing – original draft, Methodology, Data curation. **M. Gadanya:** Writing – review & editing, Writing –

original draft, Methodology, Data curation. **J. Sebastine:** Writing – review & editing, Writing – original draft, Methodology, Data curation. **B. Okoro:** Writing – review & editing, Writing – original draft, Methodology, Data curation. **O. Okafor:** Writing – review & editing, Writing – original draft, Data curation. **C. Abejegah:** Writing – original draft, Data curation. **D. Oragunye:** Writing – review & editing, Writing – original draft, Data curation. **A. Olayinka:** Writing – review & editing, Writing – original draft, Data curation.

Declaration of competing interest

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

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Appendix A. Supplementary data

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