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ORIGINAL RESEARCH

Capacity Building in Field Epidemiology in Sub Saharan Africa: Findings from Infectious Disease Field Epidemiology and Biostatistics in Africa (IDEA) Fellowship Program

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Background: Emerging and re-emerging infectious diseases (EREIDs) remain a major public health threat globally, particularly in sub-Saharan Africa (SSA), where fragile health systems, inadequate infrastructure, and limited workforce training exacerbate vulnerabilities. Uganda, a recognised hotspot for outbreaks, faces increasing risk due to anthropogenic and environmental drivers. To address critical capacity gaps, the Infectious Disease Epidemiology and Biostatistics in Africa (IDEA) Fellowship was launched as Uganda's first master's-level programme in infectious disease field epidemiology. Led by Busitema University, in collaboration with national and international partners, the programme was funded through EDCTP-II (CSA2020E).

Methods: The IDEA Fellowship combined theoretical instruction with fieldwork and research tailored to national health priorities. Activities included outbreak investigations, disease modelling, and surveillance, supported by Africa CDC, Uganda's Ministry of Health, and UK institutions. A REDCap-based survey was administered to 202 public health professionals across SSA to assess training needs, skill gaps, and barriers. Data were analysed using descriptive statistics and thematic analysis.

Results: The programme trained 15 master 's-level fellows, strengthening Uganda's capacity in surveillance, early detection, and outbreak response. Survey results showed that 55.4% of professionals required further training, with skill gaps in zoonotic disease management (64.4%), outbreak preparedness (64.9%), and data management (59.4%). Key barriers included limited diagnostic capacity (73.8%) and weak collaboration (49.5%). Qualitative findings highlighted inconsistent mentorship, restricted data access, and limited funding for fieldwork. Respondents advocated for structured mentorship, longer training durations (≥3–6 months), and hybrid delivery models (42.3%).

Conclusion: The IDEA Fellowship demonstrates a scalable model for infectious disease capacity building in SSA. Training African scientists in local contexts promotes relevance, retention, and cost-effectiveness. Regional expansion, cross-sector collaboration, and systemic investment are essential for sustainable epidemic preparedness and global health security.

Keywords: field epidemiology, capacity building, infectious disease training, Sub-Saharan Africa

Background

Despite significant advancements in healthcare, diagnostic technologies, and global information systems, the frequency and magnitude of emerging and re-emerging infectious diseases (EREIDs) continue to escalate.[1,2] Accelerated by international travel and interconnected economies, these pathogens spread rapidly across geographical boundaries.[3] Virulent and highly transmissible pathogens such as SARS-CoV-2, with variants evolving from Alpha, Beta, Gamma, Delta, to Omicron, with subtypes;[4] Mycobacterium tuberculosis from wild type to multidrug-resistant TB;[5] Plasmodium falciparum from wild type to drug-resistant malaria,[6] and Monkeypox virus with geographically distributed Clades I mainly in DRC and some African countries and II which caused a global outbreak;[7] exemplify the evolutionary

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adaptability of infectious agents. Such pathogens often overwhelm global health systems, exposing gaps in preparedness, especially in resource-constrained settings in Sub Saharan Africa (SSA).[8]

The World Health Organization (WHO) has long emphasized the importance of rapid containment to mitigate the public health, economic, and social impacts of disease outbreaks.[9] However, many countries, particularly in sub-Saharan Africa (SSA), face challenges in early identification, response, and control due to fragile healthcare systems, limited infrastructure, and inadequate investment in training and surveillance.[8] This vulnerability is compounded by biological, environmental, and anthropogenic factors that facilitate zoonotic infections, antimicrobial resistance (AMR), and the emergence of novel pathogens.[10–12] Over 75% of recently identified human pathogens have zoonotic origins, highlighting the role of human-wildlife interactions in driving epidemics.[13]

Historical outbreaks underscore the importance of robust field epidemiology and evidence-based interventions in disease control. The eradication of smallpox, for instance, relied on global coordination, effective surveillance, and vaccine development.[14] Similarly, targeted responses to the Hong Kong Flu (H3N2),[15] SARS,[16] and the ongoing HIV/AIDS pandemic;[17,18] demonstrate that while scientific advances can mitigate disease burden, delayed recognition and inadequate containment strategies, especially as a result of a lack of appropriately trained field epidemiologists, can lead to widespread morbidity and mortality.

The COVID-19 pandemic starkly illustrated global vulnerabilities, causing over 7 million deaths and 14.9 million excess deaths associated with the COVID-19 pandemic in 2020 and 2021.[19] Additionally, the pandemic also disrupted economies, education, and healthcare systems worldwide.[20,21] Sub-Saharan Africa often experiences a disproportionately heavy strain on its fragile health infrastructure, which is further complicated by endemic comorbidities such as HIV/AIDS, tuberculosis, and malaria.[22,23] Between 2016 and 2018 alone, the WHO African Region reported over 260 outbreaks, including Ebola Virus Disease, Lassa fever, and cholera, underscoring the ongoing threat posed by EREIDs.[24]

Uganda, with its unique geographic and environmental predispositions, remains a hotspot for infectious disease outbreaks. Its porous borders, refugee influx, and anthropogenic activities such as deforestation and urbanisation exacerbate the risk of zoonotic transmission of EREIDs.[9,24] Recent outbreaks of Ebola, Marburg, and Rift Valley Fever highlight the urgent need for strengthened surveillance and response mechanisms. While initiatives such as the WHO International Health Regulations (IHR 2005) prioritise epidemic preparedness,[25,26] Uganda's capacity remains constrained by inadequate workforce training in field epidemiology.[9]

To address these gaps, the Infectious Disease Epidemiology and Biostatistics in Africa (IDEA) Fellowship program joined in the ongoing efforts in Africa, with the initial establishment of Uganda's first Master's-level training initiative in infectious disease field epidemiology. This program, led by Busitema University in collaboration with national and international research and training stakeholders, aims to build a skilled workforce capable of addressing the evolving challenges of EREIDs. By aligning training efforts with national health priorities, the IDEA Fellowship represents a transformative step toward sustainable epidemic preparedness and response in Uganda and beyond.

Global health security frameworks such as the WHO International Health Regulations (IHR 2005) have long emphasised epidemic preparedness as a critical priority.[25,26] Despite these commitments, many sub-Saharan African countries, including Uganda, continue to face significant challenges due to limited workforce capacity in field epidemiology and outbreak response.[27,28] Several regional initiatives, including the Africa CDC's Regional Integrated Surveillance and Laboratory Network (RISLNET) and Field Epidemiology Training Programs (FETPs), have sought to strengthen epidemiological skills across the continent, yet gaps in practical training and retention remain pervasive.[28]

In response to these persistent challenges and the increasing burden of emerging and re-emerging infectious diseases (EREIDs) driven by environmental and anthropogenic factors, the Infectious Disease Epidemiology and Biostatistics in Africa (IDEA) Fellowship was established. As Uganda's first master's-level training programme dedicated to infectious disease field epidemiology, the IDEA Fellowship, led by Busitema University in partnership with national and international stakeholders, was designed to build a highly skilled workforce tailored to national public health priorities. This initiative aims not only to address critical capacity gaps but also to enhance sustainable epidemic preparedness by integrating advanced epidemiological theory with applied fieldwork. The IDEA Fellowship thus represents a strategic and timely intervention, strengthening Uganda's ability to detect, investigate, and respond to infectious disease threats in a rapidly evolving landscape.

This article outlines the IDEA Fellowship's conceptual framework, implementation strategies, and outcomes. It highlights the critical role of capacity building in advancing public health interventions and offers actionable insights for strengthening field epidemiology in resource-limited settings globally.

Methods

Training Setting

The Infectious Disease Epidemiology and Biostatistics in Africa (IDEA) Fellowship training program is housed at Busitema University and Mbale Clinical Research Institute, located in Mbale Eastern Uganda. The program is Uganda's first master's-level training program in infectious disease field epidemiology, led by Busitema University in collaboration with other national and international stakeholders. For its maiden cohort the program was supported by EDCTP-II funding (IDEA Fellowship - CSA2020E).

Program Design

The Infectious Disease Epidemiology and Biostatistics in Africa (IDEA) Fellowship employs a mixed-methods approach to build capacity in infectious disease field epidemiology and biostatistics. The program integrates didactic learning, field-based training, and practical research projects, aligned with Uganda's public health priorities and international standards.

Training Framework

Didactic Training (Objective 1.1)

The theoretical training, accounting for 20% of the fellowship duration, was conducted at Busitema University and Mbale Clinical Research Institute (MCRI). It covered a comprehensive curriculum, including epidemiology fundamentals, advanced biostatistics, emerging and re-emerging infectious diseases (EREIDs) with response strategies, biosafety, biosecurity, and introductory bioinformatics. Participants also engaged in research methodologies, big data analytics, systematic reviews, disease outbreak modeling, public health interventions, and grantsmanship.

Field-Based Training (Objective 1.2)

The practical skills development was achieved through structured fieldwork and case studies, focusing on outbreak investigation, containment strategies, and infectious disease surveillance in collaboration with the Clinical Information Network Project and the Uganda Ministry of Health. Participants gained exposure to cross-border disease surveillance systems, refugee health challenges, and WASH research addressing cholera and other waterborne diseases. Additionally, they utilized biobank data for genetic epidemiology studies and engaged with digital health and early warning systems.

Capacity Building and Partnerships (Objective 1.3)

The Programme's collaborations with Africa CDC, MCRI, and district outbreak taskforces offered hands-on experience in epidemic preparedness and response, applied epidemiology through clinical trials and laboratory-based investigations, and strengthening local health system resilience through mentorship and active participation in disease control initiatives.

Curriculum Validation (Theme 2)

The MSc. Infectious Disease Epidemiology and Biostatistics curriculum was validated through online surveys assessing knowledge transfer effectiveness, evaluation workshops measuring teaching quality, inclusiveness, and practical application, and a comparative analysis against CDC Field Epidemiology Training Programs and WHO International Health Regulations (IHR 2005) standards.

Advocacy and Career Pathways (Theme 3)

Workshops involving policymakers from the Ministry of Health and Ministry of Science, Technology, and Innovation advocated for formal career pathways for infectious disease epidemiologists in Uganda. The fellowship also partnered with The Open University (UK) to establish a PhD training program in field epidemiology.

Methodology for the Capacity-Building Survey

Study Design

This was a cross-sectional survey designed to assess capacity-building needs, demographic factors, and training preferences among public health professionals in Africa. The aim was to identify critical gaps in training and competencies required to enhance infectious disease management and surveillance in the content.

Study Population

The survey targeted 202 public health professionals across Sub-Saharan Africa. Respondents were from a diverse group, including researchers, field epidemiologists, laboratory technicians, data analysts, and public health officials.

Data Collection Tool

A self-administered survey was deployed via the REDCap platform, designed in clear and accessible English to facilitate comprehension and ensure structured data collection. The instrument comprised both closed- and open-ended questions to capture quantitative and qualitative data. Key variables assessed included respondent demographics (age, years of experience, education level, and area of specialization), training needs (self-reported gaps and preferred training formats), competency levels (skills in outbreak investigation, data management, GIS mapping, laboratory diagnostics, and disease modelling), perceived barriers and challenges (such as resource constraints and lack of institutional support), and preferred training modalities (including programme duration, delivery mode, and thematic focus). For master's-level fellows, self-assessment components were embedded within the tool to evaluate perceived gains in theoretical knowledge and practical competencies. In addition, qualitative interviews were conducted to further explore fellows' experiences and to assess the depth of knowledge and skills acquired through the programme.

Data Analysis

Quantitative Analysis

Quantitative data were analysed using both descriptive and inferential statistical methods. Descriptive statistics, including frequencies and percentages, summarised the distribution of demographic characteristics, training needs, and competency levels among participants. Inferential analysis involved chi-square tests to examine associations between key demographic variables, such as professional roles, education levels, and areas of specialisation, and reported training needs. P-values were calculated to assess the statistical significance of these relationships. To further investigate the combined influence of multiple demographic factors on training needs, multivariate logistic regression analysis was conducted. All statistical analyses were performed using Stata Version 18.

Qualitative Analysis

The semi structured qualitative data collected were analysed thematic to explore barriers in outbreak management. The analysis followed Braun and Clarke's six-step process: familiarisation, coding, theme identification, reviewing, defining, and reporting.

Initially, the team immersed themselves in the data by reading transcripts multiple times. Key segments were then coded manually, ensuring detailed engagement with the data. Codes were grouped into broader themes that naturally emerged, reflecting participants' experiences. The themes were reviewed for coherence and distinctiveness, then defined and named to show the underlying patterns. The final results summarized each theme with supporting quotes, highlighting participants' insights.

Data Quality Controls and Reliability

To ensure reliability and validity, coding was independently done by multiple coders, and discrepancies were resolved through discussion. Triangulation was used by comparing findings across data sources to confirm consistency. This analysis provided a comprehensive understanding of the barriers to effective outbreak management, offering critical insights for enhancing response strategies and policies.

Ethical Considerations

This study received ethical approval from the Uganda National Health Research Organisation (UNHRO), approval reference number UNHRO/MISC/BUSITEM.IDEA.PUBLICATION. The study adhered to ethical research principles, including obtaining informed consent from all participants and ensuring confidentiality and anonymity of responses throughout data collection and analysis. Although the approving institution (UNHRO) is independent of the listed author affiliations, ethical clearance was obtained through UNHRO because UNHRO is part of the IDEA consortium partners. The majority of the work was undertaken during the fellowship period, in collaboration with academic and research partners. Author affiliations have been updated accordingly to reflect this arrangement.

Results

The Infectious Disease Epidemiology and Analytics (IDEA) Training Program aimed to strengthen Uganda's capacity in infectious disease field epidemiology. Key objectives included high-quality training of 15 Epi Fellows in epidemiology and biostatistics, equipping them with skills in disease surveillance, modelling, and outbreak response. The program also sought to enhance epidemic preparedness through collaborations with Africa CDC, validate the MSc. Infectious Disease Epidemiology and Biostatistics curriculum, and advocate for career pathways in infectious disease research. Additionally, it laid the groundwork for establishing a PhD training program to sustain capacity building in Africa. See Table 1.

Quantitative Findings

Demographics and Professional Roles

A total of 202 participants responded to the survey, with 55.4% indicating a need for training and 44.6% not (Figure 1). The majority of respondents were aged 36–45 years (47.0%), followed by 46–55 years (28.2%) and 18–35 years (24.8%). Regarding work experience, most participants had either 1–5 years (35.6%) or more than 10 years (34.7%) of experience. Public health officials (28.7%) and field epidemiologists (18.8%) were the most common roles, with nearly all respondents (98.5%) coming from Sub-Saharan Africa. In terms of education, the majority held a master's degree (47.5%) or a bachelor's degree (30.7%). The leading areas of specialization were public health (37.8%) and epidemiology (25.4%), with public health being more prevalent among those requiring training (44.1%) and epidemiology more common among those not requiring training (34.4%). See Table 2.

Table 1 Objectives of the IDEA Fellowship Program

Objectives	Results
To conduct high-quality training of 15 Epi Fellows in infectious disease epidemiology and biostatistics (2021–2024).	Successfully trained master's students in infectious disease field epidemiology and biostatistics. Enhanced capacity through mentorship programs and hands-on training.
To equip Epi Fellows with skills in early disease detection, surveillance, modelling, and control (2021–2024).	Implemented practical field-based sessions involving surveillance and modelling. Conducted relevant studies to build research competencies in the targeted areas.
To contribute to enhanced response capacities for infectious disease field epidemiology in Uganda in collaboration with Africa CDC.	Strengthened collaboration with local and international partners, including Africa CDC. Contributed to improved research capacity for epidemic response.
To comprehensively validate the MSc. Infectious Disease Epidemiology and Biostatistics curriculum.	Curriculum validation is ongoing with stakeholder involvement. Supported by the development of practical training modules aligned with Uganda's public health needs.
To advocate for career paths of infectious disease specialists in Uganda.	Advocated and established pathways for master's graduates to transition into infectious disease research and public health roles.
To develop a PhD training establishment for capacity building in infectious disease field epidemiology in Africa.	Advanced planning stages for establishing a PhD program. Current trainees are being mentored for future enrollment into PhD programs.

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Figure 1 Proportion of respondents requiring capacity building needs.

Capacity Building Needs

Figure 1 presents the proportion of individuals requiring training versus those who do not. Of the 202 participants included in this study, our data shows that more than half, 55.4%, would require additional training, while 44.6% do not. See Figure 1.

Table 2 Participant's Demographics and Professional Roles

	Total n(%)	Requires Training n(%)	Does Not Require Training n(%)
N	202 (100.0)	112 (55.4)	90 (44.6)
Age			
18-35	50 (24.8)	28 (25.0)	22 (24.4)
36-45	95 (47.0)	48 (42.9)	47 (52.2)
46-55	57 (28.2)	36 (32.1)	21 (23.3)
Years of experience			
< 1 year	5 (2.5)	3 (2.7)	2 (2.2)
1-5 years	72 (35.6)	40 (35.7)	32 (35.6)
6-10 years	55 (27.2)	33 (29.5)	22 (24.4)
> 10 years	70 (34.7)	36 (32.1)	34 (37.8)
Role played			
Researcher	36 (17.8)	19 (17.0)	17 (18.9)
Field Epidemiologist	38 (18.8)	13 (11.6)	25 (27.8)
Lab technician	32 (15.8)	17 (15.2)	15 (16.7)
Data analyst	13 (6.4)	6 (5.4)	7 (7.8)
Public health Official	58 (28.7)	35 (31.2)	23 (25.6)
Others	25 (12.4)	22 (19.6)	3 (3.3)
Regions			
Others	3 (1.5)	2 (1.8)	1 (1.1)
Sub-Saharan Africa	199 (98.5)	110 (98.2)	89 (98.9)
Highest level education			
Bachelors	62 (30.7)	38 (33.9)	24 (26.7)
Masters	96 (47.5)	49 (43.8)	47 (52.2)
Doctorate	16 (7.9)	5 (4.5)	11 (12.2)
Others	28 (13.9)	20 (17.9)	8 (8.9)

(*Continued*)

Table 2 (Continued).

	Total n(%)	Requires Training n(%)	Does Not Require Training n(%)
Area of specialization			
Epidemiology	51 (25.4)	20 (18.0)	31 (34.4)
Public health	76 (37.8)	49 (44.1)	27 (30.0)
Microbiology	15 (7.5)	5 (4.5)	10 (11.1)
Biostatistics	17 (8.5)	9 (8.1)	8 (8.9)
Infectious disease	27 (13.4)	16 (14.4)	11 (12.2)
Others	15 (7.5)	12 (10.8)	3 (3.3)

Table 3 presents the training needs and proficiency levels in key public health competencies. In terms of principles of disease surveillance, 51.8% of participants requiring training reported intermediate proficiency, while 39.1% indicated basic knowledge. Conversely, 57.8% of those not requiring training demonstrated advanced knowledge in this area.

Table 3 Training Needs and Proficiency Levels in Key Public Health Competencies

	Requires Training n(%)	Does Not Require Training n(%)	Total n(%)
Principles disease survlc			
None	3 (2.7)	0 (0.0)	3 (1.5)
Basic	43 (39.1)	2 (2.2)	45 (22.5)
Intermediate	57 (51.8)	36 (40.0)	93 (46.5)
Advanced	7 (6.4)	52 (57.8)	59 (29.5)
Outbreak investigation			
None	3 (2.7)	0 (0.0)	3 (1.5)
Basic	53 (48.2)	2 (2.2)	55 (27.5)
Intermediate	48 (43.6)	33 (36.7)	81 (40.5)
Advanced	6 (5.5)	55 (61.1)	61 (30.5)
Data cleaning mgt			
None	23 (21.1)	0 (0.0)	23 (11.6)
Basic	65 (59.6)	16 (18.0)	81 (40.9)
Intermediate	18 (16.5)	34 (38.2)	52 (26.3)
Advanced	3 (2.8)	39 (43.8)	42 (21.2)
Gis mapping			
None	52 (47.7)	1 (1.1)	53 (26.6)
Basic	50 (45.9)	26 (28.9)	76 (38.2)
Intermediate	7 (6.4)	44 (48.9)	51 (25.6)
Advanced	0 (0.0)	19 (21.1)	19 (9.5)
Lab diagnostics			
None	36 (32.7)	8 (8.9)	44 (22.0)
Basic	39 (35.5)	26 (28.9)	65 (32.5)
Intermediate	24 (21.8)	29 (32.2)	53 (26.5)
Advanced	11 (10.0)	27 (30.0)	38 (19.0)
Scientific report			
None	9 (8.1)	0 (0.0)	9 (4.5)
Basic	64 (57.7)	7 (7.8)	71 (35.3)
Intermediate	37 (33.3)	42 (46.7)	79 (39.3)
Advanced	1 (0.9)	41 (45.6)	42 (20.9)

(*Continued*)

Table 3 (Continued).

	Requires Training n(%)	Does Not Require Training n(%)	Total n(%)
Modeling infectious diseases			
None	49 (45.0)	6 (6.7)	55 (27.6)
Basic	53 (48.6)	33 (36.7)	86 (43.2)
Intermediate	7 (6.4)	35 (38.9)	42 (21.1)
Advanced	0 (0.0)	16 (17.8)	16 (8.0)

Regarding outbreak investigation, 48.2% of respondents requiring training identified as having basic skills, with 43.6% reporting intermediate knowledge. Among those not requiring training, a substantial 61.1% were classified at the advanced level. For data cleaning and management, the majority of those requiring training (59.6%) were at the basic knowledge level, while 43.8% of respondents without a training need exhibited advanced proficiency. In the area of GIS mapping, 47.7% of participants requiring training indicated no knowledge, and 45.9% possessed basic skills. In contrast, 48.9% of those not requiring training reported intermediate proficiency. For laboratory diagnostics, 35.5% of respondents requiring training had basic knowledge, and 32.7% had no knowledge in this domain. Among those not requiring training, 30% had advanced skills. When considering scientific report writing, 57.7% of respondents requiring training rated their skills as basic, while 45.6% of those not requiring training were at the advanced level. Lastly, in modeling infectious diseases, 48.6% of participants requiring training had basic knowledge, whereas 17.8% of those not requiring training were classified at the advanced level. See Table 3.

Training Needs and Preferences

Table 4 presents the distribution of training format preferences and Ministry of Health (MOH) capacity assessment among respondents who require training versus those who do not. Regarding training formats, regional training sessions (38.3%) and

Table 4 Training Preferences and Institutional Capacity of Public Health Organizations

	Requires Training n(%)	Does Not Require Training n(%)	Total n(%)	p-value
Training format				0.370
In-person workshops at the Ministry of Health	21 (18.9)	10 (11.1)	31 (15.4)	
Regional training sessions	41 (36.9)	36 (40.0)	77 (38.3)	
Online learning modules (self-paced)	3 (2.7)	5 (5.6)	8 (4.0)	
Hybrid (combination of in-person and online)	46 (41.4)	39 (43.3)	85 (42.3)	
Moh capacity id research				0.164
Excellent (Well-equipped and supported)	16 (14.5)	19 (21.1)	35 (17.5)	
Adequate (Basic facilities available)	50 (45.5)	44 (48.9)	94 (47.0)	
Limited (Minimal resources and support)	37 (33.6)	26 (28.9)	63 (31.5)	
Inadequate (Severely lacking resources)	7 (6.4)	1 (1.1)	8 (4.0)	
National Disease Control (NDC)				0.196
No	66 (58.9)	61 (67.8)	127 (62.9)	
Yes	46 (41.1)	29 (32.2)	75 (37.1)	
National Health Laboratory Services (NHLS)				0.360
No	52 (46.4)	36 (40.0)	88 (43.6)	
Yes	60 (53.6)	54 (60.0)	114 (56.4)	
Epidemiology and Surveillance Division				0.914
No	39 (34.8)	32 (35.6)	71 (35.1)	
Yes	73 (65.2)	58 (64.4)	131 (64.9)	

(*Continued*)

Table 4 (Continued).

	Requires Training n(%)	Does Not Require Training n(%)	Total n(%)	p-value
Public Health Emergency Operations Centre (PHEOC)				0.515
No	41 (36.6)	29 (32.2)	70 (34.7)	
Yes	71 (63.4)	61 (67.8)	132 (65.3)	
Others				0.488
No	106 (94.6)	87 (96.7)	193 (95.5)	
Yes	6 (5.4)	3 (3.3)	9 (4.5)	

hybrid models (42.3%) were the most preferred across both groups. Only a small proportion selected online learning modules (4.0%), while in-person workshops were chosen by 15.4% of respondents. The difference in training preferences between the two groups was not statistically significant (p = 0.370). In assessing MOH capacity for research, most respondents rated it as "adequate" (47.0%), with smaller proportions selecting "excellent" (17.5%) or "limited" capacity (31.5%). The perceived capacity was not significantly different between those requiring and not requiring training (p = 0.164). For National Disease Control (NDC), 62.9% of respondents reported no involvement, with no significant difference between the groups (p = 0.196). Similarly, involvement with National Health Laboratory Services (NHLS) was reported by 56.4% of participants, with no significant difference between groups (p = 0.360). On the Epidemiology and Surveillance Division, 64.9% of participants reported involvement, with no significant difference (p = 0.914), while 65.3% indicated participation in the Public Health Emergency Operations Centre (PHEOC), again with no significant difference (p = 0.515).

Lastly, 95.5% of respondents reported no involvement in other services, with no significant difference between groups (p = 0.488). See Table 4.

Bivariate Results for Sociodemographic, Professional Roles and Critical Areas of Capacity Needs

Tables 5 and 6 illustrate the bivariate results of participants' sociodemographic, professional roles and capacity needs. There was a significant difference in training needs based on professional roles (p = 0.002). Public health officials (31.2%) and lab technicians (15.2%) had the highest proportions of individuals requiring training, while field epidemiologists (27.8%) and public health officials (25.6%) were more likely to report not needing training.

Education level also influenced training needs (p = 0.040). More individuals with a master's degree (47.5%) required training, while Doctorate holders (7.9%) were less likely to need it. Conversely, 52.2% of those not requiring training held a master's degree, and 12.2% had a doctorate.

Table 5 Bivariate Results for Sociodemographic, Professional Roles

	Requires Training n(%)	Does Not Require Training n(%)	Total n(%)	p-value
N	112 (55.4)	90 (44.6)	202 (100.0)	
Age				0.315
18-35	28 (25.0)	22 (24.4)	50 (24.8)	
36-45	48 (42.9)	47 (52.2)	95 (47.0)	
46-55	36 (32.1)	21 (23.3)	57 (28.2)	
Years of experience				0.811
< 1 year	3 (2.7)	2 (2.2)	5 (2.5)	
1-5 years	40 (35.7)	32 (35.6)	72 (35.6)	
6-10 years	33 (29.5)	22 (24.4)	55 (27.2)	
> 10 years	36 (32.1)	34 (37.8)	70 (34.7)	

(*Continued*)

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Table 5 (Continued).

	Requires Training n(%)	Does Not Require Training n(%)	Total n(%)	p-value
Role played				0.002
Researcher	19 (17.0)	17 (18.9)	36 (17.8)	
Field epidemiologist	13 (11.6)	25 (27.8)	38 (18.8)	
Lab technician	17 (15.2)	15 (16.7)	32 (15.8)	
Data analyst	6 (5.4)	7 (7.8)	13 (6.4)	
Public health official	35 (31.2)	23 (25.6)	58 (28.7)	
Others	22 (19.6)	3 (3.3)	25 (12.4)	
Region				0.694
Others	2 (1.8)	1 (1.1)	3 (1.5)	
Sub-Saharan Africa	110 (98.2)	89 (98.9)	199 (98.5)	
Highest level education				0.040
Bachelors	38 (33.9)	24 (26.7)	62 (30.7)	
Masters	49 (43.8)	47 (52.2)	96 (47.5)	
Doctorate	5 (4.5)	11 (12.2)	16 (7.9)	
Others	20 (17.9)	8 (8.9)	28 (13.9)	
Area of specialization				0.011
Epidemiology	20 (18.0)	31 (34.4)	51 (25.4)	
Public health	49 (44.1)	27 (30.0)	76 (37.8)	
Microbiology	5 (4.5)	10 (11.1)	15 (7.5)	
Biostatistics	9 (8.1)	8 (8.9)	17 (8.5)	
Infectious disease	16 (14.4)	11 (12.2)	27 (13.4)	
Others	12 (10.8)	3 (3.3)	15 (7.5)	

Table 6 Bivariate Result for Critical Areas of Capacity Needs

Lack of skilled personnel				0.340
No	46 (41.1)	43 (47.8)	89 (44.1)	
Yes	66 (58.9)	47 (52.2)	113 (55.9)	
Limited laboratory diagnostic capacity				0.276
No	26 (23.2)	27 (30.0)	53 (26.2)	
Yes	86 (76.8)	63 (70.0)	149 (73.8)	
Insufficient d management tools				0.198
No	41 (36.6)	41 (45.6)	82 (40.6)	
Yes	71 (63.4)	49 (54.4)	120 (59.4)	
Inadequate collaboration with other institutions				0.682
No	58 (51.8)	44 (48.9)	102 (50.5)	
Yes	54 (48.2)	46 (51.1)	100 (49.5)	
Others				0.211
No	106 (94.6)	81 (90.0)	187 (92.6)	
Yes	6 (5.4)	9 (10.0)	15 (7.4)	
Handling emerging zoonotic diseases				0.981
No	40 (35.7)	32 (35.6)	72 (35.6)	
Yes	72 (64.3)	58 (64.4)	130 (64.4)	
Monitoring and managing antimicrobial resistance				0.848
No	35 (31.2)	27 (30.0)	62 (30.7)	
Yes	77 (68.8)	63 (70.0)	140 (69.3)	

(*Continued*)

Table 6 (Continued).

Outbreak preparedness and response				0.002
No	29 (25.9)	42 (46.7)	71 (35.1)	
Yes	83 (74.1)	48 (53.3)	131 (64.9)	
Analyzing and interpreting surveillance data				0.858
No	76 (67.9)	60 (66.7)	136 (67.3)	
Yes	36 (32.1)	30 (33.3)	66 (32.7)	
Others				0.313
No	108 (96.4)	84 (93.3)	192 (95.0)	
Yes	4 (3.6)	6 (6.7)	10 (5.0)	
Skills gained assessed				0.299
Pre- and post-training self-assessments	44 (40.0)	37 (41.6)	81 (40.7)	
Case studies and scenario-based simulations	28 (25.5)	31 (34.8)	59 (29.6)	
Certification exams	35 (31.8)	20 (22.5)	55 (27.6)	
Others	3 (2.7)	1 (1.1)	4 (2.0)	
Receiving feedback				0.369
No	1 (0.9)	0 (0.0)	1 (0.5)	
Yes	111 (99.1)	90 (100.0)	201 (99.5)	
Enrolled for Capacity building				
Yes	112 (100.0)	90 (100.0)	202 (100.0)	
Preferred duration				0.010
1-2 weeks	9 (8.0)	17 (18.9)	26 (12.9)	
1 month	10 (8.9)	8 (8.9)	18 (8.9)	
3-6 months	38 (33.9)	22 (24.4)	60 (29.7)	
6-12 months	33 (29.5)	14 (15.6)	47 (23.3)	
24 months	22 (19.6)	29 (32.2)	51 (25.2)	

Specialisation significantly impacted on training requirements (p = 0.011). Public health specialists (44.1%) had the highest training needs, followed by epidemiologists (18.0%). Microbiologists (11.1%) and others (3.3%) had lower training demands.

Preferred training duration differed by group (p = 0.010). Those requiring training preferred longer durations, with 33.9% opting for 3–6 months and 29.5% for 6–12 months. In contrast, those not requiring training preferred 24 months (32.2%).

Outbreak preparedness and response training showed significant differences (p = 0.002), with 74.1% of those requiring training emphasising this area, compared to 53.3% of those not requiring training. See Tables 5 and 6.

Multivariate Analysis of Factors Predicting Training Needs

In the multivariate analysis, several significant factors were identified as predictors of training needs. These included education level, area of specialization, outbreak preparedness and response, and preferred training duration.

Education level emerged as a significant predictor, with individuals holding a master's degree more likely to require training compared to those with a bachelor's degree (AOR = 2.76, 95% CI: 1.153–6.618, p = 0.023). In contrast, individuals with a doctorate did not show significant differences in training needs (AOR = 3.16, 95% CI: 0.711–14.081, p = 0.131).

The area of specialization also played a role in predicting training needs, particularly among public health professionals. Public health specialists were significantly less likely to report training needs compared to those specializing in epidemiology (AOR = 0.35, 95% CI: 0.124–0.989, p = 0.048).

Outbreak preparedness and response training significantly influenced training needs. Individuals who had undergone training in outbreak preparedness and response were significantly less likely to report a need for further training (AOR = 0.24, 95% CI: 0.097–0.575, p = 0.001).

Finally, the preferred duration of training was another significant factor. Individuals who preferred training lasting 6–12 months were significantly less likely to require additional training compared to those who preferred a longer training duration (AOR = 0.12, 95% CI: 0.031–0.46, p = 0.002). See Table 7.

Table 7 Multivariate Results of Factors That Predicted Training Needs

Capacity Building Needs	COR (95% CI)	P-value	AOR (955CI)	P-value
Age				
18-35	1		1	
36-45	1.25 (0.626–2.48)	0.531	0.9 (0.298–2.701)	0.847
46-55	0.74 (0.342–1.612)	0.452	0.43 (0.1–1.859)	0.259
Years of experience				
< 1 year	1		1	
1-5 years	1.2 (0.189–7.621)	0.847	6.02 (0.256–141.292)	0.265
6-10 years	1 (0.154–6.48)	1	6.31 (0.267–149.215)	0.253
> 10 years	1.42 (0.223–9.006)	0.712	9.27 (0.382–224.967)	0.171
Region_				
Others	1		1	
Sub-Saharan Africa	1.62 (0.144–18.137)	0.696	7.93 (0.297–211.324)	0.216
Role played				
Researcher	1		1	
Field epidemiologist	2.15 (0.842–5.484)	0.109	1.94 (0.563–6.658)	0.295
Lab technician	0.99 (0.38–2.56)	0.977	0.75 (0.204–2.785)	0.672
Data analyst	1.3 (0.366–4.651)	0.683	2.95 (0.371–23.531)	0.306
Public health official	0.73 (0.317–1.701)	0.471	1.07 (0.368–3.115)	0.9
Others	0.15 (0.039–0.601)	0.007	0.16 (0.032–0.768)	0.022
Highest level education				
Bachelors	1		1	
Masters	1.52 (0.794–2.906)	0.207	2.76 (1.153–6.618)	0.023
Doctorate	3.48 (1.077–11.27)	0.037	3.16 (0.711–14.081)	0.131
Others	0.63 (0.241–1.664)	0.354	0.87 (0.263–2.902)	0.826
Area of specialization				
Epidemiology	1		1	
Public health	0.36 (0.171–0.74)	0.006	0.35 (0.124–0.989)	0.048
Microbiology	1.29 (0.384–4.335)	0.68	2.04 (0.405–10.317)	0.386
Biostatistics	0.57 (0.19–1.733)	0.324	0.26 (0.036–1.81)	0.172
Infectious disease	0.44 (0.171–1.149)	0.094	0.34 (0.096–1.217)	0.098
Others	0.16 (0.04–0.644)	0.01	0.46 (0.079–2.726)	0.395
Insufficient data management tools				
No	1		1	
Yes	0.69 (0.392–1.215)	0.199	1.35 (0.607–3.006)	0.461
Others				
No	1		1	
Yes	1.96 (0.671–5.738)	0.218	0.45 (0.116–1.717)	0.241
Outbreak preparedness and response				
No	1		1	
Yes	0.4 (0.221–0.722)	0.002	0.24 (0.097–0.575)	0.001
Preferred duration				
1-2 weeks	1		1	
1 month	0.42 (0.124–1.451)	0.172	0.56 (0.121–2.576)	0.455
3-6 months	0.31 (0.117–0.803)	0.016	0.47 (0.145–1.545)	0.215
6-12 months	0.22 (0.081–0.624)	0.004	0.12 (0.031–0.46)	0.002
24 months	0.7 (0.262–1.859)	0.472	0.7 (0.203–2.388)	0.564

(*Continued*)

Table 7 (Continued).

Capacity Building Needs	COR (95% CI)	P-value	AOR (955CI)	P-value
Moh capacity id research				
Excellent (Well-equipped and supported)	1		1	
Adequate (Basic facilities available)	0.74 (0.34–1.615)	0.451	0.79 (0.289–2.15)	0.643
Limited (Minimal resources and support)	0.59 (0.257–1.361)	0.217	1.2 (0.4–3.61)	0.744
Inadequate (Severely lacking resources)	0.12 (0.013–1.084)	0.059	0.08 (0.006–1.2)	0.068
National Disease Control (NDC)				
No	1		1	
Yes	0.68 (0.382–1.219)	0.197	0.78 (0.367–1.655)	0.517

Qualitative Findings

Our qualitative analysis identified seven key themes: Resource constraints, human resource gaps, Infrastructure and equipment deficiencies, coordination and collaboration challenges, knowledge and training gaps, logistical and operational barriers, and policy and governance issues.

Resource Constraints

Resource constraints were found to be one of the most significant limitations, both human and financial. Many participants highlighted inadequate funding as a major barrier to effective outbreak response and disease management. This lack of financial support hampers the ability to purchase essential supplies like PPE, diagnostic tools, and other critical resources. This is characterised by delays in funding allocation which always contribute to inefficiencies in response efforts. One respondent noted, "Inadequate funding, poor infrastructure, weak reporting, and political challenges severely limit our capacity to act swiftly".

Human Resource Gaps

Another critical issue that emerged strongly from our qualitative analysis was the shortage of skilled personnel. Respondents consistently mentioned the lack of trained staff, particularly in specialized fields like epidemiology, data management, and laboratory diagnostics. This shortage extends to insufficient training opportunities, resulting in a workforce that feels underprepared for the challenges they face. A participant expressed concern about the "lack of skilled personnel and inadequate human resources to support field teams", which further complicates timely responses to outbreaks.

Infrastructure and Equipment Deficiencies

The lack of adequate infrastructure and necessary equipment was frequently cited as a barrier. Several responses pointed out the insufficiency of laboratory capacity, which often leads to delayed detection and response times. The absence of essential diagnostic kits and the lack of reliable transport for sample collection were noted as critical hindrances. One respondent highlighted, "Limited diagnostic tools and inadequate laboratory capacity with very long turnaround times are significant obstacles".

Coordination and Collaboration Challenges

Poor coordination between stakeholders and insufficient inter-departmental collaboration were also identified as recurrent themes. The lack of a cohesive approach, often described as working in silos, undermines efforts to manage outbreaks effectively. Respondents emphasized the need for improved communication and coordination, with one remark, "Different departments prefer to work in silos, leading to less data sharing and a lack of coordinated response".

Knowledge and Training Gaps

Knowledge deficits and insufficient training were repeatedly mentioned, particularly in areas like outbreak investigation, disease modelling infectious diseases, and the application of new technologies. Respondents called for more comprehensive training programs to enhance the skill set of the workforce. One participant stated, "There is an urgent need for training on emerging diseases and necessary surveillance tools to build capacity".

Logistical and Operational Barriers

Logistical challenges, such as inadequate transport, insufficient funding for emergency response, and limited access to necessary materials, were common concerns. These barriers not only delay responses but also reduce the overall effectiveness of outbreak management efforts. A respondent mentioned, "Lack of transport and logistics support hinders our ability to conduct timely investigations and manage outbreaks effectively".

Policy and Governance Issues

Several responses pointed to weaknesses in policy and governance, including poor prioritization of disease surveillance and outbreak preparedness. Political instability and bureaucratic inefficiencies were also noted as factors that exacerbate these challenges. One participant observed, "Inadequate public health support and poor governance significantly impact our ability to respond to health emergencies".

Discussion

The primary objective of this study was to describe the implementation of infectious disease field epidemiology and biostatistics fellowship in Africa and to use this as a pilot on which to identify critical training needs in field epidemiology and biostatistics in Sub-Saharan Africa (SSA). On the implementation of the IDEA Fellowship, the findings between 2022 and 2024 show that the program established a master's training program at Busitema University that is open to both local and international students.

The first cohort of students in infectious disease epidemiology and biostatistics has completed face-to-face courses, field work, and are finalising their mini-theses and to graduate in 2025. These Epi Fellows are already absorbed into the Ministry of Health disease outbreak response teams, including the current Ebola 2025 outbreak in Uganda,[29] hence enhancing capacity. Practical field-based sessions strengthened surveillance, modelling, and research skills. Collaborations with the Ministry of Health and other partners have improved epidemic response capacity. Curriculum validation is ongoing, supported by practical training modules tailored to field epidemiology and public health needs in Uganda and SSA at large. Career pathways for infectious disease specialists have been advocated, facilitating graduates' transition into research, field epidemiology and public health roles. Plans for a PhD program are in advanced stages, with current trainees being mentored for future enrolment as a step towards ushering them to independent researchers, field epidemiology specialists, academicians, policy analysts and/or firstline outbreak responders.

The findings on the needs for field epidemiology and biostatistics in SSA revealed substantial gaps in several key areas of field epidemiology, notably outbreak investigation, zoonotic disease management, and data management. Specifically, 64.4% of respondents identified zoonotic disease management as a significant area requiring further training, followed closely by outbreak preparedness (64.9%) and data management (59.4%). These gaps are particularly concerning given the increasing number of zoonotic diseases emerging in SSA, driven by deforestation, urbanisation, and changing agricultural practices.

The region's vulnerability to such diseases speaks to the importance of targeted training to enhance both prevention and response efforts. Improved outbreak preparedness and data management are two critical foundational areas for effective disease surveillance and timely responses to epidemics. These findings align with global concerns about the insufficient capacity of health systems to respond to emerging infectious threats, particularly in low-resource settings.[30]

Strengthening skills in these areas is essential for improving field epidemiology responses and preventing the widespread transmission of infectious diseases.[31] Moreover, addressing these training needs is pivotal for enhancing the long-term sustainability of public health systems in SSA, as well-trained professionals are crucial for building resilience against future health crises. Similar programs in West Africa have already established the effectiveness of the FETP capacity building program on improving in graduates' skills related to data collection, analysis, and reporting, which are very essential during outbreak response.[32,33] In addition to identifying capacity gaps, our study highlighted significant barriers to effective training and public health response in SSA.

One of the most pressing barriers identified by respondents was limited laboratory diagnostic capacity. This is particularly critical, as the lack of diagnostic tools and facilities delays the identification of infectious diseases, hindering timely outbreak responses. Despite the establishment of the mobile laboratory in 5 East African countries in the year 2023.[34] The problem of inadequate laboratory infrastructure still exists due to competing outbreaks of infectious disease in the region, for instance, the recent Ebola Sudan outbreak in Uganda.[29] The Marburg Virus outbreak in Tanzania[35] and others like yellow fever that together compound the problem of laboratory diagnostics. This not only impedes the effectiveness of surveillance systems but also compromises the overall quality of epidemic preparedness.

We also identified the existence of a lack of efficient collaboration among institutions, with 49.5% of respondents noting a lack of coordination between stakeholders, which they alluded to it affecting the effective management of the outbreak. This lack of collaboration is a common challenge in many SSA countries, where fragmented health systems and insufficient communication between governmental bodies, healthcare institutions, and international organisations create inefficiencies in disease control efforts.

We also found that the lack of resources to conduct infectious disease training programs was a pervasive issue, with respondents citing insufficient financial support and logistical constraints as key factors hindering the effectiveness of capacity-building initiatives. This constraint has broader implications in sub-Saharan Africa, where limited funding directly undermines the timeliness and quality of outbreak detection and response.

Financial constraints often lead to inadequate diagnostic infrastructure, delayed laboratory confirmation, and restricted access to essential supplies and technologies, thereby impeding rapid case identification and containment during epidemics.[28,36] These systemic challenges further compound the difficulties faced by public health professionals in SSA, highlighting the need for both domestic and international investments to strengthen infrastructure and enhance training. This finding agrees with what Osamuedeme and others found in Ghana, where the lack of resources affected the health system's COVID-19 pandemic preparedness in the Ghana.[37]

When we explored the participants' preferences for training formats and durations. We found a strong preference for hybrid training models (42.3%), combining in-person and online learning. This finding reflected a broader trend in educational delivery, where flexible training formats are seen as more accessible and effective, especially in regions with limited resources and logistical challenges, where learners have to look for money while studying. Additionally, the hybrid models also provide opportunities for continuous learning and engagement, allowing participants to balance fieldwork and training.

Regarding the training duration, we found out that a significant portion of respondents (29.7%) indicated a preference for training periods of 3–6 months, while another 25.2% preferred programs lasting up to 24 months. These preferences suggest that long-term, intensive training programs are valued for their ability to provide in-depth knowledge and practical skills. Given the complexity of the public health challenges in SSA, extended training durations may be necessary to fully equip field epidemiologists with the skills required for managing outbreaks and conducting research.

Our findings on the capacity-building needs of public health professionals in SSA are consistent with those from other regional and global field epidemiology training programs. For example, the Field Epidemiology Training Program (FETP) implemented by the Centres for Disease Control and Prevention (CDC) and the World Health Organisation (WHO) has reported similar gaps in critical skills such as outbreak investigation, data management, and laboratory diagnostics across SSA countries.[30] These commonalities reflect systemic challenges that field epidemiologists face in many low-resource settings, where foundational public health infrastructure remains underdeveloped.

The IDEA Fellowship program in Uganda stands out for its integration of both theoretical and practical training, aligning closely with the training model adopted by FETPs in various countries. However, unlike FETP, which often relies on external funding and training resources, the IDEA Fellowship program emphasises local partnerships and collaboration with institutions such as the Africa CDC and the Uganda Ministry of Health. This localised approach enhances the relevance of the training, ensuring that the skills developed by fellows are directly applicable to the public health challenges in Uganda and other SSA countries.

Our findings from this study underscore the critical need for targeted investments in field epidemiology training to strengthen the public health workforce in Sub-Saharan Africa (SSA). Policymakers in SSA must recognise that the effectiveness of public health systems is heavily reliant on the expertise of field epidemiologists, who are essential for rapid outbreak detection, response, and prevention. Given the current gaps in training and capacity identified in this study, it is imperative for national and regional health policies to prioritise the development of specialised training programs in field epidemiology. Additionally, policymakers should recognise the importance of collaboration between government institutions, international organisations, and local academic institutions.

One other such recommendation, would be the need to adopt the one health approach in responding to some of these EID in the country. The integration of the One Health approach is increasingly recognized as essential for the prevention and control of infectious diseases, particularly zoonoses, in sub-Saharan Africa and globally. This interdisciplinary strategy, which emphasises collaboration across human, animal, and environmental health sectors, is critical given the rising frequency of zoonotic spillovers and the complex ecological drivers of emerging infectious diseases. However, awareness and practical application of the One Health framework remain limited among many health professionals. Recent studies, such as,[38] uncovered significant knowledge gaps even among trained medical personnel, highlighting the urgent need to incorporate One Health principles into medical and public health training programmes. The success of the IDEA Fellowship program can be attributed in part to its collaborative approach, which brought together various stakeholders such as the Uganda Ministry of Health, Africa CDC, and UK-based institutions. These partnerships are essential for maximising the impact of capacity-building programs and for ensuring that the training provided meets the needs of both the professionals and the health systems they serve.

From a practical standpoint, the study highlights several areas where public health programs can be enhanced to better support field epidemiologists in SSA. First, it is clear that a significant investment is needed in laboratory infrastructure and diagnostic capacity.

Strengths and Limitations of the Study

Our study is the best to our knowledge to identify the need for capacity building in biostatistics and field epidemiology to strengthen infectious disease outbreak prevention and control in Uganda. However, while our findings provide valuable insights into the capacity-building needs and barriers in field epidemiology training in Sub-Saharan Africa (SSA), our findings are subject to several limitations for instance, the reliance on self-reported data collected through the REDCap-based survey, which might have been affected by self-reported bias. While the survey provided a comprehensive view of the training needs and perceived barriers, self-reported data are subject to biases, such as social desirability bias or recall bias.

Additionally, our survey sample, while diverse, may not fully represent the broader population of public health professionals in SSA. The 202 participants used in the study were drawn from a specific set of countries and organizations, which may limit the generalizability of the findings. The sample was also skewed toward certain professional roles, such as public health officials and field epidemiologists, which may not fully capture the perspectives of other key stakeholders in the field, such as laboratory technicians or data analysts.

One key area for future development is the scaling of the IDEA Fellowship program to reach more countries and public health professionals across SSA. The success of the program in Uganda provides a strong foundation for expansion to other countries facing similar public health challenges. To achieve this, it is essential to establish additional partnerships with governments, international organizations, and academic institutions, ensuring that the program is sustainable and can be adapted to the unique needs of different regions. Expanding the fellowship would not only increase the number of trained epidemiologists in SSA but also create a network of professionals who can collaborate across borders, improving regional public health responses to emerging infectious diseases.

Moreover, scaling the program could involve incorporating more diverse training formats, such as online learning modules, which would allow greater flexibility for public health professionals in remote areas. Additionally, extending the duration of training programs and adding specialized modules in areas such as bioinformatics, vaccine development, and digital health would address the evolving needs of SSA's public health workforce.

Conclusion

The study highlights the critical role of the IDEA Fellowship in addressing the shortage of trained field epidemiologists in Uganda and SSA at large. By combining theoretical instruction with hands-on field experience, the program equips public health professionals with essential skills for epidemic preparedness. Key training needs include outbreak investigation, zoonotic disease management, and data management, while challenges such as limited diagnostic capacity, weak institutional collaboration, and resource constraints hinder progress. Strengthening infrastructure, fostering inter-institutional cooperation, and integrating innovative training models are necessary to overcome these barriers. Expanding the fellowship and incorporating new technologies will be vital for building a resilient public health workforce in SSA. However, sustained implementation may face detractors such as funding limitations, institutional inertia, and human resource attrition. These can be mitigated through multisectoral partnerships, alignment with national workforce development plans, and embedding the fellowship within existing public health systems. Long-term evaluations will further inform adaptability and ensure the program's relevance and sustainability.

Data Sharing Statement

The study data is available by request to the corresponding author.

Compliance with Ethical Standards

The study conformed to the provisions of ethical standards in Uganda. The curriculum for the Master's of infectious disease field epidemiology and biostatistics is approved by the Uganda National Council for Higher Education. The study was approved by the Uganda National Health Research Organisation (UNHRO).

Consent to Publish

Uganda National Health Research Organization (UNHRO), approved the publication of this manuscript.

Collaborators

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare no conflicts of interest in this work.

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