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Training of Medical Laboratory Professionals in Africa Region: A Perspective of the Practicing Laboratory Professionals

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Abstract

Approximately 70% of medical decisions require a confirmatory laboratory test. This reliance highlights the critical role of laboratory medicine in enhancing healthcare outcomes and the need for appropriately trained and skilled laboratorians. To assess levels, types, composition and training of laboratory professionals in response to the changing needs in Africa, we surveyed medical laboratory professionals in Africa on their demographics and challenges encountered during training and what would be consider as a minimum course content for a medical laboratory training program. Of the 285 professionals from 30 countries surveyed, 88% were working within their countries of birth and 82% trained at public institutions. 89.5% were employed and 151 (53%) had a bachelor's degree as their primary laboratory qualification. 63% expressed satisfaction with their career growth. Courses recommended into the primary laboratory qualification were microbiology, biosafety, biosecurity, hematology, chemistry, blood transfusion, immunology, laboratory management, attachment, molecular biology, research methods, histology and cytology. Challenges faced during training were lack of resources and equipment, limited clinical exposure, insufficient curriculum coverage and inadequate faculty staff. 30.9% of the professionals had at least one additional medical qualification. Employment status was significantly associated with satisfaction with one's career growth (p=004). A 4-year bachelor's degree with 12 months of internship is recommended for Laboratory training with microbiology, biosafety and biosecurity, hematology, chemistry, blood transfusion, immunology, laboratory management, internship, molecular biology, research methods, histology and cytology as minimum content. More laboratory-specific disciplines for post-graduate training up to PhD level, associated with defined career paths adequately compensated are recommended.

Keywords: *Bachelor's, Career, Curriculum, Internship, Qualification.*

Introduction

It has been well-recognized that despite accounting for 1-2% of healthcare expenditures, medical laboratory diagnostics are involved in up to 60-70% of clinical decisions, influencing patient management strategies [1, 2] and a critical component of public health interventions and disease surveillance [3]. This reliance highlights the critical role of laboratory medicine in enhancing healthcare outcomes, informing clinical trial endpoints and optimising clinical practices [3, 4]. Other than improving the quality of outcomes, investing in a diagnostic laboratory service improves the cost-effectiveness of healthcare.

The status of the medical laboratory profession in the African region reflects significant progress and ongoing challenges [5, 6, 7]. Since the Maputo Declaration in 2008,

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there have been notable advancements in laboratory systems, particularly in HIV diagnostics, laying the groundwork for addressing broader health threats [5, 8]. However, the profession still faces issues such as underfunding, workforce shortages, and inadequate training, which hinder the effectiveness of laboratory services across the continent [5]. The investment in laboratory systems has been inconsistent and inadequate, particularly in African countries and was evident during the COVID-19 pandemic [9]. This lack of investment has seen about 47% of the global population not having access to diagnostics, with the majority of these in the World Health Organization Regional Office Region (WHO Afro) [10].

The history of clinical laboratory sciences in North America dates back to the 19th century when outbreaks of diseases such as typhoid, tuberculosis, and diphtheria highlighted the need for laboratory testing in patient care [11]. Although its origins can be traced to the American Revolution, the profession became formalized in the early 20th century, with significant milestones like the 1919 American College of Surgeons' requirement for hospital laboratories and the establishment of the Board of Registry by the American Society for Clinical Pathologists in 1928 [12, 13]. Initially viewed as a temporary profession for women during World War I, it has since gained recognition, especially with technological advancements and public health crises like the COVID-19 pandemic [13, 14]. In Africa, laboratory medicine dates back to the late 1800s with limited tests, evolving significantly in the 1950s and 1960s as formal training programs were established [15]. The rise of diseases like HIV/AIDS and tuberculosis increased investment in laboratory medicine, prompting a need to revolutionize training. Today, programs have evolved from training aides to scientists, incorporating accreditation and aligning with international standards to include disciplines like haematology, microbiology, and molecular diagnostics.

However, the profession and discipline of laboratory medicine have always experienced lower visibility and diminished rewards compared to other disciplines of doctors, nurses and pharmacists [1]. Laboratory professionals operating in the background are often perceived as operating automated equipment deserving of no shared clinical leadership. The profession has long been confronted with challenges, including recruitment and retention challenges, inconsistent funding, inadequate learning facilities, inadequate practical placements, unclear career paths for advancement, inconsistency in training standards and curriculum, limited professional development and limited continuing professional development opportunities as compared to other medical and allied professions.

In this study, we surveyed laboratory professionals to assess levels, types, composition and training in response to the changing needs in Africa. Findings can be used to inform decisions of training curriculum and approaches, career development and paths for laboratory professionals.

Materials and Methods

The study only analysed data collected with expressed informed consent and did not involve identifiable individuals.

We used a survey approach to administer a standardised and validated tool to medical laboratory professionals in Africa. Variables included demographics, types, levels, duration of laboratory training (primary and professional training) and challenges encountered. Data was also collected on what medical laboratory practitioners would consider as a minimum qualification and course content for a medical laboratory training program. Survey Data were downloaded/exported into MS Excel and cleaned for analysis. We used descriptive statistics to summarise our findings. We assessed for predictors of training outcomes,

such as perception about the prior training, career growth and development, using Chi-squared tests and logistic regression analysis. All statistical analysis was conducted using STATA version 18 (STATA Corporation, College Station, TX).

Participants were required to provide consent to participate in the survey. However, their participation was completely anonymised.

Results

Demographic Characteristics

A total of 285 Laboratory professionals responded from 30 countries across the African continent, with the most respondents from Zimbabwe (20.8%), Ghana (16.5%), Botswana (n=28) and Tanzania (9.5%). Most of the participants (88%) are working within their countries of birth.

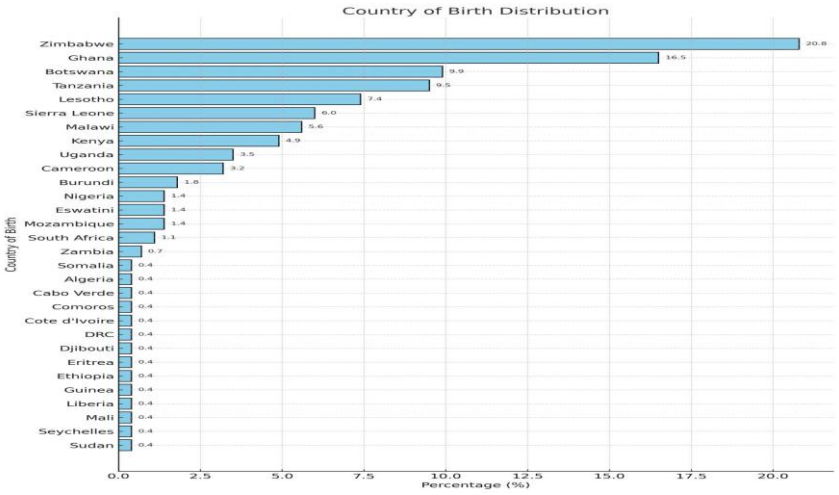

Figure 1. Distribution of the Country of Birth for Laboratory Professionals Participating in the Survey.

Primary Laboratory Training and Qualifications

Most of the professionals were trained at government and or public institutions (n=234; 82%), with the rest at private (n=36; 12.6%), faith-based institutions (n=14; 4.9%) and others (n=1; 12.6%). The majority of the professionals had a bachelor's degree (n=151; 53%) as their first laboratory qualification, with a diploma (n=96; 34%) as the second first qualification, then a certificate (n=23; 8%). Medical Laboratory Sciences was the most used name of the qualification (43%), followed by Medical Laboratory Technologist (20%) and Medical Technology (19%). Figure 2.

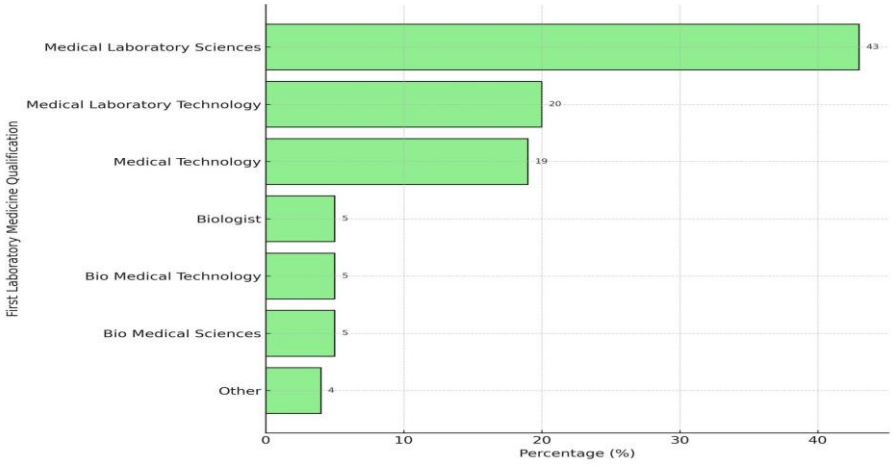

Figure 2. Distribution of the Primary Laboratory Qualification Held by the Laboratory Professionals.

The respondents qualified as medical laboratory professionals between 1990-2024, with the majority qualifying between 2015-2019 (n=72; 25.3%) and the least between 1990 – 1994 (n=9; 4.9%). The duration of the qualification ranged from 1-6 years, with the most at 4 years (n=135; 47.4%), followed by 3 years (n=102; 35.8%), 2,5,1 and 6 years respectively (n=34; 11.9%;), (n=9; 3.2%), (n=3; 1.0%) and (n=2; 0.7%). Those with 4 years duration of training were the ones mostly employed (n=118, 46%).

91.6% (n=261) of the training had an internship program with up to 12 months (n=260; 91.2%) duration as the most common, followed by 13-18 months (n=12; 4.2%), 19-24 months (n=9; 3.2%), 25-20 months (n=8; 2.8%) and 31-36 months (n=3; 1.1%) as the least common. English (n=266; 93.3%) was the most important language of delivery of the training, with French (n=14; 4.9%) and Portuguese (n=4; 1.4%) as the other languages.

The majority (63%) of those satisfied with their first laboratory qualification also expressed satisfaction with their career growth. Those with a bachelor's degree as their first laboratory qualification were the most satisfied (49%) with their qualification.

Curriculum Content and Structure

Most qualifications had content that included genetics, molecular biology, cytology, laboratory management, histology, blood transfusion, haematology, immunology chemistry and microbiology (Figure 3). The laboratory professionals recommended some additional disciplines of biosafety and biosecurity, artificial intelligence, pathogen genomics and bio-informatics not previously offered during their first laboratory qualification. The following modules were recommended by at least 50% of the participants for inclusion as a minimum requirement for the first laboratory qualification: microbiology (86%), Biosafety and Biosecurity (86%), haematology (83%), chemistry (80%), blood transfusion (76%), immunology (76%), laboratory management (76%), laboratory attachment (75%), molecular biology (65%), research methods (64%), histology (61%) and cytology (58%). Figure 3.

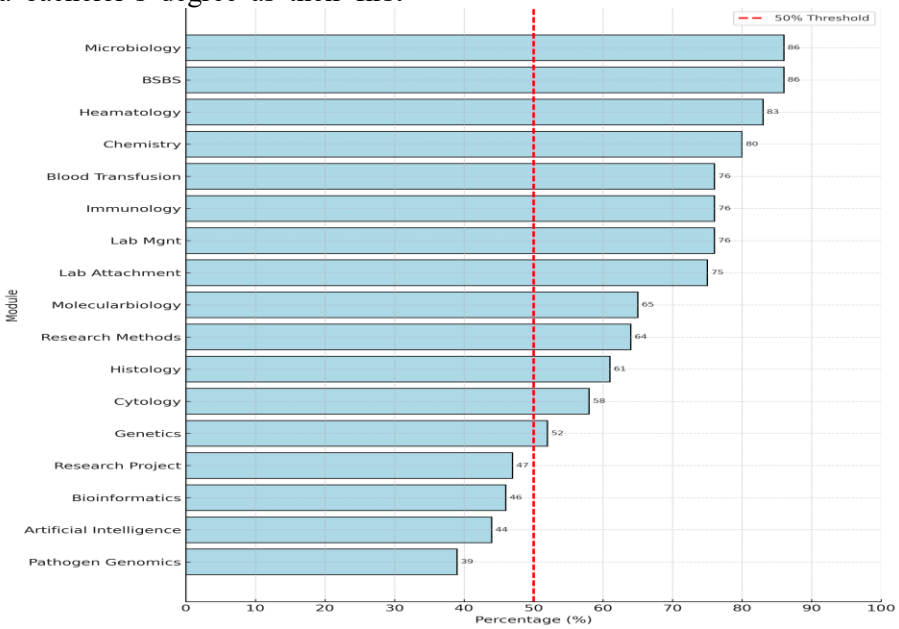

Figure 3. Curriculum Content Proposed for First Laboratory Training Programs

Most (n=118; 41.4%) proposed that the lowest laboratory training qualification be a diploma, while 95 (33.3%) proposed a bachelor's degree, 61 (21.4%) certificate and 11 (3.9%) PhD. The majority (n=227; 79.6%) proposed 3-4 years as the duration of training in

laboratory medicine, while 33 (11.6%) proposed up to 2 years and 25 (8.8%) to be at least 5 years. Most (n=179; 62.8%) of the laboratory professionals were satisfied with their career growth, and 270 (94.7%) would advise young people to pursue laboratory medicine as a career.

Most of the professionals were part of graduating classes that had less than 21 graduates (n=78; 27.4%), followed by classes of 21-30 graduates (n=73; 25.6%), 31-40 (n=45; 15.8%) and 41-50 (n=25; 8.8%). However, there were 64 (22.5%) who were part of a graduating class of more than 50 graduates. 155 (54.4%) indicated that there was a mechanism provided to them to give feedback on the training received for purposes of improving the training.

140 (49.1%) had a mandatory probation period of up to 1 year, 61 (21.4%) between 1 and 6 years, and 78 (27.4%) did not have any form of probation. More than half supported their education (n=158; 55.4%), 85 (29.8%) were on full scholarships, and 42 (14.7%) were partially supported.

Challenges Faced During First Laboratory Qualification Training

The most cited challenge faced during the first laboratory qualification training was lack of resources and equipment (n=107; 37.5%), while limited clinical exposure during training (n=54; 19.0%), insufficient coverage curriculum coverage (n=27; 9.5%) and inadequate faculty staff (n=22; 7.7%) were also mentioned.

However, most professionals (n=166; 58.3%) were satisfied with the first training in laboratory medicine they received, while 90 (31.6%) were very satisfied. 25 (8.8%) were neither satisfied nor dissatisfied, while only 4 (1.4%) were dissatisfied with the training they received.

Highest Laboratory Qualification

97 (34%) of the laboratory professionals had added at least one qualification at the time of the survey. A Bachelor's degree was the most common (n=43; 44.3%) highest qualification achieved, followed by a Master's degree (n=39; 40.2%), PhD (n=21; 21.6%) and only 1 (1.0%) diploma. The most progression was from Diploma to Bachelor degree (n=30; 30.9%) with the least (1.0%) from Certificate to Diploma qualification. Figure 4.

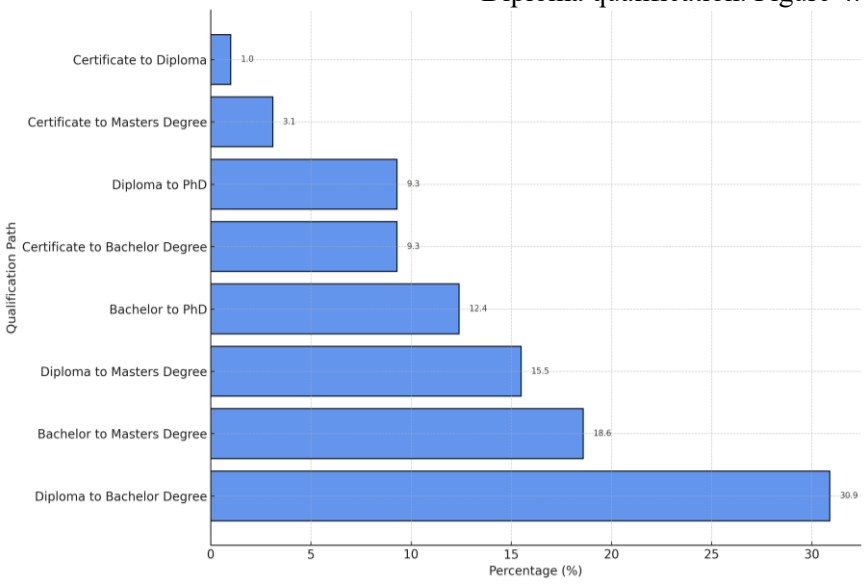

Figure 4: Distribution of Laboratory Qualification Transition from First Qualification to Highest Attained by the Laboratory Professionals

It took between 1-8 years for the professionals to complete their highest laboratory qualification. Most of the professionals (n=62; 21.8%) took 4 years to complete their highest qualification, 51 (17.9%) took 2 years, 41 (14.4%) 3 years, 13 (4.6%) 1 year, 11 (3.9%), 3 (1.1%) 6 years and 1 (0.4%) too 8 years to complete their highest qualification. 191 (67.0%) attained these highest laboratory qualifications at a government or public institution, with 202 (70.1%) using English as a medium of learning.

Most of the professionals were part of graduating classes that had less than 21 graduates (n=79; 27.7%), followed by classes of 21-30 graduates (n=47; 16.5%), 31-40 (n=24; 8.4%) and 41-50 (n=15; 5.3%). However, there were 38 (13.3%) who were part of a graduating class of more than 50 graduates. 126 (46.3%) indicated that there was a mechanism provided to them to provide feedback on the training received for purposes of improving the training.

Challenges Faced During Highest Laboratory Qualification Training

The most cited challenge faced during the highest laboratory qualification training was lack of resources and equipment (n=71; 24.9%), while limited clinical exposure during training (n=37; 13.0%), insufficient coverage curriculum coverage (n=17; 5.6%) and inadequate faculty staff (n=17; 5.6%) were also mentioned.

However, most professionals (n=145; 50.9%) were satisfied with the highest training in laboratory medicine they received, while 62 (21.8%) were very satisfied. 66 (23.12%) were neither satisfied nor dissatisfied, while 4 (1.4%) were dissatisfied, and 8 (2.8%) were very dissatisfied with the training they received.

Highest Other Medical Qualification

88 (30.9%) of the laboratory professionals had another medical qualification. A Master's degree was the most common (n=55; 62.5%) highest other medical qualification achieved, followed by Bachelor's degree (n=18; 20.5%), Diploma (n=8; 9.1%), PhD (n=4; 4.5%) and Certificate (n=3; 3.4%). It took between 1-5 years to complete this highest other medical qualification, with 2 years as the most (n=41; 14.4%). Most (n=82; 28.8%) of these trainings were at a government or public institution and delivered mostly (n=111; 39.0%) in English.

Challenges Faced During Highest Other Medical Qualification Training

The most cited challenge faced during the highest laboratory qualification training was lack of resources and equipment (n=30; 42.9%), while limited clinical exposure during training (n=18; 25.7%), insufficient coverage curriculum coverage (n=13; 18.6%) and inadequate faculty staff (n=9; 12.9%) were also mentioned.

Highest Other Qualification

54 (18.9%) of the laboratory professionals had another non-medical qualification. Most had a Masters degree (n=40; 74%), with 7 (13%) with a bachelor's degree, 4 (7.4%) diploma and 2 (3.7%) a certificate all completed between 2001 and 2024. Majority of the qualification were completed over 3 years (n=26; 48.1%), followed by 2 years (n=11; 20.4%), 4 years (n=9; 16.7%) and 5 years (n=1; 1.9%). The majority (n=52; 96.3%) were completed at a government institution and 50 (92.6%) were delivered in English.

The most reported challenge experienced when training for other qualifications was a lack of industrial and practical exposure (n=26; 48.1%), followed by a lack of resources and equipment to use (n=18; 33.3%) and inadequate staffing (n=10; 18.5%).

Most of the professionals were part of graduating classes that had less than 21 graduates (n=20; 37.0%), followed by classes of 21-30 graduates (n=13; 24.1%), 31- 40 (n=9; 16.7%) and 41-50 (n=2; 3.7%). However, there were 10 (18.5%) who were part of a graduating

class of more than 50 graduates. 126 (46.3%) indicated that there was a mechanism provided to them to provide feedback on the training received for purposes of improving the training.

255 (89.5%) of the medical laboratory professionals surveyed were employed, with the majority (n=76; 30%) as Heads of Departments. Figure 5.

Current Employment Status

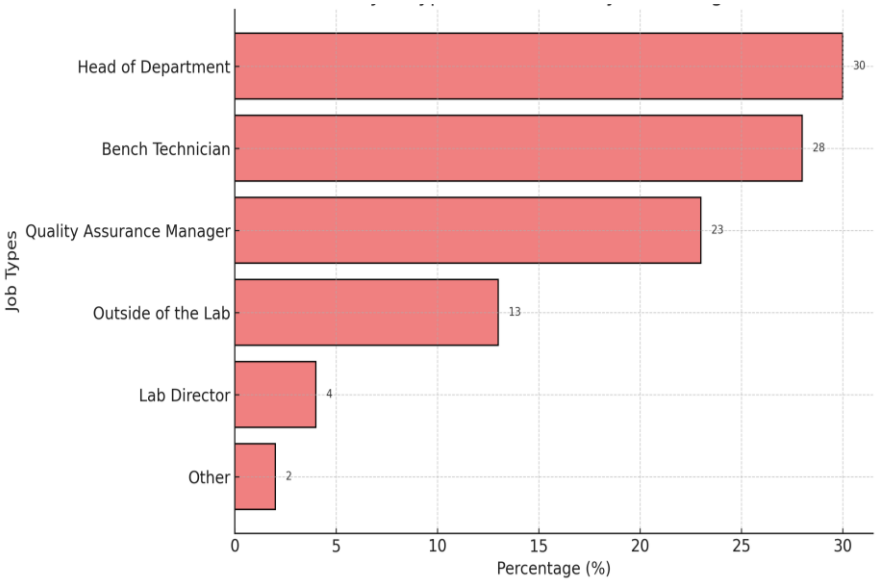

Figure 5. Job Types of Laboratory Professionals Employed at the Time of the Survey

164 (61.6%) were employed within the public sector, followed by Non-Governmental Organizations (n=54; 20.3%), private sector (n=33; 12.4%) and those employed by Faith-based organizations (n=15; 5.6%). The majority (n=234; 82%) and (n=201; 70.5%) indicated that there were opportunities available for continuous professional development (CPD) and postgraduate within their workplaces, respectively.

Employment status was significantly associated with satisfaction with one's career growth (p=004). Although not statistically significant (p=0.11), the majority of those employed (73%) were satisfied with their highest laboratory qualification. 92% of those employed had internships as part of their first qualification training program.

Discussion

Results of this study show that a bachelor's degree in Medical Laboratory Sciences is the most common entry-level qualification. Countries like Botswana introduced a bridging program to convert diplomas to bachelor's degree [16]. The American Society for Clinical Pathology (ASCP) has also offered programs to upgrade medical technologists to the Medical Laboratory Scientists [17]. On average, the duration of training is 4 years, incorporating the internship program consistent with other training programs in Africa [18, 19]. The inclusion of internship in the training offers an opportunity for students to connect theory with practice as well as get exposure to current technologies and testing methodologies [20]. The study also showed that participants who had internships included in their training were more employed, probably indicating a preference for clinically exposed graduates by employees.

Even with just entry-level qualifications, there were high satisfaction levels with the laboratory training as well as career growth. This could be attributed to the high employment rates of these laboratory professionals in this study. Although laboratory professionals in this study added more qualifications up to the PhD

level, the most progression in qualification was from diploma to degree in laboratory sciences. Beyond the degree level, laboratory professionals begin to slightly deviate to other areas of speciality, mostly Masters in Public Health. There is a need to expand options for further studies in laboratory sciences, for example, Masters in Microbiology, Clinical Chemistry, and Blood Transfusion, as examples with corresponding and matching career progression as motivators.

Across all levels of training, most training programs faced challenges in resources from equipment to adequacy of faculty members. The lack of adequate and up-to-date equipment can affect the quality of graduates. The study also showed smaller graduating classes of about 20, which could be a result of a poorly resourced training program. Although laboratory professionals showed high employment rates, most were employed in government hospital institutions, and fewer were returning to participate in the training of other professionals. Given that more laboratorians deviate to other disciplines after their first degree, there could be fewer of them with higher laboratory disciplines specific available. More investment into training programs and incentives can attract laboratory professionals to come back and contribute to training more laboratorians.

Laboratory professionals in employment are better placed to identify what should constitute basic and post-basic training in laboratory sciences. In this study, a diploma was proposed as the lowest allowable qualification in laboratory sciences. This could be attributed to high employment rates even for those with diplomas. The following disciplines were proposed as required at minimum for a qualification: microbiology, Biosafety and Biosecurity, haematology, chemistry, blood transfusion, immunology, laboratory management, laboratory attachment, molecular biology, research methods, histology and cytology. Biosafety and Biosecurity was a discipline proposed that most did not have when they trained. The other emerging areas suggested included artificial intelligence, pathogen genomics and bioinformatics. Consideration should be given to begin to introduce these either as standalone disciplines or as part of existing disciplines, e.g. pathogen genomics and bio-informatics could be part of molecular biology while artificial intelligence could be part of laboratory management.

Conclusion

At a minimum, laboratory professionals should be trained with a 4-year bachelor's degree that includes 12 months of internship at an approved facility. A standardized curriculum for all laboratory degree programs should include, at minimum, microbiology, biosafety and biosecurity, haematology, chemistry, blood transfusion, immunology, laboratory management, laboratory attachment (internship), molecular biology, research methods, histology and cytology. More investment is required in laboratory medicine training programs in modern equipment and appropriately qualified faculty members to increase training institutions' outputs to continue to meet the high demand for laboratory professionals. A deliberate effort is needed to increase the options in laboratory-specific disciplines for post-graduate training up to PhD level. These opportunities must be associated by defining career paths adequately compensated to minimize the observed deviation to other disciplines.

Limitations

Our findings are subject to some limitations. Although we attempted to cover most of the African countries, the response rates were varied, and more than 50% of the respondents came from 6 countries.

Acknowledgments

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Conflict of Interest

The authors report no conflicts of interest in this work. There are no financial conflicts of interest to disclose.

Ethical Approval

The study only analyzed data collected from individuals from multiple countries with expressed informed consent (included on the survey questionnaire) and did not involve identifiable individuals, hence no ethical approval was required.

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