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Training the next generation of Biostatisticians in West Africa: The Vanderbilt Nigeria Biostatistics Training Program (VN-BioStat)

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Abstract

Biomedical HIV research is growing in West Africa, but biostatistical expertise is lagging. The Vanderbilt-Nigeria Biostatistics Training Program (VN-BioStat) seeks to establish a research and training platform for biostatisticians doing HIV-related research in Nigeria. The objectives of the program are: 1) Host two Nigerian data scientists per year (a total of 10 over 5 years) at Vanderbilt University Medical Center to gain hands-on biostatistics training and experience via one-year fellowships. Eligible trainees will be junior investigators with PhDs or nearing completion of their PhDs in statistics or related fields, including mathematics and computer science. 2) Conduct annual workshops in Nigeria to provide biostatistics training. Trainees will undertake biostatistics coursework and hands-on training and participate in mentorship as biostatisticians involved in HIV research. Trainees will be at Vanderbilt for a full year and be part of an active biostatistics department. They will be immersed in a dry-lab HIV biostatistics project in collaboration with a Nigerian HIV research project and lead a methodologically focused research project. They will also participate in a one-month research training/grant writing program in Nashville. The VN-BioStat program will build on the existing momentum of ongoing initiatives to enhance research capacity in Nigeria by developing biostatistics leadership. VN-BioStat trainees will interact with

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investigators from Nigeria to provide collaborative biostatistical assistance with study design and data analysis, thus gaining real-world experience that will benefit the trainees and the broader research community in Nigeria.

Keywords

biostatistics; capacity building; HIV; West Africa

Biostatisticians have played and continue to play significant roles in designing, monitoring, and analyzing data from clinical trials to develop the next generation of HIV therapies, reducing the incidence of HIV, and addressing HIV-associated comorbidities. Biostatistics expertise is essential to making sense of large observational databases to understand trends in the HIV continuum of care and HIV-related complications. Biostatisticians have also played and continue to play fundamental roles in laboratory studies aiming to develop HIV vaccines or cures. In short, strong biostatistics support is critical for high-quality HIV research.

A large amount of HIV research is being conducted in Africa because of the high prevalence, incidence, and burden of HIV in the region. For instance, the proportion of the world's total HIV publications from Africa increased from 5.1% in 1986 to 31.3% in 2020. The total indexed HIV publications during this period was strongly correlated to the number of persons living with HIV (r=0.72, P<0.01) [1]. Much of this effort has been joint research between institutions in high-income countries and medical centers in low- and middle-income countries (LMICs). As a result of these collaborations and targeted training programs, the number of biomedical researchers has grown in Africa to the point that in some places, including Nigeria, there is in-country research leadership. However, as pointed out by others, "Growth in biostatistics lags far behind" [2].

In September 2009, the National Institute of Allergy and Infectious Diseases (NIAID) of the US National Institutes of Health (NIH) conducted a workshop aimed at strengthening biostatistics resources in Africa [2]. The workshop identified challenges to strengthening biostatistics, many of which persist more than a decade later. Some of these challenges include: 1. Limited connections between statisticians and biomedical research; although many universities in Africa have statistics departments that offer graduate degrees, most of these programs do not emphasize biostatistics, and they are usually not involved or linked with biomedical research; 2. Lack of a critical mass and limited support for biostatisticians at universities; 3. Competition with the financial sector and other industries for quantitatively-minded graduates. This workshop also highlighted opportunities for training biostatisticians, including Fogarty International Center (FIC) training grants, partnerships between US and African institutions, and short-term training programs. Many of these ideas have been implemented, and progress has been made. Over the past ten years, funded training initiatives have successfully built biostatistics networks in Southern Africa and East Africa [3]. However, to our knowledge, no such program currently exists in West Africa.

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The need for in-country biostatistics leadership in West Africa is huge. Local researchers are most likely to understand the particular needs and research questions relevant to improving the HIV epidemic in their area. Local collaborative biostatisticians are critical because they can be part of teams that lead independent research; one of the biggest challenges facing junior biomedical researchers in Africa is insufficient access to statistical support. Biostatisticians from partnering, high-income institutions are often willing to help, but their time is typically stretched thin to provide substantial and ongoing support. They often do not understand subtle contextual issues that are understood by being on the ground where the data are collected, and such support leads investigators from the LMIC institution to be dependent on institutions in high-income countries.

Nigerian investigators have repeatedly expressed a need for more local biostatistics support. The idea of developing a training program focused on HIV biostatistics grew from many conversations between Vanderbilt and Nigerian investigators regarding the need to expand HIV research capacity at the Aminu Kano Teaching Hospital (AKTH) in Kano, Nigeria. At one of the biannual FIC/NIH-funded HIV research training workshops held in March 2021 in Kano, Nigeria, trainees from Bayero University, Kano, Nigeria (BUK) and AKTH listed additional biostatistics training as one of the high-priority areas of need [4]. The Vanderbilt-Nigeria Biostatistics Training Program (VN-BioStat) program and its specific aims grew from these conversations.

There is a need for biostatisticians who are more than technicians but who are co-investigators, principal investigators, and thought leaders. Such valuable colleagues would understand biomedical research and could help design studies – not just compute sample sizes but provide statistical intuition regarding optimal ways to design and implement studies, identify pitfalls, develop solutions, create robust analysis plans that directly address questions of interest, and direct/conduct analyses resulting from data collection. The over-arching goal of the VN-BioStat Program is to develop such biostatistics leadership in Nigeria, thus advancing HIV research led by in-country investigators.

METHODS

Specific Aim 1

Send two Nigerian data scientists annually (a total of 10 over 5 years) to Vanderbilt to understudy systems and get hands-on HIV biostatistics training during one-year fellowships.

Objectives—Our immediate objective is to provide deep biostatistics training to a group of Nigerian data scientists. Our long-term objective is to create a critical mass of biostatisticians who can lead and provide high-level biostatistics leadership to HIV research studies at AKTH.

Specific Aim 2

Conduct annual one-week workshops at AKTH/BUK in Nigeria to provide mid-level biostatistics training for up to 20 HIV researchers / data scientists from West Africa.

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Topics will include hands-on training in specific statistical techniques and their application to HIV research. An example topic could be regression modeling strategies: students will learn how to fit linear, logistic, and Cox regression models in R; how to relax linearity assumptions using splines; how to compute confidence intervals using the bootstrap; how to perform penalized regression; and how to account for missing data with multiple imputations. Workshops will be hands-on, with liberal use of de-identified HIV data. They will be team-taught by Vanderbilt biostatisticians in collaboration with Nigerian colleagues and, in later years, with Nigerian biostatisticians who have successfully completed the one-year training program (Specific Aim 1).

Objectives—There are multiple objectives of these short-term training workshops, including:

1. Provide HIV researchers / data scientists with training in contemporary biostatistics to help them develop mid-level skills and understanding that will improve their research.
2. Provide a forum for gathering similar minds and creating a community of HIV researchers with common interests in biostatistics. We hope this will foster innovation, commitment, and enthusiasm towards the field. Similar gatherings of biostatisticians have occurred in southern and eastern Africa and have energized biostatisticians there [3].
3. The workshops will be used as a platform to recruit scholars to come to Vanderbilt for one-year training (Specific Aim 1). We envision many workshop attendees will be quantitatively minded but not familiar with biostatistics and the data science opportunities in HIV research. These workshops will allow us to showcase the exciting work biostatisticians can do in HIV research. Workshop attendees will be aware of the opportunity for a few students to spend one year at Vanderbilt and receive hands-on advanced HIV biostatistics training (Specific Aim 1).
4. Mentoring and continued engagement of former trainees. Scholars who spend one year at Vanderbilt receiving training in biostatistics will help teach the workshops. This will allow them to teach biostatistics to their fellow Nigerian scholars, interact with their former mentors at Vanderbilt, and strengthen ties. Our goal is for these individuals to be biostatistics leaders in Nigeria, so this provides them with the opportunity to grow through teaching and networking.

Training sites

This training program is a collaboration between four leading research institutions, the Aminu Kano Teaching Hospital (AKTH), Bayero University Kano (BUK), Ahmadu Bello University (ABU) (all in northwest Nigeria), and Vanderbilt University Medical Center (Vanderbilt).

Aminu Kano Teaching Hospital (AKTH)—Aminu Kano Teaching Hospital (AKTH) is a 700-bed tertiary care facility affiliated with BUK and located in Kano, Nigeria (population

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~ 9.4 million). AKTH was selected as the collaborating institution for this training program based on its longstanding research collaborations and existing relationships with Vanderbilt, its past performance in NIH-funded clinical studies, and the volume of HIV-positive patients seen annually in its HIV center. The HIV clinic at AKTH is the largest in the state, with over 10,000 patients enrolled in active care [5].

Bayero University Kano (BUK)—Bayero University Kano (BUK) is the academic home for clinical and basic science programs at AKTH. The Faculty of Clinical Science comprises 15 departments and 180 faculty members, >90% of whom have dual appointments with AKTH. The Faculty of Clinical Sciences hosts the Masters in Public Health (MPH) and the Master of Science (MS) programs in several areas; biostatistics is taught as a core MPH course. There is no Department of Statistics at BUK, but there are Departments of Mathematical Sciences and Computer Science. The Mathematical Sciences Department offers undergraduate courses and Bachelor of Science (BSc) degrees in Statistics.

Ahmadu Bello University (ABU)—Ahmadu Bello University (ABU), located in Zaria, is approximately 95 miles south of Kano. ABU has a Department of Statistics (established in October 2016) and offers PhDs in Statistics. Before this, Statistics was housed under the Department of Mathematics (founded in 1962). Because of its proximity to Kano and historical ties to AKTH/BUK, we will recruit trainees from ABU in addition to AKTH/BUK.

Vanderbilt University Medical Center (VUMC)—Vanderbilt University Medical Center (VUMC) is a large academic medical center in Nashville, Tennessee, United States. VUMC includes a highly ranked school of medicine and is closely affiliated with Vanderbilt University. VUMC houses the Department of Biostatistics and the Vanderbilt Institute for Global Health (VIGH). The Vanderbilt Biostatistics Department was established in 2003 and has grown to over 45 faculty and 50 staff biostatisticians, bioinformaticians, data scientists, and application developers. The Department's graduate program currently has approximately 30 students and offers MSc and PhD degrees. Department faculty are on more than 200 NIH-sponsored grants. VIGH was established in 2005 to facilitate the expansion and coordination of global health research, service and training initiatives and to improve health in resource-limited settings [6]. VIGH comprises 30 core faculty members, >80 affiliated faculty members, and more than 20 programmatic and administrative staff. VIGH research and training engagements span the globe, including Africa, central and South America, and Southeast Asia.

Specific Training Activities

One year fellowship at Vanderbilt (Specific Aim 1)—Eligible trainees will be junior investigators at BUK or ABU with PhDs or nearing completion of their PhDs in statistics or related fields, including mathematics and computer science. Trainees will be immersed with a team of biostatisticians doing HIV research at Vanderbilt University. They will be assigned to projects using AKTH data and provide analysis support while developing and leading a methodologically focused project that will culminate in a publication. While at Vanderbilt, they will also take appropriate biostatistics courses (up to 8 credit hours per semester for 2

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semesters) to deepen their understanding of biostatistics. They will receive mentorship from Vanderbilt and AKTH faculty (one biostatistics mentor, one clinical Vanderbilt mentor, and one Nigerian mentor).

Trainees will learn from biostatistics coursework, particularly via hands-on, mentored participation as a biostatistician involved in HIV research. Trainees will be at Vanderbilt for a full year and be part of an active biostatistics department. They will be immersed in an HIV biostatistics dry-lab, they will work on a collaborative Nigerian HIV research project, lead a methodologically focused research project, take courses, and participate in an intensive one-month research training program in Nashville (Vanderbilt Institute for Research Development and Ethics "VIRDE"). Trainees will also participate in online biostatistics clinics with investigators from Nigeria.

Immersion in HIV biostatistics dry-lab—Trainees will become part of an HIV biostatistics dry-lab that meets weekly to discuss projects and analysis strategies. The VN-BioStat principal investigator will direct the dry-lab, including another PhD statistician, 6 staff (MS-level) biostatisticians, and 1–2 PhD students. Each staff member/student is on one or more HIV research projects, and this meeting is a time to touch base on the status of projects and to ask the team analysis questions, all in the context of HIV/AIDS research. The dry-lab learns from each other: sharing of analysis code is common, and team members often help each other on projects outside of the meeting. Trainees will be assigned a specific collaborative research project based on ongoing HIV research studies in Nigeria, and they will come to the dry-lab meetings with analysis/coding questions for the team to address.

Collaborative Research Projects—Each trainee will be assigned a collaborative research project that uses data from an HIV-related study in Nigeria. Trainees will work with Nigerian and Vanderbilt mentors to create and implement a statistical analysis plan. The trainee will then work with the investigators to publish the collaborative project. A few examples of potential collaborative HIV projects are in Table 2. The research mentoring will be tightly linked with priority HIV research needs identified by AKTH while falling under the NIH priorities for HIV research [6]. By taking this approach, the research studies proposed by each trainee will have direct policy relevance, increasing the likelihood of sustainable, national impact. The trainee's faculty mentorship team will include a Nigerian faculty mentor and a VIGH faculty mentor whose research is related to their project. The trainee will also select a Vanderbilt biostatistics faculty mentor with relevant expertise to consult with the trainee on the project.

Trainees will meet regularly (weekly or bi-weekly) with their research teams to complete the collaborative research project. In consultation with their mentors, the trainee will be expected to learn the necessary background material to understand the rationale for performing the study, write a statistical analysis plan, carry out the statistical analyses, produce a reproducible report, explain and interpret results to the research team both orally and in writing, draft the methods and results sections of a manuscript, and provide critical feedback to the larger manuscript. The trainee will typically be listed as the co-first or second author on the manuscript. The collaborative research project will give the trainees

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important, hands-on experience with a research project and opportunities to gain many skills through this process.

HIV Biostatistics Methods Research Projects—Midway through the fellowship, the trainee and his/her mentors will identify a methodologic research project that the trainee can lead. This will typically arise from the collaborative research project in consultation with the trainee's biostatistics mentor. The purpose of this project is to gain a better understanding of different analysis approaches, their assumptions and properties, and to help the trainee gain more confidence in making decisions about analysing studies and conducting methodological research. Projects will be tailored to the skills and interests of the trainee. The trainee will typically conduct a literature review of potential statistical methods for performing analyses, compare and contrast the assumptions of the various methods, perform a simulation study comparing methods, and then apply the methods to the original HIV data from Nigeria. The final product will be a publishable paper, with the trainee as the first author. A few potential examples of HIV biostatistics methods research projects, paired with examples of potential collaborative research projects, are shown in Table 2. We envision most of these projects will not involve developing new methods but rather comparing existing methods – as the latter is more consistent with the trainees' time frame and the goals of our training program.

Courses—There are many biostatistics courses taught at Vanderbilt that the trainees can access freely. No more than 2–3 courses per semester (total of 8 credit hours) will be recommended to allow students sufficient time for their other VN-BioStat program activities. Before they arrive in Nashville, trainees and their mentors will come up with a plan to tailor the trainees' course selection. Most trainees will have had foundational classes in statistics, so a potential class plan could include more focus on biostatistics methods, such as courses in applied survival analysis, regression modeling strategies, clinical trials and experimental design, and longitudinal data analysis. Barring exceptional situations, students will be encouraged to take more applied and less theoretical courses. Depending on the trainees' background, courses in epidemiology, HIV, and/or global health research may also be warranted. Students will be able to attend any course that they and their mentors agree would be beneficial. Trainees will be able to either audit the course or take it for credit that can be applied towards their degree at their home Nigerian institution. VN-BioStat leadership will work with Nigerian institutions to ensure that courses taken during the training will be credited at trainees' home institutions.

Vanderbilt Institute for Research Development and Ethics (VIRDE)—Each October, junior investigators worldwide participate in the one-month-long VIRDE program in Nashville [7]. VIRDE was originally developed with NIH/FIC support and has expanded to include scholars supported by other training grants. VIRDE provides intensive training in the conduct of clinical research, with emphasis on clinical trial design, responsible conduct of research, survey development, and data analysis/management, including the use of appropriate software and ethical research governance. VIRDE is intended to enable trainees to develop the skills necessary to conduct responsible human participants' research and develop grant proposals. VIRDE trainees are matched with a Vanderbilt faculty

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mentor who shepherds them through the grant development process. VIRDE trainees also complete 12 contact hours of specially tailored research ethics and integrity coursework. After the VIRDE course, mentors continue to provide formal one-on-one mentoring on trainees' hypothesis-driven proposals. A total of 69 trainees from Brazil, Bangladesh, China, Kenya, Ghana, Mozambique, Pakistan, Tanzania, Nigeria, Peru, Malawi, and Zambia have participated in the program; 41 trainees have successfully received grant funding.

Biostatistics trainees will participate in selected VIRDE activities. They will attend essential lectures with VIRDE trainees, including training lectures on responsible conduct of research. However, biostatistics trainees will not develop a grant proposal but will instead act as collaborators on another trainee's proposal. To this end, each of our trainees will be partnered with another trainee. They will serve as a co-investigator on this proposal and help with the statistical aspects of it. The biostatistics trainees will work with their mentors and the paired VIRDE trainee – the ultimate responsibility for the proposal will be on the VIRDE trainee. However, the biostatistics trainee will provide detailed advice, learn how to maneuver through the grant writing process as a biostatistician, and potentially develop a partnership with a junior clinical HIV investigator that can lead to future collaboration. We will aim to pair our trainees with other Nigerian scholars participating in VIRDE, although some may be paired with colleagues from other countries, potentially leading to South-South collaborations.

Other Training Opportunities—The biostatistics trainees will be in an environment with continuous education and learning opportunities. Other potential activities that might be beneficial to trainees include weekly biostatistics seminars, weekly global health grand rounds, monthly work-in-progress Tennessee Center for AIDS Research (CFAR) presentations, other TN-CFAR activities, Vanderbilt Institute for Clinical and Translational Research studios, and a week-long Vanderbilt Center for Quantitative Sciences summer institute that takes place every fall.

Annual workshops (Specific Aim 2)—The annual workshops will be held at a regular time each year that is convenient for instructors and Nigerian investigators/students. The workshop will be five complete days of instruction and hands-on learning. Topics will be updated regularly so that if the same students attend each year, they will learn new materials. The workshop will target students familiar with statistics and biomedical research, but it will be taught in such a manner that the first day will provide an adequate foundation for students with less experience to follow and students with more experience to receive a good review of the material. Workshop topics will be decided through consultations between VN-BioStat program leaders and other Nigerian investigators. Potential topics for the one-week course include methods to address missing data, introduction to causal inference, regression modelling strategies, big data in biomedical research, and survival analysis.

Students will be asked to bring a laptop to the training workshops; a handful of computers will be loaned out for students who do not have laptops. The instruction will be hands-on and use freely available R statistical software. Students will be expected to install R on their computers before the workshop. Some knowledge of R prior to the workshop will be helpful, but students will receive hands-on training in R throughout the workshops.

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A recent and successful NIH-funded workshop in Kano, Nigeria introduced AKTH/BUK junior faculty to basics of R analysis [4].

Workshops will generally be taught by Vanderbilt biostatistics faculty. This will include a physician-scientist with expertise in HIV to ground the instruction in practical problems of importance to the field of HIV. Having our VN-BioStat trainees help with instruction will be an important part of their development as biostatistics leaders and promote sustainability.

The workshops will be widely advertised throughout AKTH and relevant BUK and ABU departments. Advertisements will also be sent to other Nigerian universities and potentially more broadly to other institutions in West Africa. Advertisements will be via emails, flyers, and posters. Faculty at AKTH/BUK will identify potential students and invite them to attend.

Students will be asked to register for the workshop via a REDCap application. They will provide background information to help tailor the instruction, a personal statement about their motivation to attend, and a place indicating that their supervisor supports their attendance. We will have a cap of 25 students to ensure that students get individual attention. VN-BioStat leadership will examine all applications and select the top 25; priority will be given to students from AKTH/BUK with a quantitative background currently engaged in HIV research. We will ensure that approximately 50% of participants are women to improve representation. A limited number (4) of travel scholarships will be offered to students outside the Kano area.

Trainee Candidate Pool and Recruitment

Two (2) trainees will be identified and recruited yearly (total = 10) for the one-year HIV biostatistics fellowships at Vanderbilt. We will actively recruit from departments of mathematics, computer science and related fields at BUK and other universities. Our first target will be students enrolled in or who recently obtained PhDs in statistics at BUK and ABU. Second, we will target students getting PhDs in related quantitative fields, including Mathematics and Computer Science. We prefer students with formal training in mathematical and applied statistics because these students will require less learning to catch-up during the year at Vanderbilt. Quantitative researchers who are already involved in HIV research at AKTH but who need additional biostatistical training will also be considered. Students with less statistical training will be asked to take pre-requisite statistics and probability classes before arriving at Vanderbilt.

Recruitment will be led by VN-BioStat leadership. Talented students will be identified and approached with the opportunity to apply to the program. Interest in biomedical research will then be assessed as described earlier. Qualified candidates may also make self-referrals. The program will be advertised on the AKTH, BUK, and ABU websites and by word of mouth through faculty mentors. In particular, women will be encouraged to apply. BUK graduates approximately 300 students with first degrees in statistics (n=100), mathematics (n=50), and computer science (n=150), and an average of 120 students with masters (n=100) and PhD degrees (n=20) in mathematics and computer science. In addition, BUK admits 25 PhD students in mathematics and computer science every year. The Department of

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Statistics at ABU admits approximately 10 PhD students per year. The robust applicant pool at BUK and ABU suggests that we should have minimal difficulty recruiting highly qualified candidates now or in the future.

Recruitment will be performed during the annual one-week workshop (Specific Aim 2). The workshop will be an avenue to advertise the one-year fellowships, and enthusiastic learners will be encouraged to apply. The workshops will also be widely advertised to students across multiple quantitative departments as a way to pique the interest of potential students in biostatistics who could then take pre-requisite steps to make them a strong candidate for an upcoming year. This way, we will also build a pipeline of competitive applicants for the one-year fellowship program.

Trainee Selection

Applicants for the one-year biostatistics training at Vanderbilt will be required to submit the following materials: 1) Curriculum Vitae; 2) Personal statement including career goals; 3) Transcripts; and 4) Three letters of recommendation (from faculty, potential mentors, supervisors). Top candidates will be interviewed by VN-BioStat leaders and potentially other AKTH and Vanderbilt investigators (via Zoom).

The selection of VN-BioStat trainees will be based on:

- Ability to complete the program, as evidenced by excelling in pre-requisite courses in mathematical statistics, applied statistics, and computer programming;
- Interest in biostatistics and HIV research demonstrated with evidence of commitment to a career in academic research;
- Preference will be given to candidates:
- Who have recently finished or are completing a PhD in statistics or applied mathematics;
- With current employment/collaboration with AKTH, allowing VN-BioStat to optimize the likelihood of long-term retention of graduates as faculty researchers;
- With prior HIV research experience and who currently work with or have links with established Vanderbilt-affiliated research programs at AKTH.

We will not discriminate against anyone based on race in our selection processes, and we will encourage applicants from various ethnic backgrounds. We will strongly encourage and support applications from qualified women and will target at least 50% female representation among our visiting scholars and workshop participants.

Mentorship

Each trainee will be matched to a Vanderbilt Biostatistics faculty mentor, a VIGH faculty mentor, and a Nigerian mentor. Multiple faculty involved in mentorship will ensure that each trainee receives the full benefit of faculty mentors' expertise, perspective, and attention. Trainees will be paired with mentors based on similar research interests, collaborative

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research projects, methods of research projects, skill sets, and personalities. On a case-by-case basis, additional mentors will be assigned to help trainees address specific content areas or career planning.

During the fellowship, trainees will meet at least monthly with VN-BioStat leadership and their three faculty mentors (Biostatistics, VIGH, and AKTH). These meetings are in addition to regular research meetings, training, etc. The purpose of these meetings will be to discuss the trainees' progress and goals specifically and to identify and rectify any barriers to success.

Retention

We are aware of the potential for "brain drain" when training scientists from LMICs [8,9]. Scholars will be carefully selected by VN-BioStat leaders with this possibility in mind. Our in-country selection process will incorporate steps to ensure all VN-BioStat trainees complete their training and return to Nigeria. Upon acceptance into the VN-BioStat program, scholars will be required to sign a contract with VN-BioStat leadership, signifying their agreement with the clause that mandates their return to Nigeria after graduation. In addition, per BUK policy, scholars approved to proceed on study leave must sign a formal commitment contract to return to BUK. We will also prioritize scholars with ties to AKTH/BUK and, therefore, secure employment status. The need for biostatistics expertise at AKTH is great and recognized by AKTH/BUK leaders, who are committed to the growth of biostatistics; therefore, we do not anticipate that our trainees who do not currently have secure employment will experience difficulties securing employment post-graduation. We will ensure that future grant proposals between Vanderbilt and AKTH include support for graduating biostatistics trainees; the training program will prepare trainees to act as biostatisticians on future proposals.

Program Evaluation

The success of VN-BioStat will be based on objective measures and a mixed methods approach to guide evaluation activities. Our evaluation logic model will include the following elements: inputs (resources), activities/processes (program components), outputs (products of program implementation), outcomes (changes in trainees knowledge, skills, attitudes, practices), and impact (trainee career trajectory, sustainable changes in health conditions). We will use REDCap [10] to track, evaluate, and report short- and long-term training outputs, outcomes, and impact. All evaluation information will be fed back to VN-BioStat leaders and a Training and Advisory Committee. The Training and Advisory Committee will include 6–8 members, including Nigerian investigators, biostatisticians, HIV researchers, and leaders of other training programs.

Baseline evaluation—We will collect baseline evaluation data on all new trainees upon program entry. The data will include trainee demographics, prior training, research experience, and scholarly accomplishments (e.g. prior publications, presentations, previous grants submitted and funding).

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Annual evaluations—VN-BioStat will administer an online survey via REDCap annually to trainees and alumni to assess the program's progress. Metrics will include demographics (gender, age, education); position, institution, and rank; the number of publications; the number of grants submitted and awarded; the number of presentations at scientific conferences; the number of new research partners and collaborations; and satisfaction with mentor relationships and new academic appointments, especially in HIV research. Alumni surveys will further assess the program's overall quality, career accomplishments, and whether certain program elements should have been covered or emphasized in greater depth.

Other Evaluations

a. Surveys will be completed at the beginning and end of in-country workshops to assess knowledge learned and to evaluate and tailor future workshops. Trainees will be asked to complete an evaluation of the activity via online questionnaires, including an assessment of course learning objectives, quality of instruction, areas for improvement and unmet needs, and contribution to continued interest in HIV biostatistics. Based on this feedback, course content and structure will be modified if necessary. Up-and-coming workshop students will be encouraged to apply for the one-year biostatistics trainee fellowships at Vanderbilt (Specific Aim 1).

b. All trainees attending Vanderbilt for one year will participate in exit interviews. The program manager will conduct interviews and cover overall trainee experience, satisfaction, perception of quality of training, and immediate and long-term career plans. c) Annual mentor surveys will assess feedback regarding their mentoring experience, process satisfaction, and program improvement recommendations.

The person-level data obtained from the evaluation surveys will be aggregated annually to produce cumulative metrics by category, e.g., the total number of biostatistics credit hours completed, the total number of grants submitted and funded, the total number of trainees who obtained academic appointments, etc. All cumulative data will be entered into FIC's CareerTrac database.

The Executive Committee will meet twice a year with the Training and Advisory Committee to review all survey results, and any problem areas will be identified and addressed. VN-BioStat staff will also meet with trainees regularly throughout the year to address issues as they arise. All evaluation data will be shared with AKTH, BUK, and ABU leadership to enable strategic planning and policy. Future programs will take into account findings from the various evaluations and incorporate changes that will improve the quality of instruction and educational content as well as enhance the entire learning experience for trainees.

Timeline

VN-BioStat launched immediately after receiving the grant award (Table 3). Subcontracts with AKTH and BUK were executed in the first quarter, and the Executive Committee and Training and Advisory Committee meetings are ongoing. The first two HIV biostatistics trainees to Vanderbilt completed their one-year training in August of 2022, and the second

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cohort of trainees are currently in their third month of training. The first local skills-building workshop took place in Nigeria in June 2023. The next workshop is scheduled for early summer 2024. VIRDE workshops take place every fall in Nashville, and the second workshop since the beginning of the VN-BioStat program is currently ongoing.

DISCUSSION

Funded training initiatives have been successful in building biostatistics capacity in other parts of Africa [3]. VN-BioStat will replicate these efforts in West Africa via excellent opportunities for trainees to build their skills in biostatistics and HIV research. VN-BioStat will help address the need for in-country biostatistics leadership in West Africa through strong academic training, seminars, workshops, symposia, and other academic activities. The program will harness the longstanding and highly successful research partnership between Aminu Kano Teaching Hospital, Bayero University Kano, and the Vanderbilt Institute for Global Health to establish a platform that will create a cohort of highly skilled Nigerian biostatistics leaders with the capacity to lead independent and collaborative research focused on HIV.

CONCLUSION

The Vanderbilt-Nigeria Biostatistics Training Program (VN-BioStat) will establish a strong research and training platform for biostatisticians doing HIV-related research in Nigeria. Lessons learned from our experience will inform the development of similar programs elsewhere.

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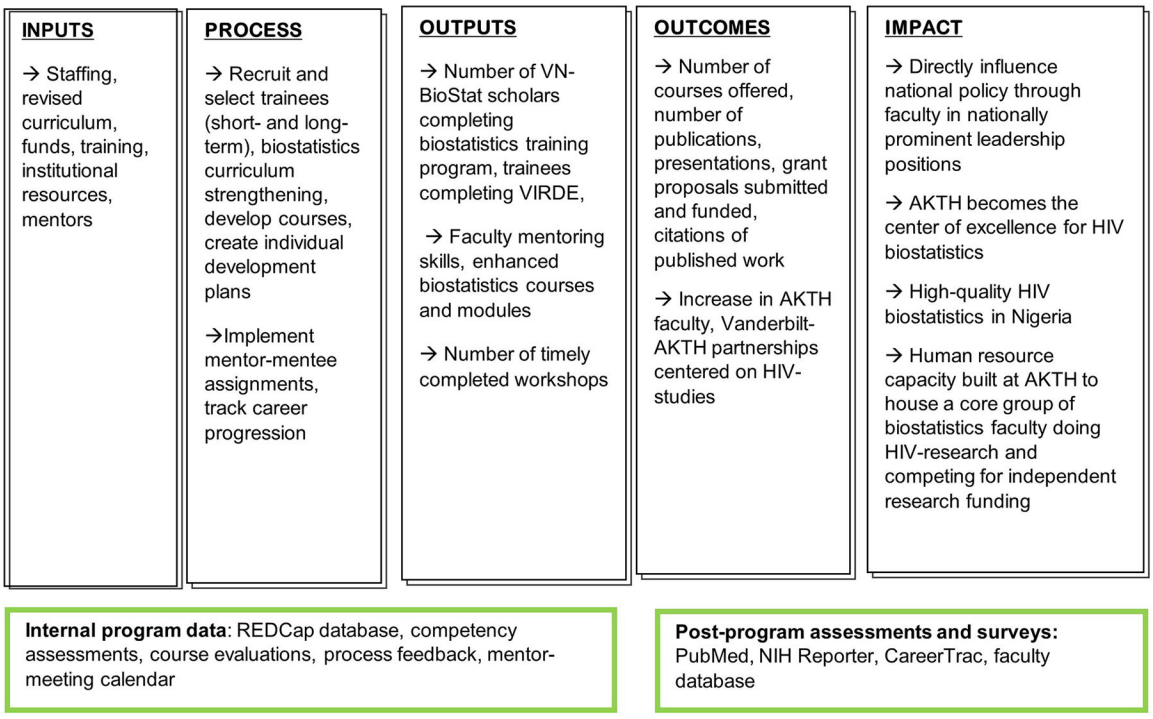

Figure:

The Vanderbilt Nigeria Biostatistics Training Program (VN-BioStat): Program Inputs, Processes, Outputs, Outcomes and Impact

Note. AKTH = Aminu Kano Teaching Hospital, Nigeria; HIV = Human Immunodeficiency Virus; VN-BioStat = Vanderbilt-Nigeria Biostatistics Training Program

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Table 1:

Summary of VN-Biostat one-year training plan.

Fall Semester (August to December)	**Spring Semester (January to May)**	**Summer (June to July)**
Biostatistics Courses	Biostatistics Courses	No formal courses
e.g.,	e.g.,	
Clinical trials	Longitudinal data analysis	
Applied survival analysis	Regression modeling strategies	
Start Collaborative Research Project	Finish Collaborative Research Project	
VIRDE (October)	Start Methods Research Project	Finish Methods Research Project
Monthly biostatistics clinics	Monthly biostatistics clinics	Monthly biostatistics clinics
Weekly HIV biostatistics dry-lab meetings	Weekly HIV biostatistics dry-lab meetings	Weekly HIV biostatistics dry-lab meetings

Note. HIV = Human Immunodeficiency Virus; VN-BioStat = Vanderbilt-Nigeria Biostatistics Training Program

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Table 2:

Examples of potential collaborative and methods research projects.

Potential Collaborative HIV Research Projects	Potential HIV Methods Research Projects
1) Develop a model to predict albuminuria among persons living with HIV (PLWH) who are attending the AKTH clinic.	1) Comparison of different models (e.g., logistic regression vs. random forests) in the context of predicting albuminuria among PLWH at AKTH.
2) Explore correlations between candidate markers for coronary endothelial dysfunction in adult Nigerians with HIV infection.	2) Comparison of different approaches to address multiple comparisons (e.g., false discovery rate, Bonferroni) in the context of coronary endothelial dysfunction.
3) Estimate the incidence of and risk factors for frailty among persons living with HIV at the AKTH clinic who are on antiretroviral therapy.	3) Study different statistical approaches in the literature for addressing loss to follow-up, and investigate their impact on findings.
4) Perform secondary or subgroup analysis for a clinical trial investigating efficacy of lisinopril for the prevention of chronic kidney disease among PLWH.	4) Study and apply different methods for addressing non-compliance (e.g., instrumental variables, per protocol analyses, inverse probability weighting) in the context of the lisinopril RCT.

Note. AKTH = Aminu Kano Teaching Hospital, Nigeria; PLWH = Persons living with HIV; RCT = Randomized Controlled Trials

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Table 3:

Timeline of activities, VN-BioStat Program

Activity	Year 1			Year 2			Year 3			Year 4			Year 5		
Months (1=January,12=December)	5–8	9–12	1–4	5–8	9–12	1–4	5–8	9–12	1–4	5–8	9–12	1–4	5–8	9–12	1–4
Aim 1: two trainees at Vanderbilt/year; total=10															
Recruit Trainees	x		x			x			x			x			
Biostatistics Courses		x	x		x	x		x	x		x	x		x	x
VIRDE		x			x			x			x				
Research projects	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Aim 2:															
Recruit for Workshop			x			x			x			x			x
Nigeria Workshop				x			x			x			x		x
TAC meetings	x		x	x		x	x		x	x		x	x		x
Program evaluation			x			x			x			x			x
Dissemination activities													x	x	x

Note: TAC = Training Advisory Committee; VIRDE = Vanderbilt Institute for Research Development and Ethics; VN-BioStat = Vanderbilt-Nigeria Biostatistics Training Program