Commentary

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Neurogenomics in Africa: current state, challenges, opportunities, and recommendation

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Abstract

Neurological diseases are becoming more common in Africa. Current estimates indicate that Africa has a significant burden of neurological illnesses, though it is unclear what fraction of the burden may be linked to genetic transmission. In recent years, there has been a significant expansion in the knowledge of the genetic basis of neurological illnesses. This has been made possible mainly by the positional cloning research paradigm, which uses linkage studies to pinpoint specific genes on chromosomes and targeted screening of Mendelian neurological illnesses to identify the causative genes. However, there is currently very little and unequal geographic knowledge about neurogenetics in African people. The lack of collaboration between academics studying neurogenomics and bioinformatics contributes to the scarcity of large-scale neurogenomic investigations in Africa. The primary cause is a shortage of funding from the African government for clinical researchers; this has resulted in heterogeneity in research collaboration in the region as African researchers work more closely with researchers outside the region due to pulling factors of standardized laboratory resources and adequate funding. Therefore, adequate funding is required to elevate researchers' morale and give them the resources they need for their neurogenomic and bioinformatics studies. For Africa to fully benefit from this significant research area, substantial and sustainable financial investments in the training of scientists and clinicians will be required.

Keywords: Africa, Neurogenomics, Neurology

Introduction

Neurological diseases are becoming more common in Africa. Current estimates indicate that Africa has a significant burden of neurological illnesses, though it is unclear what fraction of the burden may be linked to genetic transmission. In recent years, there has been a significant expansion in the knowledge of the genetic basis of neurological illnesses[1]. This has been made possible mainly by the positional cloning research paradigm, which uses linkage studies to pinpoint specific genes on chromosomes and targeted screening of Mendelian neurological illnesses to identify the causative genes[2]. However, there is currently very little and unequal geographic knowledge about neurogenetics in African people. For example, only 17 of Africa's 58 independent states have conducted genetic research on neurological issues. These are primarily found in 13 countries in sub-Saharan Africa. Of the thousands of genome-wide association studies (GWAS) that have been conducted globally, only seven (for HIV susceptibility, malaria, tuberculosis, and podoconiosis) have been conducted exclusively on African participants; four others included some African participants http://www.genome.gov/gwastudies/.

The current state of neurogenomics in Africa

In the last decade, there has been a tremendous increase in neurogenomic research worldwide. However, there are few studies regarding large-scale neurogenomic studies in Africa. The human population in the African region has a high degree of genetic variation, which can be linked to early migration, geographic distribution, demographic history, population organization, linguistic classification, and nutritional variations[3,4]. Genomics, as a novel tool, plays an essential role in managing various disorders by reviewing human, pathogen, disease, disorder, plant, and animal evolutionary histories through the study of genetic variations[5]. Akinyemi *et al*.[6] in 2016 showed that neurogenomic studies in Africa had been carried out in only 17 countries: 4 countries are in the North African region, while 13 countries are in the sub-Saharan region.

Through the identification of genetic variants in neurological and mental health disorders, GWAS have proved beneficial in identifying genomic variables related to some of these disorders. Furthermore, through the GWAS, Quansah and McGregor[7] studied the extensive representation of people of African ancestry in neurogenomic studies. The study's findings revealed that, out of 569 different GWAS studies, 63 were of African ancestry, representing 11.2% of all people in Africa. Similarly, only 1.2% of the total population involved in the study had African ancestry[7]. It was also found in the survey that most participants with African ancestry were heterogeneous (i.e. people of mixed

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race), including African-Americans and Afro-Caribbeans[4]. This demonstrates a poor representation of homogenous races in large-scale neurogenomic studies in Africa.

Recently, there has been a significant advancement in the field of neurogenomics in Africa, which was sparked by new initiatives by numerous regional and international organizations to modernize the study area. To address the issue of the under-representation of Africans in genomic studies, the Human Heredity and Health in Africa initiative (H3 initiative) was established. Its goal is to produce extensive and intricate genomic datasets from various ethnic groups throughout Africa[8]. The African genome variation project, in addition to the H3 project, has helped with the execution of extensive genetic diversity studies in sub-Saharan Africa and has classified 2.2 million genetic variants within the study population[9]. Other significant projects include the 1000 Genome Project, the Drakenstein Child Health Study, the Stroke Investigative Research and Education Network (SIREN) Project, the Psychiatric Genomic Consortium (PGC), and the Enhancing Neuro Imaging Genetics through Meta-analysis Network (ENIGMA)[6,7,10–12].

Challenges and prospects facing neurogenomics in Africa

Various challenges facing neurogenomics in Africa include a lack of human and infrastructural resources; ethical collection, sharing, and reuse of neurogenomic data; and inadequate funding supporting research and bioinformatics.

Firstly, the African continent lacks a wide range of human resources such as geneticists; computational genomics and data scientists; and clinical and laboratory geneticists[13] owing to a lack of education, brain drain, and poverty. This demonstrates the need for capacity building, retraining, and training in the area. Additionally, it has been discovered that Africa lacks the infrastructure needed for extensive neurogenomic research, such as cold storage rooms for blood samples, cloud-based technologies for phenotypic data collection and analysis, and biobanks for the maintenance and storage of biological samples[14,15]. The significant reasons are the high cost of this equipment and the lack of resources devoted to this healthcare section. This has led to the wastage of blood samples due to poor storage and inaccurate data reports on studies conducted in the region.

Due to the novelty of neurogenomics in Africa, there have been challenges due to ethical data collection, sharing, and reuse in the region. The significant reasons are that there is a need for data sharing with a wide range of users by funding agencies to achieve higher statistical prospects, which has led to various concerns of data subject endangerment and subsequent use of data among clinical researchers in Africa[16–19]. Other reasons stem from the ethical acceptance of the use of genetic data in low-income and middle-income countries. There is a low desire to participate in genetic studies among people in the region because of illiteracy and limited access to healthcare facilities. This is because of the ideologies that view their inclusion as a favorite among these people[20]. It is essential to keep this in mind while efforts are made to address the ethical problems that neurogenomics in Africa is currently experiencing.

The lack of collaboration between academics studying neurogenomics and bioinformatics contributes to the scarcity of large-scale neurogenomic investigations in Africa. The primary cause is a shortage of funding from the African government for clinical researchers; this has resulted in heterogeneity in research collaboration in the region as African researchers work more closely with researchers outside the region due to pulling factors of standardized laboratory resources and adequate funding[21]. Therefore, adequate funding is required to elevate researchers' morale and give them the resources they need for their neurogenomic and bioinformatics studies.

Current efforts and recommendations

African researchers in genomics research are putting increased attention and effort forward. For instance, many African scientists are involved in genomics applications in biomedical research and clinical healthcare. This feat can be credited to funding and training support from institutions like the National Institute of Health and the Wellcome Trust[22]. Such capacity-building programs offer excellent venues for scientific cooperation and resource sharing to improve genomics research in Africa. However, additional work is required to make these projects sustainable.

A broad scientific community must be involved in neurogenomics. Scientists competent in neuroscience, genetics, and bioinformatics can collaborate in this group[23]. While genomics researchers would supplement these with competence in designing and implementing high-throughput sequencing technology-based investigations, neuroscientists would offer their abilities and knowledge in experimental neurobiology[24]. Additionally, bioinformaticians are required for neurogenomics research projects since modern sequencing technologies necessitate familiarity with the informatics tools and procedures needed to access samples, analyze data, and publish findings. There is a significant amount of scientific capacity available in these fields, which are either established or developing throughout Africa. The growing infrastructure and financial investments in genomics-related research in Africa present chances to find researchers with a shared interest in these fields and work together to address issues pertinent to neurogenomics. This sector would also greatly benefit from creating genomic sample repositories in important African institutions, like those started by the H3Africa Consortium.

Notably, the established rules for gathering genetic samples, sharing data, and working together on research projects in Africa would be helpful in this regard, guaranteeing fairness and transparency as well as scientific reproducibility. Collaboration in neurogenomics research, whether amongst researchers in the same institution, nation, or even across multiple countries, would also open up much potential for the progress of scientific knowledge in Africa, including clinical care and student teaching. Improved understanding of the genetic and molecular bases of memory, attention, and stress, for instance, can help learning and education. Improved neurogenomics research in Africa would also support the growth of student training in this field. Expanding research facilities frequently results in greater student access to tools and professional training. Due to the absence of experimental tools, teaching neuroscience, like many other scientific subjects, is difficult in Africa[24]. To address this issue, researchers in bench-intensive fields should be encouraged to collaborate with their peers in the computer sciences to create new methods of instruction[25].

Neurogenomics would aid in student training, for instance, by having students use web-based bioinformatics tools to forecast and analyze particular situations. There is numerous potential in this field due to the low cost of bioinformatics and the abundance of free, readily accessible genomics data. A select few organizations have assumed significant roles in providing training programs for resident scientists to aid in developing Africa's neurogenomics capacity[26]. For interested scientists, the H3ABioNet nodes around the continent routinely host training sessions in genomics, methods, and data processing. Scientific organizations that assist capacity building in this area include the African Society for Bioinformatics and Computational Biology and the African Society for Human Genetics. Nonprofit organizations, including Teaching and Research in Natural Sciences for Development in Africa, organize training courses in neuroscience and genomic data processing for African scientists to broaden the scope of this support network. These include yearly neuroscience summer courses where participants are trained in using potent yet affordable model organisms, tools, and techniques for genetic and genomic studies.

Conclusion

African scientific research and healthcare are poised to benefit significantly from the emerging discipline of neurogenomics. There is not enough research, nevertheless, examining neurogenomic elements of illness occurrences, risk, and spread among Africans. Further research is urgently required in light of the finding that some African populations lack common disease-associated genetic mutations. Knowledge of the genomic causes of neuronal diseases in Africa would aid in improving the timeliness and precision of clinical diagnosis and treatment. The continent would greatly benefit from the utilization of current genomics research facilities and the construction of new institutions devoted to neurogenomics research. For Africa to fully benefit from this significant research area, substantial and sustainable financial investments in the training of scientists and clinicians will be required.

Ethics approval

Not applicable.

Patient consent

Not applicable.

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Author contribution

A.N.: conceptualization, project administration, and writing – review and designing. M.A.O.: collection and assembly of data. A.N.: reviewed and edited the final draft. The manuscript writing and final approval of the manuscript were done by all authors.

Conflicts of interest disclosure

The authors declared no conflicts of interest.

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