Editorial: Integrating artificial intelligence for better eye health in Africa: Potential challenges

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Artificial Intelligence (AI) is the ability of a computer system to mimic the cognitive functions of the human brain[1]. This emerging technology has rapidly expanded, and it is being applied in various fields, such as speech recognition, image, and video processing even in health systems assisting clinicians in decision-making for diagnosing and treating a wide range of diseases[1,2]. In eye health, AI is mainly applied in the diagnosis and classification of the common diseases of the back of the eye, such as Diabetic Retinopathy (DR)[3], Age-Related Macular Degeneration (ARMD)[4], and glaucoma[5]. Studies have reported the use of AI in detecting other eye diseases such as cataracts, keratoconus, and others. For the past decades, efforts have been made at the global scale to develop AI algorithms that could effectively diagnose DR. As of now, more than 400 AI-based DR screening algorithms exist, yet only a few are currently used in the clinical practice[6-9].

In the resource-limited context of most African countries, health systems face challenges in delivering appropriate health care to patients with multisystemic chronic diseases such as DM, hypertension, and cancers. In eye care, DR screening and treatment services are poorly organized, and the scarcity of specific skills and resources needed to manage DR remains the biggest challenge.

In the era of digital innovations and AI technology, AI has an important role in supporting clinicians and healthcare systems to streamline care pathways and provide timely and high-quality care for patients. In eyecare, AI is an effective tool that can potentially lower the burden of screening DR and vision loss. This tool is a potential solution to overcome manpower scarcity in resource-limited settings. Recently, AI DR screening has been adopted and successfully implemented in most high-resource settings to screen for DR in primary care. For example, the IDX-DR system, the first FDA-approved AI-based DR screening system, is used in primary care in the USA[10]; EyeART DR in the UK, Netherlands, and USA[11-13], and SELENA Plus System in Singapore[14] to mention a few.

With the currently available knowledge about AI DR screening systems, it is well established that this tool can effectively detect DR and outperform human graders: it is faster, accurate, with a very short learning curve, and does not need specifically a specialized health worker to produce an accurate result. However, challenges related to its application and integration in clinical practice remain the major problem that scientists have yet to find a solution to. The major concerns include ethics, technical, liability, and regulatory issues, workforce, social and patient safety[15]. These concerns are real in both, resource-limited and high-resource settings. However, it weighs more in resource-limited countries.

In Africa, besides the ethics, liability, and regulatory concerns, the technical capacity and workforce are the most critical concerns for integrating AI DR screening in Africa:

(1) From the development to clinical validation
   (i) The development of an AI Diagnostic Retinal (DR) algorithm necessitates considerable resources, including specialized skills in data science, retinal imaging, image grading, image labeling, and computing. It also requires substantial financial support to cover all associated activities and significant time for data collection and preparation for algorithm training.
   (ii) The developed algorithms must undergo both internal validation and external clinical validation testing to assess their performance. This process is essential for obtaining regulatory approval. However, it is time-consuming and requires substantial funding, which many African countries are often unable to secure.

(2) *The origin of the AI DR screening algorithm*: Current knowledge shows that the same AI-based Diabetic Retinopathy (DR) screening algorithm can perform differently in various settings[9,10,15,16]. The origin of the algorithm is not the primary concern anymore. Each AI algorithm needs to undergo local clinical validation in the specific setting or population where it will be used to evaluate its performance. Even when African countries decide to implement a foreign AI tool, local clinical validation is necessary in that specific context. This process allows for adjustments and adaptations of the algorithm to better fit the local environment.

(3) *Infrastructure*: Besides the infrastructure required to develop an AI DR screening tool, there are other "hidden" factors that need to be considered while

planning to integrate an AI-based DR screening in Africa.

(i) While internet connectivity may not be a concern in high-resource settings, this is a serious fact in most African countries, specifically in rural areas. Most AI DR tools are cloud-based software, the server is usually located in the country of origin. For an AI screening to take place, high-speed internet is required for uploading the image in the system, and processing and interpreting the findings. Offline versions of these AI systems would be ideal for Africa.

(ii) Electricity is another hidden fact that is to be considered. A stable power supply throughout the screening process. Another source of energy such as solar systems must be considered in Africa.

(iii) The quality of the fundus camera to use must be taken into consideration. Image quality is one of the most important determinants of an accurate AI screening. A poor retina image quality may not be processed by the AI system or may result in inaccurate reading. Higher-quality cameras would require significant financial investment which may be challenging to acquire in the African context.

(4) *Organization of health system:* Most African countries have not managed to incorporate a systematic screening of DR using traditional methods, that is fundus examination or fundus photography. Most patients are screened opportunistically when they present to an eye clinic for visual issues. Integrating an AI screening method would help overcome manpower shortages, but if health systems are not strengthened to coordinate referrals and if there is no infrastructure and skilled retina specialists who will treat these patients, we will be creating more problems than solving them. For AI screening to revolutionize eye health in Africa, there should be an established workforce to coordinate and establish a systematic DR screening program in each country. The health systems must be strengthened at all levels, local, district, and national levels to coordinate DR screening activities. There should be mechanisms for planning consecutive visits after the initial screening; the referral pathways must be well established; treatment centers must be created, equipped, and accessible to the rural population.

CONCLUSION

AI technology has the potential to enhance eye health service delivery in Africa. While there are significant challenges related to its application and integration into clinical practices, these can be managed through collective efforts aimed at improving eye health in the region. As a starting point, DR screening programs across African countries must be supported to establish a robust screening framework equipped with reliable, up-to-date technology that produces high-quality images and is accessible to all. The data collected from these screenings can serve as a foundation for creating a well-curated database of retinal images at the country level. Through data-sharing agreements, these databases can be utilized to develop algorithms that detect retinal diseases across Africa.

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