Developing an Accessible and Scalable Computational Model for Early Detection of Alzheimer's Disease and Related Dementias in Low- and Middle-Income Countries

Introduction.

Alzheimer's Disease and Related Dementias (ADRD) present a significant and growing public health challenge worldwide, with an escalating prevalence observed across diverse populations. While considerable attention has been devoted to high-income countries, a critical gap persists in understanding the burden of ADRD in low- and middle-income countries (LMICs), particularly in sub-Saharan Africa (sSA). This deficiency in understanding is particularly pronounced in LMICs like Nigeria, where unique challenges in diagnosis and management emerge due to constrained resources, healthcare infrastructure limitations, and restricted access to specialized tools. Nigeria, boasting the highest population on the African continent, faces a multitude of healthcare challenges amidst rapid demographic and epidemiological transitions, further impairing the complexities of addressing ADRD.

A report from Alzheimer's Disease International, noted that about 55 million people worldwide living with dementia in 2020 with someone developing the condition every 3 seconds. Over two-thirds of ADRD cases resides in LMICs, including Africa, where access to social protection, care services, and support is severely limited (Adeloye et al.). Rhiannon et al. (2012) underscored that 76% of individuals living with ADRD in Africa hail from sub-Saharan Africa. Moreover, studies by Davies et al. (2019) utilizing United Nations demographics for Nigeria indicate a staggering 400% increase in the absolute number of people living with dementia from 1995 to 2015. However, some studies done in India indicated that up to 90% of ADRD cases in LMICs remain undiagnosed. Prince et al. (2016) contend that the true burden remains substantially underestimated due to insufficient awareness, underdiagnosis, and inadequate healthcare infrastructure.

In the realm of technological advancements, the utilization of artificial intelligence (AI) and machine learning holds promise for developing non-invasive and accessible tools for early ADRD diagnosis. Research by Hosseinzadeh et al. (2020) and Sun et al. (2018) demonstrates encouraging outcomes in utilizing neuroimaging data for early detection. Despite these advancements, significant limitations persist concerning their applicability to LMICs. Nonetheless, recent successes in ongoing research by Samuel et al. whose work is a motivation for this research, Cui et al., and Facal et al. has showcased the potential of machine learning-based models for risk prediction of dementia.

The successful development and implementation of this accessible and scalable computational model for early ADRD diagnosis in LMICs has the potential to significantly improve public health outcomes by enabling timely interventions, reducing healthcare costs, and enhancing the quality of life for individuals and families affected by dementia.

In light of these challenges and advancements, this literature review underscores the pressing need for the development of an innovative, accessible, and scalable computational model for early ADRD diagnosis in areas like Nigeria. Leveraging and harnessing AI techniques offers a promising approach to bridge the diagnostic gap in LMICs.

Aims.

The primary aim of this PhD research is to develop an innovative, accessible, and scalable approach for the early diagnosis of Alzheimer's Disease and Related Dementias (ADRD) in the context of Nigeria, with a broader objective of addressing the diagnostic challenges faced by other LMICs in sub-Saharan Africa by leveraging computational science, data science, and artificial intelligence (AI) techniques which would be able to

Objectives.

1. Investigate and identify readily available and accessible biomarkers, including but not limited to demographic, clinical, and cognitive factors, associated with the early stages of ADRD within Nigerian populations and across sSA countries.

2. Develop a robust and adaptable computational model that integrates diverse biomarkers to enable accurate and accessible early diagnosis of ADRD, considering the unique healthcare contexts and resource limitations prevalent in LMICs.

3. Validate the efficiency and scalability of the developed computational model through pilot studies and validation exercises conducted in Nigerian healthcare settings, aiming to demonstrate its applicability and potential for adoption in similar LMIC settings across sSA.

4. Explore avenues for knowledge transfer and capacity building by disseminating research findings, sharing methodologies, and fostering collaboration with stakeholders in other LMICs, thereby facilitating the wider adoption and implementation of the developed approach for early ADRD diagnosis on a regional scale.

Deliverables.

1. A comprehensive review of existing literature on ADRD epidemiology, diagnosis, and management, with a specific focus on Nigeria and other LMICs.
2. Development and validation of a computational model for early ADRD diagnosis, including detailed documentation of the model architecture, algorithms, and validation results.
3. Pilot studies and validation exercises conducted in Nigerian healthcare settings, along with detailed reports outlining the feasibility and effectiveness of the developed computational model.
4. A final PhD thesis documenting the research findings, methodology, conclusions, and recommendations for future research and implementation efforts in the field of ADRD diagnosis in LMICs.