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**Global Lessons for Local Challenges: A
Mixed-Method Study Using ²³Alzheimer's Disease
Neuroimaging Initiative (ADNI) to Understand
Alzheimer's Progression and Its Implications for
Bangladesh**

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1 Research Aim

This study aims to analyse Alzheimer's disease progression and implications using the Alzheimer's Disease Neuroimaging Initiative (ADNI) dataset, with a focus on the influence of age, sex, neuroimaging biomarkers and to explore how these global insights can inform strategies for early diagnosis and management of Alzheimer's disease in Bangladesh. By linking international evidence with local challenges, the study seeks to provide context-specific recommendations to strengthen awareness, healthcare infrastructure and policy responses to the growing burden of Alzheimer's disease (AD) in Bangladesh.

2 Research Question

1. How can ADNI-derived insights on age, sex and biomarkers inform strategies for early detection and intervention in Bangladesh?
2. Which risk factors or progression patterns from ADNI are most relevant for the Bangladeshi population, considering demographic and healthcare differences?
3. What lessons from ADNI's longitudinal studies can guide public health awareness, screening and care planning for Alzheimer's disease (AD) in Bangladesh?

3 Introduction

Dementia is a state in which the function of brain neurons is damaged due to various reasons. Dementia has a lot of types, such as Alzheimer's dementia (AD), Vascular dementia, Lewy body dementia, Frontotemporal dementia, Parkinson's disease dementia (PPD), Huntington's disease, Creutzfeldt-Jakob disease (CJD), Hydrocephalus and Mixed dementia. Among them, Alzheimer's disease or Alzheimer's dementia (AD) is one of the most common forms of dementia because 60 to 70 percent of cases are related to Alzheimer's disease (AD).

The Alzheimer's Disease Neuroimaging Initiative (ADNI) is a large-scale, longitudinal research project that is situated in the United States and was established in 2004 under Dr. Michael W. Weiner. Till now, this project has 5 phases: ADNI 1 (2004), ADNI-GO (2009), ADNI 2 (2011), ADNI 3 (2016) and ADNI 4 (2022). Right now, they are working in the fifth phase (ADNI 4), which is about spreading it to a more diverse population and optimising clinical trial measures and biomarkers. Jack et al. [3] describe ADNI's MRI methodologies, including volumetric and functional imaging techniques and Petersen et al. [6] provide an overview of ADNI's clinical characterisation, integrating cognitive testing, cerebrospinal fluid biomarkers, and genetic profiling. This indicates the authenticity and clarity of the work.

In Bangladesh, over 8% of the elderly population (age 60 or above) is fighting with AD, which means 1 in every 12 people is an Alzheimer's patient. Data from the World Health Organization (WHO) in 2020 showed that a total of 14,993 (2.09%) deaths occurred from Alzheimer's and dementia disease. Additionally, most patients are from Rajshahi and Rangpur than any other district in Bangladesh. With these consequences, Rahman et al. [7] and Rahman et al. [8] show limited healthcare infrastructure, insufficiently trained specialists, and a lack of standardised treatment facilities. It highlights that Bangladesh is underdeveloped in this field and there is a lot of opportunity to explore.

4 Literature Review

4.1 Global Perspective on Alzheimer's Disease

4.1.1 Sex and Gender Factor

¹⁶Alzheimer's disease (AD) is a neurodegenerative disorder that generally affects memory, cognition and daily functioning. Studies have found that sex and gender have their own effect and risks. Nebel et al. [5] and Meilke et al. [4] illustrate that women are disproportionately more affected compared to men. For this, factors are hormonal, genetic and lifestyle habits. This clearly emphasises the need for sex-specific approaches in both research and healthcare management.

4.1.2 Age Factor

Besides sex and gender, ²⁵age is also a fundamental risk factor for AD. Guerreiro et al. [1] claim that advancing age remains the most consistent determinant or factor of disease. Herrup [2] further proposes an age-based hypothesis that indicates AD progression can be distinguished depending on age.

Collectively, these research papers portray that both sex and age must be considered in understanding and managing AD on a global stage. Sex and age should both be discussed when anything comes up related to AD.

³4.2 Alzheimer's Disease in Bangladesh

4.2.1 Limited Facilities

²⁴Despite global progress, Bangladesh faces significant challenges in AD treatment. Previously, Rahman et al. [7] and Rahman et al. [8] showed in their research that Bangladesh has a lack of healthcare infrastructure, specialists and diagnostic protocols. That is an alarming situation to take emergency initiative to overcome this unstructured healthcare system.

4.2.2 Awareness

Since AD has no cure till now, people should be aware of AD from the very beginning. Roy et al. [10] and Sultana et al. [11] indicate that knowledge and awareness among the general population are low and that is why a lot of patients received delayed diagnosis and it becomes more complicated to treat.

4.2.3 Hospital-Based Survey

Rifat et al. [9] reveal the reality of inequality in the Bangladesh healthcare system between urban and rural healthcare levels in a hospital-based survey. Patients in rural areas receive fewer healthcare services and face greater difficulties in accessing proper treatment compared to those in urban areas.

4.2.4 Cross-Sectional Pilot Study

Uddin et al. [12] investigate dementia risk among geriatric populations in Bangladesh in a cross-sectional pilot study, demonstrating a rising prevalence of cognitive impairment and underscoring the pressing need for early detection strategies.

These findings help us to imagine the current situation of Bangladesh. There is a huge gap between the disease burden and the healthcare capacity and a call for evidence-based research or inventions in the Bangladeshi context.

4.3 Alzheimer's Disease Neuroimaging Initiative (ADNI)

4.3.1 Method

The Alzheimer's Disease Neuroimaging Initiative (ADNI) provides a standardised and comprehensive framework for longitudinally studying AD progression using neuroimaging, cognitive assessments and biomarkers. Jack et al. [3] describe ADNI's MRI methodologies, including volumetric and functional imaging techniques that enable precise tracking of brain atrophy over time.

4.3.2 Clinical Characterisation

Clinical Characterisation plays a vital role when it comes to dementia. Petersen et al. [6] provide an overview of ADNI's clinical characterisation, integrating cognitive testing, cerebrospinal fluid biomarkers and genetic profiling to monitor disease progression longitudinally.

4.3.3 Bangladesh's Scope of Advancement

ADNI datasets facilitate the identification of early biomarkers [3], evaluation of sex [5], [4] and age-related differences [1], [2] and modelling of disease trajectories [6]. These insights can broaden the chances to fill the gaps in local diagnostic and treatment strategies that are being introduced in [7] - [12] for improving the healthcare system and patient outcomes.

These illustrate that Bangladesh has more to explore and scope to enhance greater possibilities by applying the above insightful ideas and concepts.

4.4 Progression and Implication of Bangladesh

4.4.1 International studies

International studies emphasise the impact of sex [5], [4] and age [1], [2] on AD.

4.4.2 Local Bangladeshi Studies

On the contrary, local studies focus more on disadvantages, problems and difficulties and try to find solutions rather than the sex and age variables.

4.4.3 ADNI

ADNI provides insightful resources to compile the global insights with data-driven strategies for early diagnosis and treatment planning [3], [6].

Thus, ADNI's neuroimaging and clinical data can inform evidence-based approaches to address the rising burden of AD in Bangladesh because global and local findings reveal clear opportunities.

5 Research Methodologies

5.1 Qualitative Method

5.1.1 Survey: Primary Dataset

A structured survey will be conducted with N = 500 Alzheimer's patients in Bangladesh (N1 = 250 males, N2 = 250 females). This will ensure balance of each sex. Participants will be recruited through neurology departments of tertiary hospitals, memory clinics and Alzheimer's care organisations. A Google survey form (online and printed) with a 5-point Likert-scale questionnaire (strongly disagree - strongly agree) will explore the following themes:

- a. Symptom recognition
- b. Knowledge about AD
- c. Attitudes and stigma
- d. Help-seeking and access to healthcare
- e. Caregiver support
- f. Perceived barriers to treatment
- g. Willingness for testing and research participation
- h. Health literacy
- i. Preventive behaviour
- j. Satisfaction with existing services

5.1.2 ADNI: Secondary Dataset

The secondary quantitative data source will be the Alzheimer's Disease Neuroimaging Initiative (ADNI) datasets. The datasets will be on:

- a. Longitudinal neuroimaging,
 - b. Cerebrospinal fluid (CSF)
 - c. Genetic and cognitive assessment data.
- Variables of interest include:
- a. Age, sex, hippocampal and cortical atrophy,
 - b. CSF amyloid- β and tau levels,
 - c. APOE genotype and
 - d. Neuropsychological test scores (e.g., MMSE, ADAS-Cog).

These measures will allow an investigation of how sex and age influence Alzheimer's progression and how such biomarkers may inform early diagnosis. Access will be sought through the LONI/IDA portal by submitting a project synopsis and complying with ADNI's Data Use Agreement (DUA), data security and publication requirements.

5.2 Quantitative Method

In addition to the quantitative method, semi-structured in-depth interviews with selected n = 50 patients (n1 = 25 males, n2 = 25 females) will provide a richer understanding of the lived experiences of Alzheimer's patients in Bangladesh. Interviews will be conducted at neurology departments of tertiary hospitals, memory clinics and Alzheimer's support centres to ensure access to participants. The main areas that will be covered in the interview are:

- a. Symptom trajectory and recognition
- b. Diagnostic journey and experiences with health services
- c. Care and treatment experiences
- d. Relationship with caregiver

- e. Stigma, beliefs and social reactions
- f. Knowledge about AD
- g. Awareness level
- h. Barriers for receiving treatments
- i. Existed facilities
- j. Expectations and recommendations

5.3 Data Analysis

5.3.1 ADNI Data

Neuroimaging and clinical measures will be statistically analysed using SPSS. There will be:

- a. Descriptive statistics,
- b. Independent-samples t-tests,
- c. Chi-square tests and
- d. Regression models will be applied to assess the impact of age and sex on disease progression.

5.3.2 Survey Data

Likert-scale responses will be coded and analysed in SPSS. There will be:

- a. Reliability will be checked via Cronbach's alpha and
- b. Factor analysis will be applied to validate thematic groupings.

5.3.3 Interview Data

Transcripts will be analysed in NVivo using thematic analysis. Codes will be developed deductively from the interview guide and inductively from emerging patterns. Cross-comparisons will be made between male and female participants to explore gendered differences.

6 Roadblocks and Potential Limitations

Every research has backstage difficulties and limitations. The same goes for this research; many problems have to be faced to complete this research successfully. These are the possibilities of roadblocks and potential limitations:

- a. Access to ADNI Data: If access to raw ADNI data is delayed, then the first step would be to contact a professional consultant to fix the gap; otherwise, publicly available ADNI summary metrics and alternative open neuroimaging datasets (e.g., OASIS) will be used.
- b. Survey and Interview Challenge: Contacting neurology departments of tertiary hospitals, memory clinics and Alzheimer's support centres to find Alzheimer's patients and obtain consent from themselves, legal guardians, caregivers and official authorities is a big challenge in itself.
- c. Biased information: Risk of biased responses due to social stigma around dementia and emotional sensitivity of patients and families, leading to limited disclosure.
- d. Fieldwork and Logistics: Possible delays due to the availability of field assistants, getting consent and ethical clearance.

7 Project Practicalities

Period	Length of Time	Description
Pre-arrangements	15 days	Prepare Likert scale and interview questionnaires while brainstorming and send an email with proper information to ADNI and wait to get access to the datasets.
Literature Review	30 days	Hire 2 assistants to help with field work (conducting interviews) and 2 assistants to distribute the survey form to Alzheimer's patients.
Ethical Approval	10 days	Review previous international and local papers and journals to have more in-depth knowledge and cite them later.
Data Collection	90 days	Contact hospitals, clinics and Alzheimer's support centres to find participants and obtain permission from the authorities, the patient's legal guardian and caregiver.
Data Analysis	60 days	After getting permission, conduct interviews, surveys and collect data.
Final Paper Writing	30 days	Analyse ADNI, survey data using SPSS and interview data using NVivo.
Total Approximate Time	245 days (8-9 months)	

Table 1: Timeline

Item	Approximate cost (BDT)	Description
ADNI Data Access	10,000	Professional consultation for dataset access (if needed)
Survey Cost	20,000	Printing, distributing and collecting surveys for N = 500 participants
Interview Cost	10,000	Audio recording (with consent), video recording (with consent), transcription for 50 participants
Field Workers	16,000	4 Assistants (2 for interviews, 2 for survey distribution); honorarium 4,000 BDT each
Travel Cost	15,000	Transport to hospitals, memory clinics and Alzheimer's support centres for surveys and interviews
Software for Qualitative Data Analysis	7,000	SPSS license
Software for Quantitative Data Analysis	10,000	NVivo license
Stationery and Printing	6,000	Consent forms, survey forms, documentation
Miscellaneous	6,000	Contingency, phone calls, communication
Total Estimated Cost (BDT)	1,00,000	

Table 2: Budget List

8 Conclusion

In conclusion, this research aims to shorten the gap in Alzheimer's disease acknowledgement in the Bangladeshi context by combining the raw ADNI datasets with local datasets obtained through surveys and interviews. Some potential roadblocks may arise but a perfect plan and execution can offer a holistic perspective on how age, sex, and contextual factors shape Alzheimer's progression. Ultimately, the findings are expected to provide meaningful contributions to understanding Alzheimer's disease in Bangladesh. That will provide an idea to improve the healthcare system of Bangladesh. Furthermore, this will lead professionals and researchers to develop more effective diagnostic and intervention strategies for Alzheimer's Disease (AD).

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