

Machine Learning Algorithms for Distinguishing Mild Cognitive Impairment from Alzheimer’s Disease Using MRI: A Diagnostic Meta-Analysis

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INTRODUCTION	METHODS	RESULTS	CONCLUSIONS	REFERENCES
Early and accurate differentiation of mild cognitive impairment (MCI) from Alzheimer’s disease (AD) is critical for prognosis, patient stratification, and therapeutic decision-making. Magnetic resonance imaging (MRI) combined with machine learning (ML) algorithms has emerged as a promising non-invasive approach for automated classification; however, reported diagnostic performance varies across studies. We conducted a meta-analysis to systematically evaluate the diagnostic accuracy of ML-based MRI models in distinguishing MCI from AD.	This systematic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive literature search was conducted on PubMed, Scopus, Embase, Web of Science, and IEEE Xplore from inception to December 31, 2025, to identify studies applying ML algorithms to MRI data for MCI versus AD classification. Eligible studies reported sufficient data to construct diagnostic accuracy metrics. Study quality was assessed using validated diagnostic accuracy tools. A bivariate random-effects model was applied to pool sensitivity and specificity. Summary receiver operating characteristic (SROC) curves and area under the curve (AUC) were calculated to assess overall diagnostic performance, with heterogeneity quantified using the I ² statistic.	A total of 41 studies met the inclusion criteria. Pooled sensitivity for ML-based MRI models was 0.81 (95% CI: 0.75–0.86; I ² = 65%), while pooled specificity was 0.93 (95% CI: 0.86–0.97; I ² = 92.8%). The SROC analysis demonstrated excellent overall diagnostic performance, with an AUC of 0.897, indicating high discriminative ability between MCI and AD. Substantial heterogeneity was observed, likely reflecting differences in MRI acquisition protocols, feature extraction methods, ML algorithms, and validation strategies across studies.	Machine learning algorithms applied to MRI data demonstrate high specificity and good sensitivity for distinguishing MCI from AD, with overall excellent diagnostic accuracy. These findings support the potential role of ML-assisted MRI as a complementary tool for early AD detection. Future research should focus on standardized imaging protocols, external validation, and prospective multicenter studies to enhance clinical translation and generalizability.	CONTACT ammadabid@kemu.edu.pk ALZHEIMER’S ASSOCIATION AAIC>26