

Effectiveness Of Digital Screening Tools In Detecting Cognitive Impairment Among Community-dwelling Elderly In Northern China

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KEY TAKEAWAYS

Fusion is superior: Combining eye-tracking & digital drawing achieved an AUC of 0.958 (Accuracy >90%) in detecting CI.

Early detection: The fusion model effectively identified MCI from NC (AUC = 0.928).

Biomarker correlation: Multiple digital features (drawing, gait, eye-tracking) significantly correlated with plasma p-tau217 levels (|r|>0.3, p<0.001).

Practical solution: Digital tools outperformed traditional scales (AD8/MMSE) and are feasible for large-scale community screening.

INTRODUCTION

❑ Problem: Dementia prevalence is rising; early MCI detection in communities is hindered by invasive tests (lumbar puncture), high equipment costs (PET/MRI), and subjective traditional scales (MMSE/AD8).

❑ Solution: AI-powered digital behavioral markers (Drawing, Gait, Eye-tracking) offer objective, non-invasive, and efficient screening.

❑ Gap: Lack of large-scale cohort validation and correlation analysis with core AD biomarkers (p-tau217).

METHODS

❑ Design: Community-based cross-sectional cohort study (Shanxi, China)

❑ Participants: N=1,083 (aged ≥65); 337 CI (216 MCI, 121 Dementia), 746 NC

❑ Digital Tools: 1. Drawing: Tablet-based Mini-Cog (Clock drawing + Word recall); 2. Gait: Depth-vision system (Single-task & Dual-task: counting/naming); 3. Eye-tracking: VR-based system (Smooth pursuit, Saccades, Fixation).

❑ Biomarkers: Plasma p-tau217 (Simoa HD-X), APOE genotyping.

❑ Modeling: LightGBM machine learning models (Single modality vs. Multimodal fusion).

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RESULTS

❑ Subgroup Analysis

✓ MCI vs NC: Fusion model AUC = 0.928.

✓ MCI vs Dementia: Fusion model AUC = 0.746 (suggesting distinct digital phenotypes).

❑ Correlation with Pathology (p-tau217)

✓ 13 digital features showed strong correlation with p-tau217 (e.g., GPS-Fast completion time r=0.470; Gait speed r>0.3).

✓ Indicates digital features reflect underlying AD neuropathology.

Diagnostic Performance (AUC Comparison)

Model	AUC (CI vs NC)	Accuracy	Sensitivity	Specificity
Traditional AD8	0.836	0.798	0.716	0.881
Traditional MMSE	0.843	0.731	0.675	0.786
Digital Drawing	0.860	0.770	0.687	0.853
Gait Analysis	0.848	0.789	0.800	0.778
Eye Tracking	0.895	0.812	0.796	0.828
Fusion (Eye + Drawing)	0.958	0.902	0.934	0.869

Note: Fusion model significantly outperformed single tools (p<0.001).

CONCLUSIONS

❑ High Accuracy: Digital multimodal fusion (eye-tracking + drawing) provides a highly accurate, non-invasive method for community CI screening (AUC 0.958).

❑ Clinical Utility: Effectively bridges the gap between normal aging and dementia, specifically targeting MCI detection.

❑ Biological Relevance: Digital phenotypes correlate with plasma p-tau217, validating their role as surrogate biomarkers.

❑ Future Directions: Integration into primary care workflows for scalable, cost-effective dementia prevention strategies.