

Passive Keypress and Speech Biomarkers for Monitoring Cognitive and Psychosocial Fluctuations in Dementia Caregivers

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Methodological Issue Being Addressed Family caregivers of persons living with dementia bear substantial cognitive, emotional, and functional burdens that can compromised both caregiving capacity and personal well-being. Yet, methodological limitations in existing assessment approaches hinder precise measurement of these fluctuations. Standard cognitive screening tools (e.g., MMSE) may lack sensitivity to detect subtle day-to-day fluctuations in cognition or affective distress experienced by caregivers. Mobile digital assessment tools—including passive keypress analytics and active speech-based evaluations—offer promising avenues for more continuous, ecologically valid monitoring of caregiver functioning. However, few studies have directly compared these digital biomarkers or explored how they jointly relate to self-reported mood, fatigue, and caregiver burden. This study addresses this methodological gap by evaluating the concurrent validity and complementarity of keypress- and speech-derived metrics in family dementia caregivers.

Introduction As the population of dementia caregivers grows, scalable and sensitive tools are needed to track their cognitive and emotional fluctuations outside clinical settings. Digital biomarkers from everyday mobile interactions offer a noninvasive, real-time window into caregivers' cognitive and affective states. This pilot study examines the feasibility, validity, and convergence of passive keypress data, active speech assessments, and self-reported outcomes in dementia caregivers.

Methods Nineteen family dementia caregivers (mean age=61 years, SD=14; 68% women; 63% married; 89% co-residing with care recipient; 79% college-educated) were recruited from UCSD and UCLA. Participants completed 60 consecutive days of mobile keypress tracking using the KeyWise AI app and weekly speech-based assessments using the ki:elements Mili app on personal iPhones. Keypress metrics included typing speed, typing variability, and the KeyWise Clarity score (a composite measure of keypress-derived cognitive performance). The primary speech-based score was the Speech Biomarker for Cognition (SB-C) composite score and its memory, processing speech, and executive function subscales. Standardized self-report surveys assessed mood, fatigue, self-efficacy, and caregiver burden. Relationships among keypress metrics, speech-derived composite scores, and self-report measures were analyzed to evaluate marker redundancy, complementarity, and predictive value.

Results Mean keypress adherence was 94.7% and Mili app adherence was 71.7% (5.7 surveys).

Keypress metrics, including typing speed and variability, were moderately related with the SB-C (r 's 0.47 and 0.52, p 's < 0.05). Greater variability in typing speed predicted lower executive function score as assessed by the Mili app ($r \approx -0.6$, $p < .01$), while slower backspace intervals were associated with reduced speech-based processing speed and memory scores ($r \approx 0.5$, $p \approx .025$). Increased variability in spacebar transitions correlated with higher psychological fatigue and substance use risk. KeyWise Clarity scores were lower with older age ($r = -.56$, $p = 0.01$) and lower self-efficacy ($r = -.55$, $p = 0.3$), whereas better SB-C scores were related to older age ($r = .74$, $p < 0.001$). Speech-based executive function declined with greater physical fatigue ($r = -.56$, $p = 0.01$).

Conclusion These preliminary findings support the feasibility and potential validity of active and passive digital biomarkers for detecting subtle cognitive and psychosocial challenges among dementia caregivers. Variability-based keypress metrics and speech-derived cognitive composites each captured unique yet complementary aspects of caregiver functioning and well-being. Integrating passive and active mobile data may enable more ecologically valid, continuous monitoring of dementia-related risk and resilience—offering a valuable adjunct to traditional cognitive screening tools.

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Guidelines I have read and understand the Poster Guidelines

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AK, NL, and JT are a co-founder and has equity interest in ki:elements