

Dementia and Technology

Enhancing Cognitive Health in Dementia: Integrating Co-Design, Exergaming, Digital Twins, and Biomarkers Pistritto, SC, Hung, P, Hogue, A, Burhan A, Chiu, M, Sun, W. *Gerontechnology* 25(s)

Dementia is a progressive neurological condition that impairs memory, thinking, and daily functioning, with global prevalence projected to triple by 2050 and Canadian cases expected to rise by nearly 187%. Combining physical activity with cognitive stimulation has shown promise in addressing modifiable risk factors, slowing decline and improving quality of life, yet few person-centred, engaging interventions exist that simultaneously support people living with dementia (PLwD) and their caregivers. Additionally, tools to monitor real-time neurobiological change remain limited. Emerging approaches such as exergames and digital twins (DT) models offer new opportunities for personalized care, but challenges persist in accessibility, integration of multimodal data, and scalability. This mixed-methods PhD study aims to co-design, refine, and pilot a personalized exergame program for PLwD and caregivers, while developing a DT biomarker tool capable of integrating assessment scales, salivary biomarkers, and wearable metrics to model and predict individual responses. Guided by a generative co-design framework and the MRC framework for complex interventions, the study will proceed in three phases: (1) co-design focus groups and participatory workshops with PLwD, caregivers, clinicians, and digital health experts; (2) iterative refinement of the exergame prototype, including cooperative play to foster social connectedness; and (3) a 4-week pilot evaluating feasibility, usability, engagement, and preliminary cognitive, physical, and psychosocial outcomes. Quantitative analyses (paired t-tests, repeated-measures models) and qualitative thematic analysis will capture changes over time and user experiences. In parallel, a multimodal DT model will be developed using large public datasets and individualized with pilot data to enhance prediction accuracy. This research addresses a critical gap in dementia care by integrating person-centred design with emerging digital technologies to deliver adaptable, accessible interventions. Findings will support scalable strategies that strengthen cognitive stimulation, physical activity, social engagement, and overall well-being among PLwD and their caregivers.

Keywords: dementia, exergaming, digital twins, BDNF, caregivers, cognitive health

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