

# Enhancing Cognitive Health in Dementia Through Co-Designed Exergaming and Digital Twins Technology

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**Project Summary:** Dementia is a progressive neurological condition that affects memory, thinking, and daily functioning. Global cases are projected to triple by 2050, with Canadian cases expected to rise by nearly 187%, creating increasing pressure on health and community care. Up to 45% of dementia risk is linked to modifiable factors identified by Livingston, including physical inactivity, social isolation, depression, and cognitive inactivity. Combining physical activity with cognitive stimulation can help address these risks, slow decline, and improve quality of life, yet few person-centred, engaging interventions exist that simultaneously support people living with dementia (PLwD) and their caregivers. Tools to monitor real-time neurobiological change are also limited as challenges remain in accessibility, integration of multimodal data, and usability. Emerging approaches such as exergames and digital twins—virtual models that replicate an individual’s physiological, cognitive, and behavioural characteristics using real-world data—offer new opportunities for personalized, scalable care. In this project, digital twins are used to model and simulate dementia progression, longitudinal patterns, and potential treatment responses by integrating multimodal data (e.g., biomarkers, imaging, cognitive assessments, and behavioural patterns) within a web-based platform, supporting the development of adaptive interventions that strengthen cognitive stimulation, physical activity, social engagement, and overall well-being for PLwD and their caregivers.

## Project Goals:

- **Primary Objective (1):** Co-design, refine, and pilot a personalized exergame program for people living with dementia and their caregivers.
- **Secondary Objective (2):** Create a digital twins model and web-app integrating multimodal data to simulate dementia progression and support personalized care planning.

## Outcomes:

1. Co-designed exergame prototype with cooperative play.
2. Pilot study results demonstrating feasibility, usability, engagement, and preliminary cognitive, physical, and psychosocial outcomes.
3. Digital twins web- app prototype integrating wearable, biomarker, and assessment data for personalized care.

## Methods:

Three-phase mixed-methods study:

1. **Co-Design Focus Groups and Design Workshops** with PLwD, caregivers, and clinicians.
2. **Prototype Refinement** including cooperative play and wearable integration.
3. **4-Week Pilot Study** assessing of feasibility, engagement, and preliminary cognitive, physiological, and psychosocial outcomes.
4. **In parallel, a multimodal digital twins model was developed.** Pilot study data will serve as the primary validation dataset, with secondary data from Ontario Shores used to further refine and strengthen the model.

## Anticipated Impact:

This project demonstrates how person-centred design and digital innovation can:

- Enhance cognitive and physical health,
- Support caregivers,
- Enable data-driven personalized, dementia care and,
- Provide scalable solutions in community and long-term care settings.



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