



University of  
**Southern  
Queensland**



# **Feasibility Study on Innovative Virtual Reality Training for Fall Prevention in Older Adults with Mild Cognitive Impairment**

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# What are the Usefulness on VR CAVE Technology for Fall Prevention in Older Adults with Mild Cognitive Impairment?



Fall prevention assisted by the VR training can provide a new training approach in preventing falls for older adults with MCI.

Falls are public health challenges in older population

**FALL PREVENTION**



How would older adults perceive to use technology?



What are VR application benefits in older adults with MCI?

Research Methods: Quantitative Study  
Feasibility study

Sampling =203 Community-dwelling Older Adults from Hong Kong China

VR CAVE Program = 16 VR sessions by 8 weeks

Outcomes: MoCA, FES-I, TUG, 6 MWT & Berg Balance scale, Self-rated Questionnaire: VR usability questionnaire (HK-version)

Fall risk assessments

1. Walk speed and Balance
2. Functional mobility
3. Fear of falling
4. Cognitive function



Results:

Positive training effects on falls prevention by VR CAVE technology

- \* Walk speed and Balance
- \* Cognitive function
- \* High acceptancy of using VR training in older adults



Inconsistent findings:

- Functional mobility and fall efficacy between the two groups



Visual Abstract by Dr WK IP Benson  
University of Bedfordshire, UK

Results show a significant decrease in falls incidents and improvements in cognitive-motor health performances among VR intervention participants. High acceptance of VR technology for fall prevention suggests its potential in aged care and rehabilitation services, advocating for its adoption.

Reference: Ip, W.K.; Soar, J.; Fong, K.; Wang, S.-Y.; James, C. An Exploratory Study on Virtual Reality Technology for Fall Prevention in Older Adults with Mild Cognitive Impairment. *Sensors* 2025, 25, 3123. <https://doi.org/10.3390/s25103123>



# Background

- ❑ Falls management in aging population poses an international health challenge as creating huge financial burdens in healthcare system (Montero-Odasso, 2023). (Unmet need)
- ❑ 1/3 older adults aged > 65 falls at least once per year (WHO, 2018).
- ❑ Older adults with cognitive impairment fall twice than the healthy older population (Logan et al., 2010).
- ❑ Falls and cognitive Impairment are interrelated and associated with aging (Montero-Odasso et al., 2012).
- ❑ Multiple risk factors: **intrinsic factors** (cognitive & physical impairments, fear of falling) and extrinsic factors (slip floor & environmental hazards) (WHO, 2023).
- ❑ Virtual Reality Technology (VRT) intervention as a novel approach in aged care service (Gao,2020, Ip et al., 2024)
- ❑ VRT as a potential cognitive-motor intervention in fall prevention specifically on people with mild cognitive impairment (Neri, 2017; Ip et al., 2025).
- ❑ Fall management research focused on older persons with cognitive impairment and dementia is limited. (Unmet need)
- ❑ No current **full immersive VR Cave research** has been done in preventing falls for older adults with mild cognitive impairment and dementia (Zahabi & Razak, 2020). (Major gap)



## Relationship between VRT & Risk Factors of Falls

- ❑ Improving cognition and motor function will reduce the fall risks in older persons (Shirley, 2017 & Thepa, 2020).
- ❑ Investigating the possible relationship between VRT as a promising cognitive-motor intervention and fall risk factors in people with cognitive impairments (MCI & dementia).
- ❑ VRT as a human-end computer interface, provides multiple sensory platform (stimulating and interactive to improve executive and motor functions e.g attentional capacity and motivation, postural balance and walk speed) (Mirelman, 2016)
- ❑ VRT intervention will reduce fall risks, may slow down the cognitive decline process from MCI to dementia. (*Fig. 1*)

## Research Philosophy

Using a deductive approach

Prediction of cause effect relationship – VRT intervention vs Fall Risk Factors (Intrinsic factors)

Theoretical framework is modified and added on Cognition and Gait in Falls from Montero-Odasso et al. (2020)

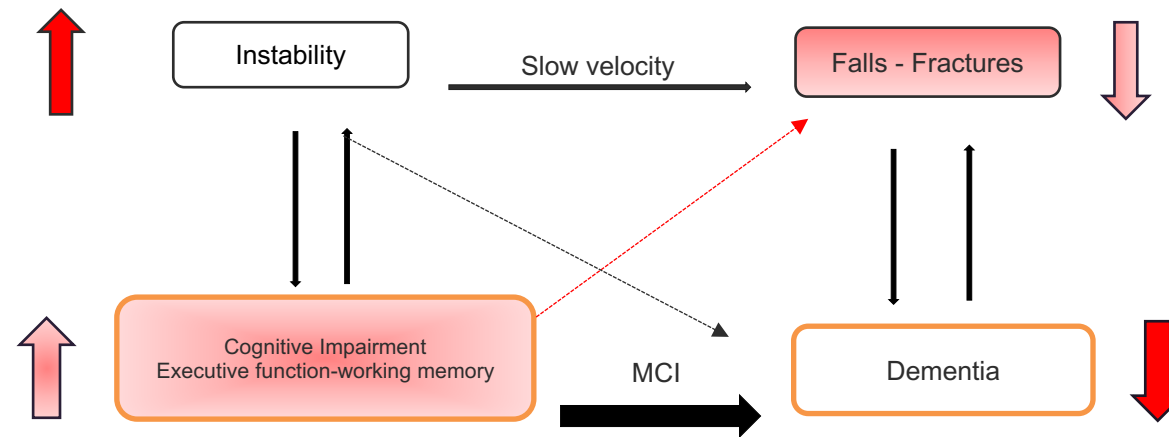


Fig. 1 Adapted from Montero-edasso et al. (2020)



## Research Questions

Research Questions:

Phase 1. What are the effects of VR technology (VR CAVE) on reducing the risk of falls in older adults?

Phase 2. What are older adults' perceptions toward accepting and using VRT(CAVE) in fall prevention ?

Keywords: Full-immersive Virtual reality (VR); cognitive-motor training; community-dwelling older adults; mild cognitive impairment (MCI); falls prevention.



## Research Framework

No unified research framework on VRT research in older adults (MCI/Dementia).

The new VRT CAVE application is based on these theories: Social Cognitive and Motor Learning theories (Imam, B., & Jarus, T. (2014).

The proposed working model builds on and integrates the concepts of two models mentioned i.e.. Fear of Falling (FoF) and Central Benefit models (Fig. 2).

## Proposed Virtual Cognitive-motor Reality Model (VCMR)

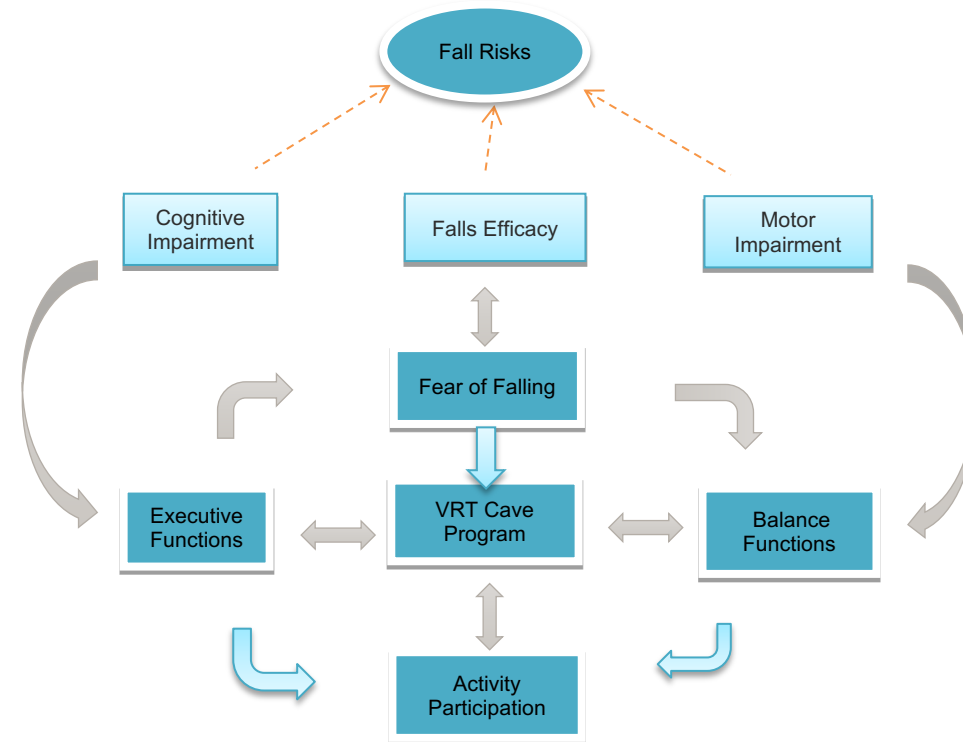


Fig. 2 Proposed VCMR model in Fall Prevention Technology



# Research Methodology

Quantitative methodology adopted

Measurable variables (risk factors)

Experimental design

Sampling method – service members recruited from 3 district elderly community centers (DECC) in Hong Kong

NGOs working partners: The Salvation Army Hong Kong & St. James Settlements (Elderly Division)

Research center: VR CAVE research laboratory at the Department of Rehabilitation Sciences (OT), The HK Polytechnic University

***# Ethics application approved from University of Southern Queensland and Hong Kong Polytechnic University***

***Additional General Liability Insurance Coverage***

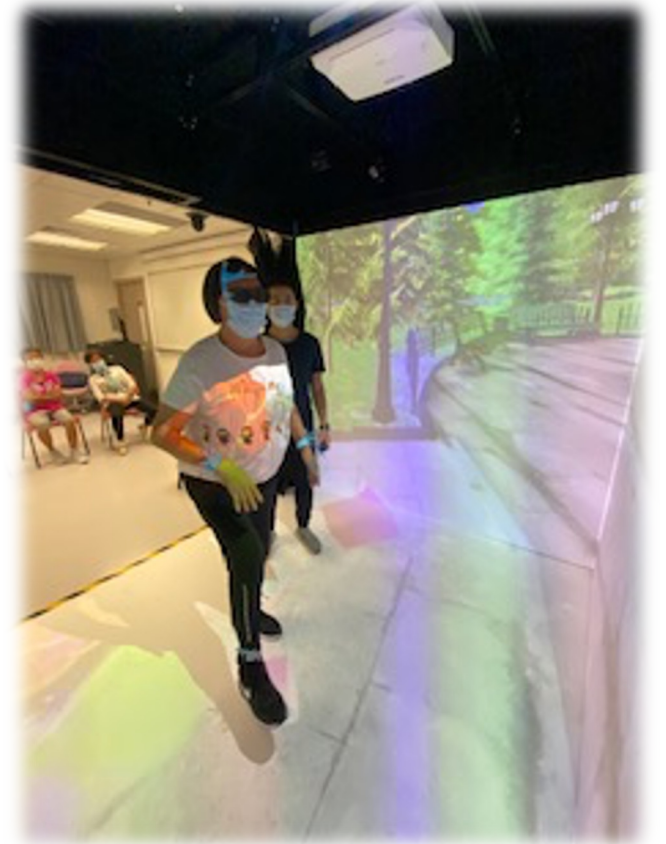


# Data Collection Methods – Phase 1

## (Screening & VR Cave study) – From July 2021 to June 2022

- ◆ ~ 203 screening assessments completed
- ◆ ~ 55 participants were assigned into VR groups and Non-VR group
- ◆ Intervention: 8-week VRT Cave intensive training + Non-VR exercise group (2-3 times/week, 45 minutes/session)
- ◆ Eligible criteria for research participants:
  1. Aged from 65-85 with a fall history (fall reason)
  2. Cognitive function screening Ax : Hong Kong Montreal Cognitive Assessment Scale (HK-MoCA <22)
  3. Physical tests: Timed Up and Go (TUG), 6-minute walk test (6MWT) and Berg Balance Scale (BBS)
  4. Able to commute
  5. Voluntary participation
  6. No severe visual & hearing impairment

## VR CAVE Program (VirCube)



## VR CAVE Activities – Memory skills, physical & balance training



# Date Collection – From July 21 to June 2022

1. 55 participants enrolled
2. All research participants will conduct fall risk assessments pre and post training assessment & 3-month follow up
3. VR Cave group – 8-week VR training (2-3 times/week, <45 minutes/session)
4. Non-VR group – control group
5. VR Cave Lab (HKPU) – using handy VR headset (stereoscopic eyewear) and full equipped VR CAVE facility
6. Full immersive VR Cave program – **VirCube VR program**
7. Each VR session lead by the research team (Occupational Therapist)

## Phase 2 (Follow up)

1. Post 3-month follow up (Between Jan 2022 to May 2022)
2. VR experimental groups will conduct post 3 months fall risk assessment and VR usability questionnaire
3. Estimate a drop-out rate
4. Count if any fall incident/reason
5. No. of hospital admission rate (due to fall incident)

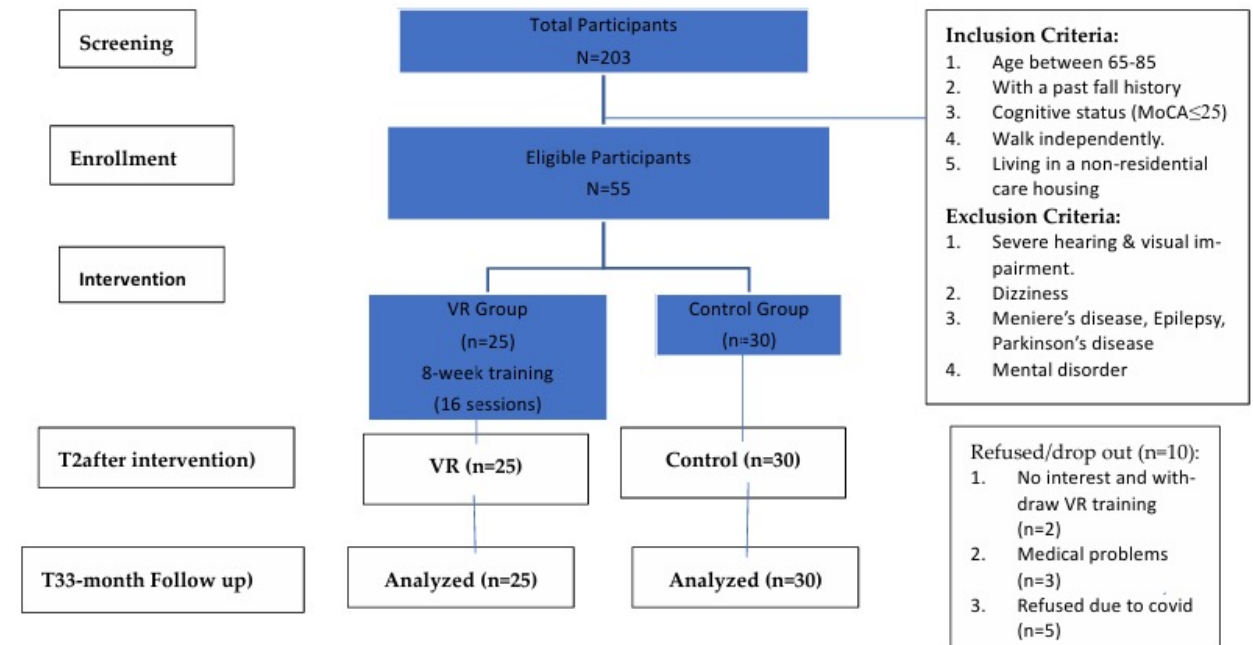


Figure 1. Consort diagram of this study.

## Data Analysis Methods (SPSS)

To prepare a data analysis, we define three specific hypotheses:

*H1: The participants of VRT group could significantly reduce the risk factors of falling.*

*H2: The participants of VRT group could significantly reduce the fear of falling.*

*Independent variable (IV): VRT (By VirCube VR program) intervention*

*Dependent variables (DV): fear of falling, walk speed, postural balance & functional mobility*

Hypothesis	Fear of Falling (FES-I) Total score 64	Walk Speed (6MWT) Metre (m)	Postural Balance (BBS) Total score= 56	Time Up and Go Test (TUG) <12 seconds
H1		Increase	Increase	Decrease
H2	Decrease			

## Demographic Data – Findings

Table 1: Age group					
Age range		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<65	5	2.5	2.5	2.5
	65-69	45	22.2	22.2	24.6
	70-79	106	52.2	52.2	76.8
	>79	47	23.2	23.2	100.0
	Total	203	100.0	100.0	

## Fall History & Fracture (fall)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes (>12 months)	86	42.4	42.8	42.8
	<b>Yes (&lt;12 months)</b>	84	41.4	41.8	<b>84.6</b>
	None	31	15.3	15.4	100.0
	Total	201	99.0	100.0	
Missing	System	2	1.0		
Total		203	100.0		

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	157	77.3	77.3	77.3
	Yes	46	22.7	<b>22.7</b>	100.0
	Total	203	100.0	100.0	



## Limitations

1. The sample size is small due to low recruitment rate under Covid-19 restrictions in Hong Kong.
2. The study reports primarily on quantitative findings, more investigations such as a participant-observational or ethnographic study would be recommended in a follow-up study.
3. The technological support is inevitable and more challenging compared with other VR apps and devices (Oculus (Meta) Quest & Sony PlayStation VR)
4. VR CAVE program is a pioneer VR application to adopt in fall prevention for older adults, the similar research evidence is limited.



## Conclusion

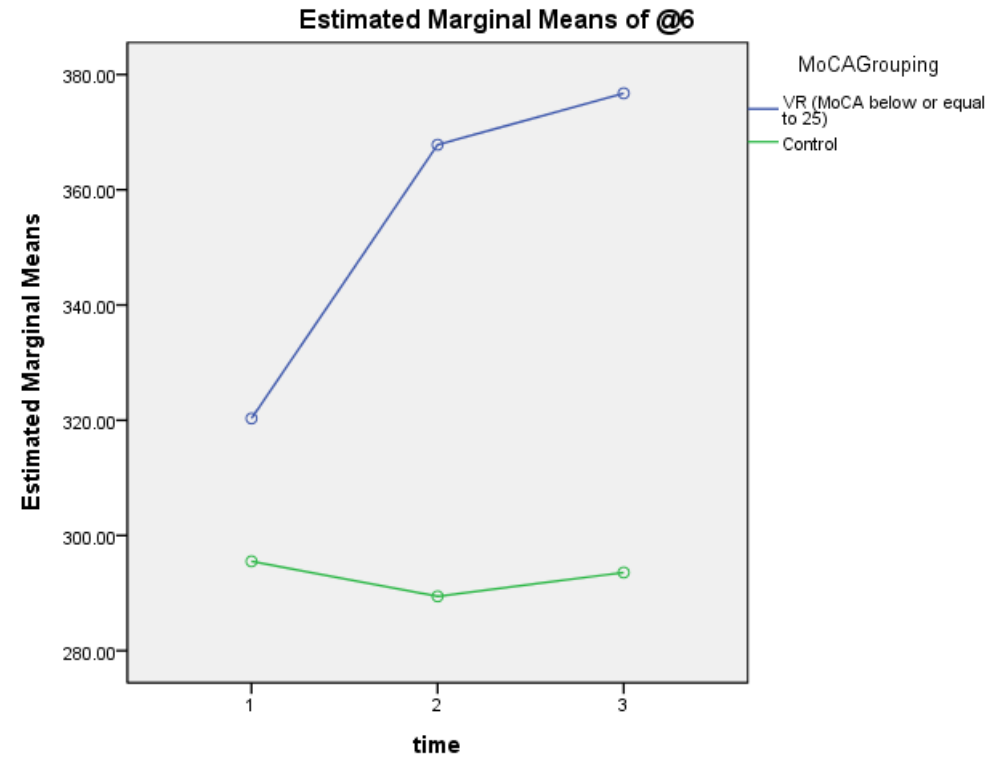
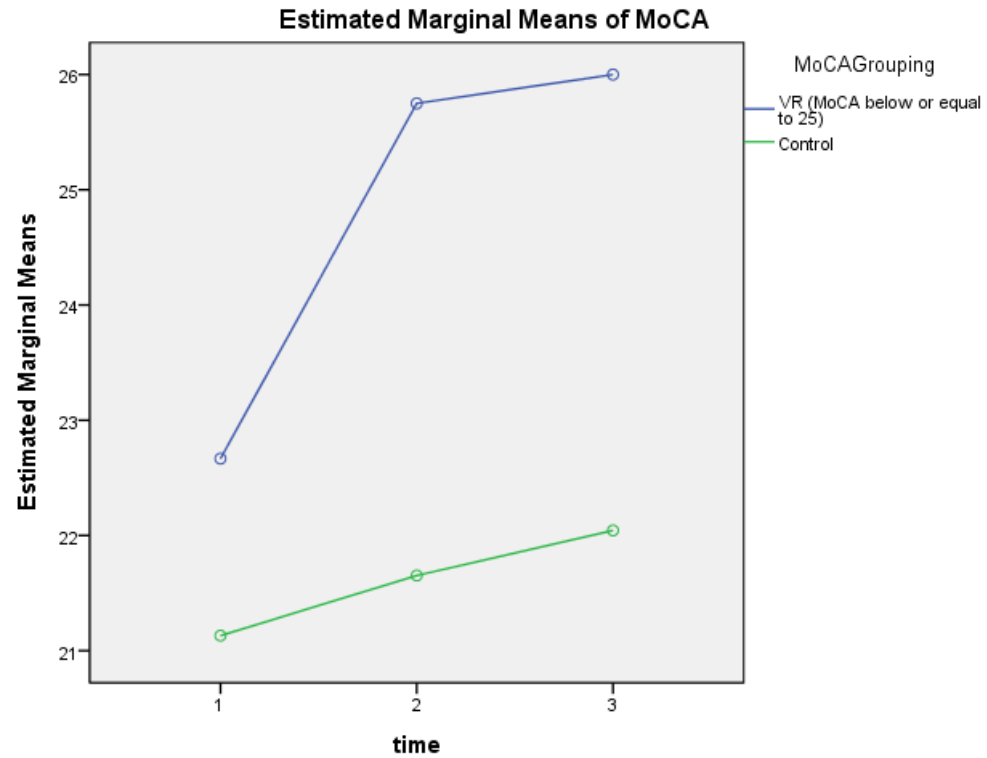
- ✓ The study reaffirms the promising evidence on the usefulness and acceptance of using full immersive VR technology among Chinese older persons from Hong Kong
- ✓ Research participants perceived the VR CAVE application on preventing of falls was useful and innovative.
- ✓ The study shows positive perceptions and users' experiences adopting new VR CAVE technology in older adults.



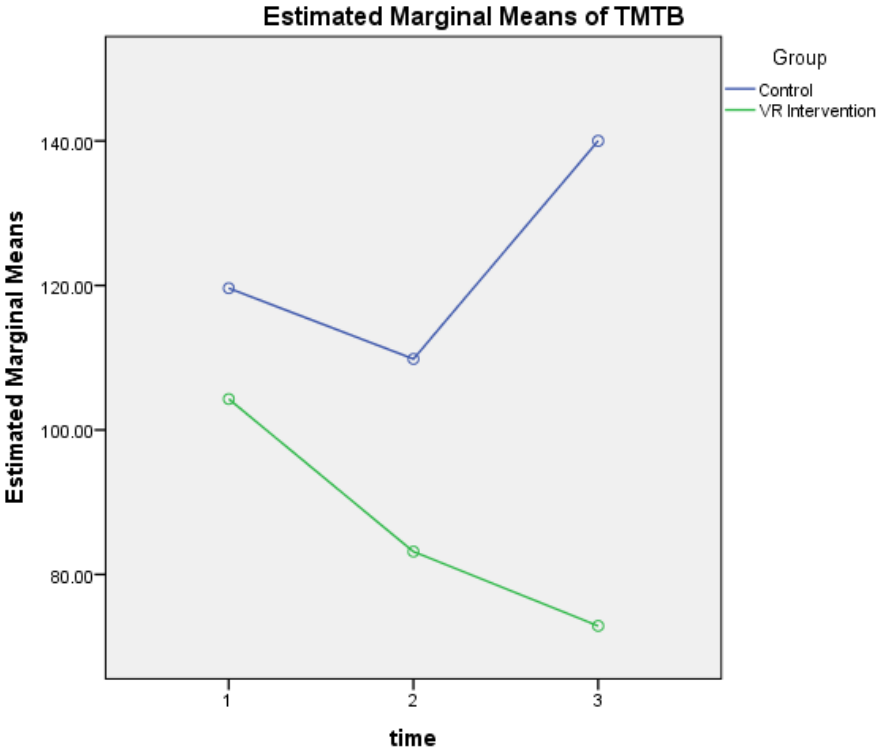
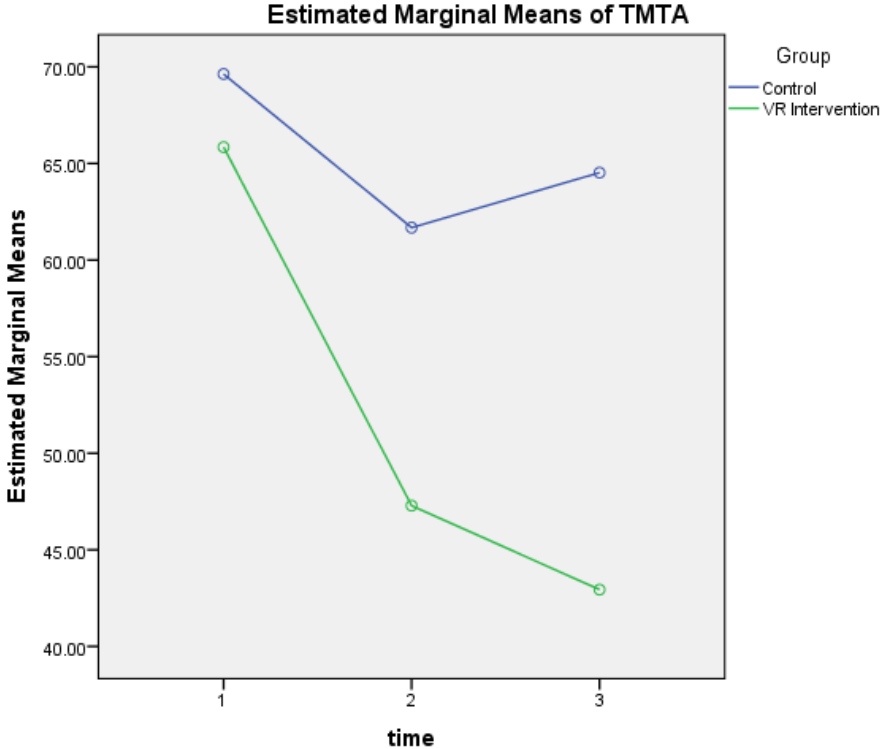
## Research Summary

- ❑ Statistically, the intensive VRT intervention could reduce the risks of falls among older adults particularly with risk or mild cognitive impairment.
- ❑ The effectiveness of VRT intervention could sustain after post 3-month intervention particularly on cognitive and physical functions.
- ❑ VR research participants showed positive perceptions and acceptancy on using VRT application in the research project.
- ❑ The Covid-19 pandemic may have hinder impacts on research design and the participants daily and social routine.
- ❑ The application of VRT as a new alternative approach has promising evidence to reduce the risks of fall and showing positive perception and acceptance among community dwelling adults with mild cognitive impairment in community living.

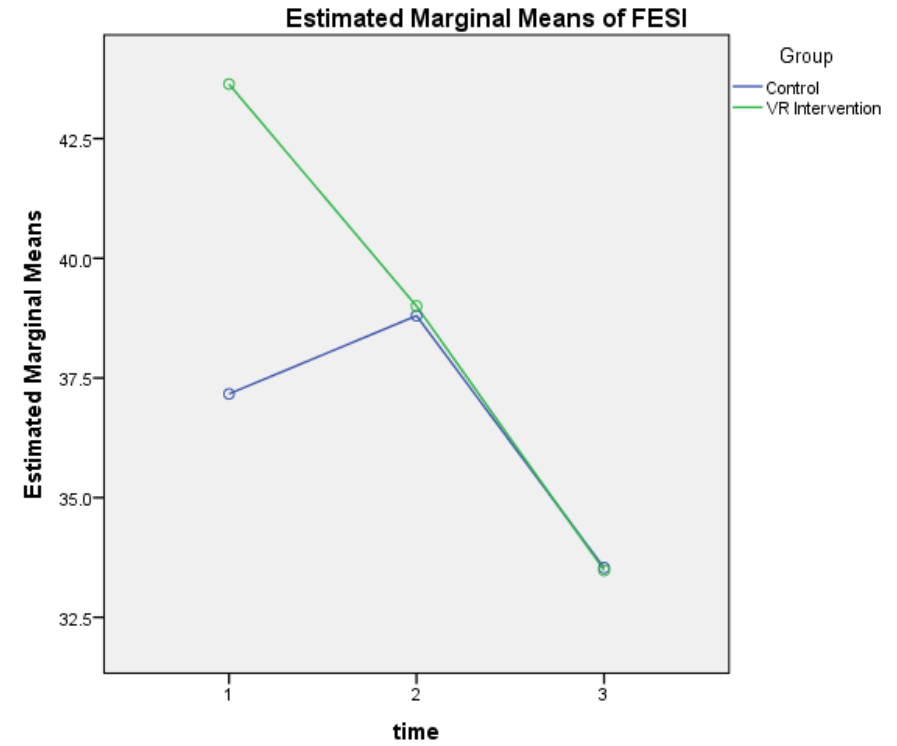
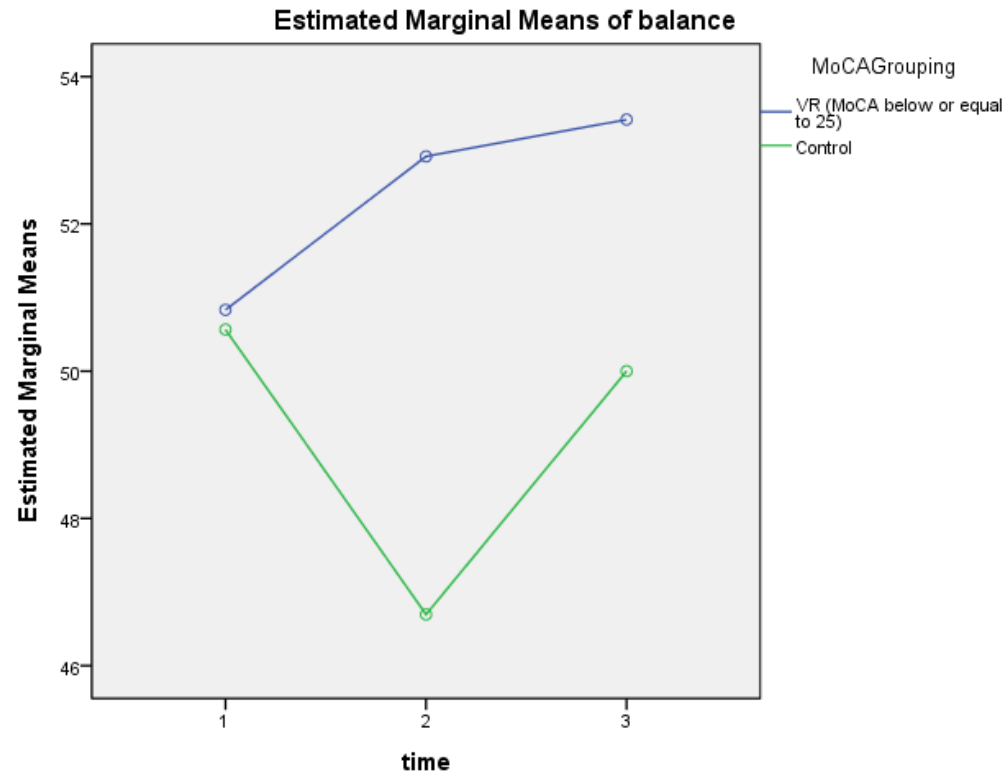
# Cognitive Function (HK-MoCA) & Walk Speed (6MT)



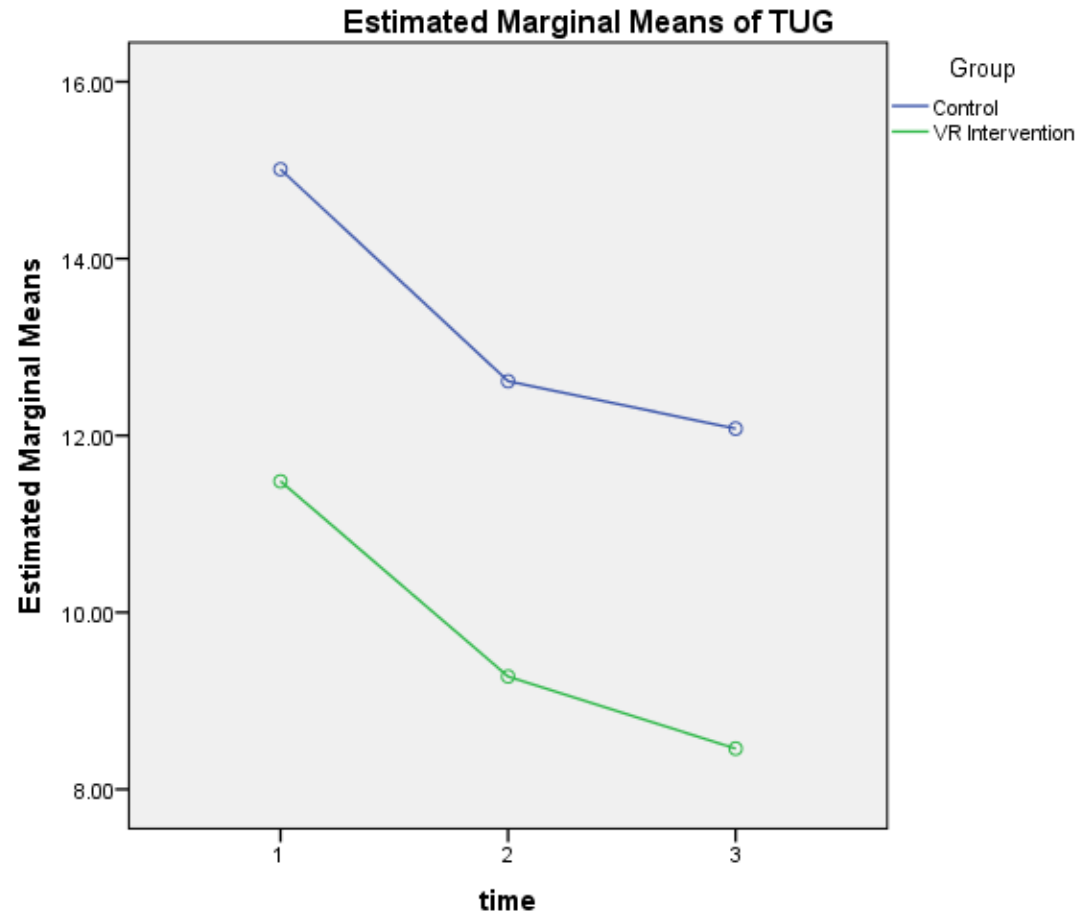
# Executive Function (TMT-A , TMT-B)



# Postural Balance (BBS) & Fear of Falling (FES-I)



# Time Up and Go Test (TUG)





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# My Journey - Occupation



## 1. Collaborations

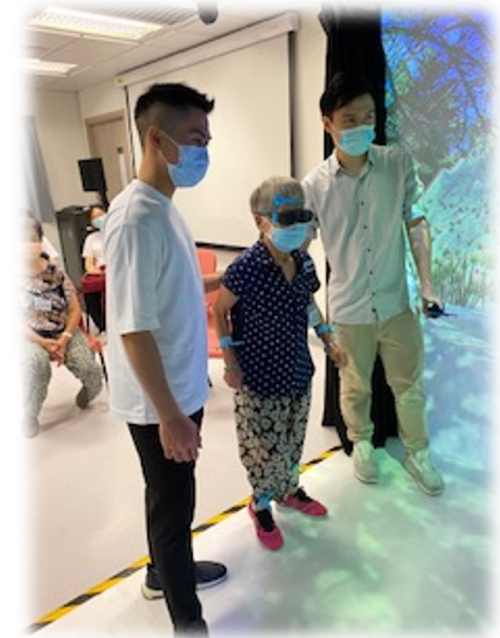
- ❑ University of East Anglia (External examiner) UK
- ❑ University of Liverpool (External program reviewer) UK
- ❑ University of Southern Queensland (PhD supervision) AU

## 2. Projects Consultancy

- ◆ Dementia education in Asia Pacific
- ◆ Committee member (Salvation Army, Macau)
- ◆ External accreditation committee member (Hong Kong Association for Gerontology)

## 3. Global Project & VR Business Innovation

- Project Assessor in African & Global Fund Project (2020-2023) (Rehabilitation International, WHO)
  - \* Assistive Technology for People Living with Physical Disability
- Hong Kong Research Project Innovation Fund – VR Simulated Leisure Program for Older Adults



## Acknowledgements

Principal Supervisor: Prof Jeffrey Soar

Research team: Dr Benson Ip, Prof Kenneth Fong, Dr Christina James & Dr Zoe Wang

Research Partners:

1. All participants
2. St. James Settlement & Salvation Army Hong Kong (NGOs)
3. VR Research centre (HKPU)

Supporting Universities:

1. University of Southern Queensland
2. Department of Rehabilitation Science, The Hong Kong Polytechnic University

