Functional Neuroimaging Techniques to Examine Falls and Cognition in Older Adults: A Systematic Review

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Introduction

Background

- Populations are aging both globally and in Canada[1,2], approx. 28-35% of people aged 65 and over experience falls[3].
- Falls are the second leading cause of premature unintentional injury deaths[4,5].
- Falls are costly to the healthcare system in Canada with an estimated annual direct cost of $5.6 billion in 2018[6].

Risk factors for falls can involve impaired neurocognitive function[7,8,9]. Identifying major risk factors associated with cognition may alleviate fall-related issues among older adults. The use of functional neuroimaging techniques may enhance understanding of the biological components involved in fall.

Objective

This systematic review was conducted to investigate how functional neuroimaging has been used to examine the relationship between falls and cognition among older adults

Methods

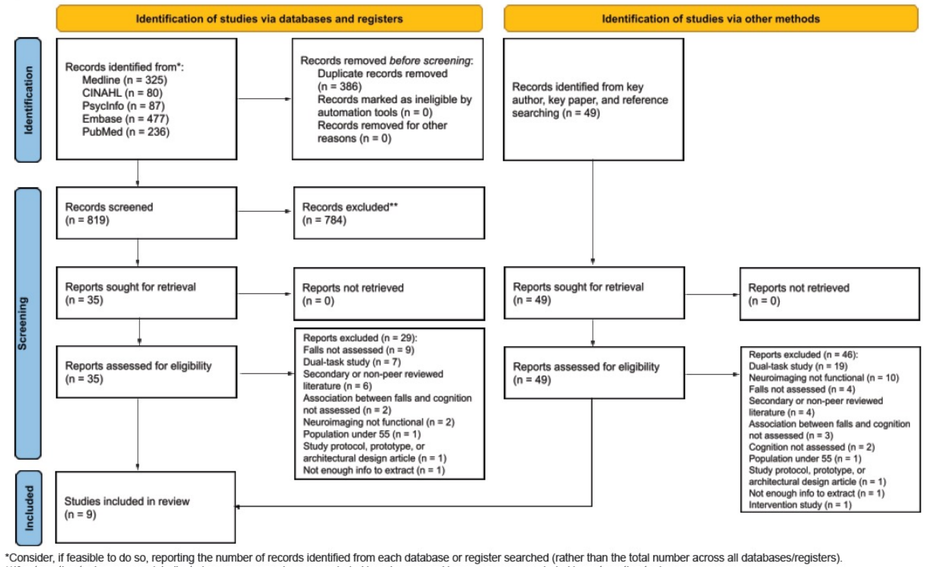
A search was conducted in these **5 databases** to identify peer-reviewed articles in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses[10,11]: (1) Medline (via OVID) (2) PsycINFO (via OVID) (3) CINAHL (via EBSCO) (4) EMBASE (via OVID) (5) PubMed. As well as, looking through the **studies references** and **key author searches**. **Quality assessment** for each study was assessed using a questionnaire which is comprised of 7 questions[12].

Results

The systematic search included a total of nine articles that were grouped together based on their neuroimaging techniques.

- **EEG**: Of the selected studies (n=5), two found that fallers display deficits in attentional facilitation when processing stimuli in the left visual field[13,14], and one EEG study reported decreased phase-amplitude coupling between alpha and gamma brain activity in older fallers[15].The last two studies found measures of falls/falls risk to not be associated with cognition[16,17].
- **fMRI:** The studies (n=3) found a relationship between falls and reduced functional activation in older adults during the Erikson Flanker test.
- **PET:** One study[18] showed decreased executive functioning and gait performance to be associated with lower glucose metabolism in the primary sensorimotor cortices and posterior cingulate under the fast condition.

Figure 1. PRISMA flow diagram



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).
**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

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Conclusion

- To our knowledge, this was the first systematic review to report on how falls and cognition have been examined in older adults using functional neuroimaging techniques.
- A comprehensive analysis of nine studies suggest functional neuroimaging techniques have the potential to identify cognitive risk factors associated with falls.
- Risk factors associated with cognition may alleviate fall-related issues among older adults through the development of screening practices and falls prevention strategies.

Funding

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References

1. United Nations. World Population Aging 2019 - Highlights. 2019
2. Government of Canada. Action for Seniors report. 2014
3. World Health Organization. WHO Global Report on Falls Prevention in Older Age. Ageing and Life Course, Family and Community Health. 2007
4. World Health Organization. Step Safely: Strategies for preventing and managing falls across the life-course. 2021
5. Murray et al. The Global burden of disease : a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020 : summary. Harvard University Press. 1996
6. Parachute. Cost of Injury in Canada. 2021
7. Tinnetti ME. et al. Risk factors for falls among elderly persons living in the community. NEJM. 1998
8. Liu-Ambrose T. et al. Increased Risk of Falling in Older Community-Dwelling Women With Mild Cognitive Impairment. PTJ. 2008
9. Masdeau JC. et al. Brain white-matter changes in the elderly prone to falling. JAMA Neurology. 1989
10. Moher D. et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. BMC. 2015
11. Shamseer L. et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ. 2015
12. Hsu CL. et al. Examining the relationship between specific cognitive processes and falls risk in older adults: a systematic review. Osteoperosis Int. 2012
13. Nagamatsu L. et al. Are impairments in visual-spatial attention a critical factor for increased falls risk in seniors?. An event-related potential study. Neuropsychologia. 2009
14. Nagamatsu L. et al. Altered visual-spatial attention to task-irrelevant information is associated with falls risk in older adults. Neuropsychologia. 2013
15. Scurry A. et al. Impoverished Inhibitory Control Exacerbates Multisensory Impairments in Older Fallers. Frontiers in Aging Neuroscience. 2021
16. Payne A. et al. Lower Cognitive Set Shifting Ability Is Associated With Stiffer Balance Recovery Behavior and Larger Perturbation-Evoked Cortical Responses in Older Adults. Frontiers in Aging Neuroscince. 2021
17. Walshe E. et al. Dual-task and electrophysiological markers of executive cognitive processing in older adult gait and fall-risk. Frontiers in Human Neuroscience. 2015
18. Sakurai R. et al. The neural substrate of gait and executive function relationship in elderly women: A PET study. Geriatrics & Gerontology International. 2017