

Co-design of an mHealth application to support an evidence-based fall prevention program for people who use wheelchairs and scooters full-time

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Fall Prevention for People Who Use Wheelchairs and Scooters: A Critical Gap in Research

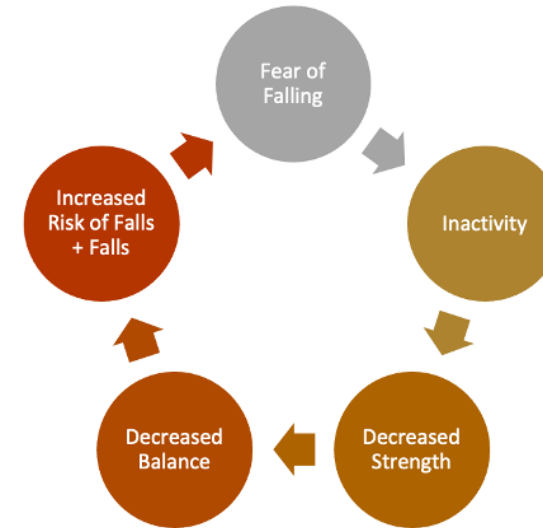
- Fall prevention is a widely recognized public health priority.
- Existing research focuses on people who are **ambulatory**.
- Falls are common among people with mobility disabilities such as people with spinal cord injury (PwSCI) and multiple sclerosis (PwMS), who use wheelchairs and scooters full-time.
 - **Fall Prevalence:**
 - MS: 75% in a period of six months
 - SCI: 69% within a one-year period
 - Falls occur during **routine unavoidable activities**.

Consequences of Falls: Fatal and Injurious

- 68% of fatal WC/S-related accidents are caused by falls.
- **25%- 34%** of PwSCI and PwMS sustained injuries following falls.
 - **Common injuries:** bruises, abrasions, cuts, fractures
 - **Consequences:** Inability to leave home, loss of functional mobility, and impaired participation.

Fear of Falling (a.k.a Concern about Falling): Psychosocial Impact

- Fear of falling > reduced autonomy > curtailed activity.
- Fear of falling was reported by **64%** of people who used WC/S with various health conditions
 - **57%** limited the performance of their daily activities.
- Creates potential for **disuse-disability cycle** among PwMS, PwSCI



<https://rehabinkmag.com/2022/06/16/the-power-of-words-how-to-talk-about-fall-risk/>

Fall prevention/management interventions for non-ambulatory populations

- The Individualized Reduction Of Falls (iROLL) program.
 - Specifically for people who use wheelchairs and/or scooters full-time.
 - Evidence-based 6-week program.
 - Developed and evaluated by an Interprofessional team of physical and occupational therapists.
 - Addresses the multifaceted influences on fall risk.
 - Grounded on Health Belief Model and Social Cognitive Theory.

iROLL Components

‘GET WISE’

G-Goals

E-Exercise to improve sitting balance and core strength

T-Transfer Training

W-Wheelchair/Scooter Management

I-Individual Activity in the Home & Community

S-Symptom Management

E-Environmental Safety



iROLL Pilot Study Findings:

Benefits of translation into a mHealth platform

- **iROLL–In-person:** Positive outcomes with:
 - Transfer skills, Community participation, and Knowledge of fall management strategies
 - Participants suggested value of remote delivery.
- **iROLL-Online:** 6 weeks **Asynchronous** learning activities + **Synchronous** group videoconferencing.
 - Online environment was positively reviewed by participants
 - Increased program reach and study outcomes remained consistent
 - Participants expressed desire for a mobile app to increase ease of access and communication

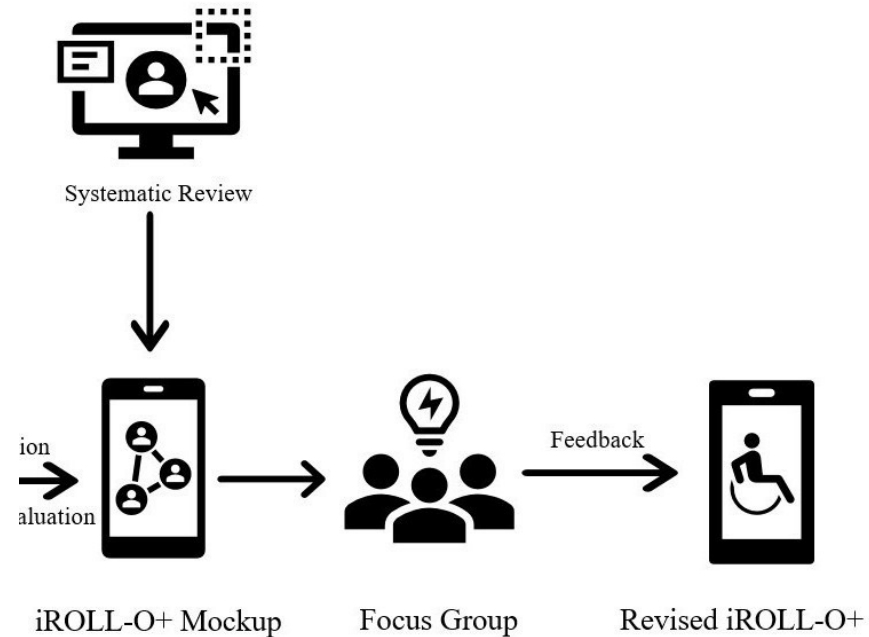
Study purpose

- To describe the **co-design process** of a mobile Health (mHealth) application (iROLL-O+) to support the delivery of the iROLL program.
- Data source:
 - Systematic literature review
 - Focus groups with end-users

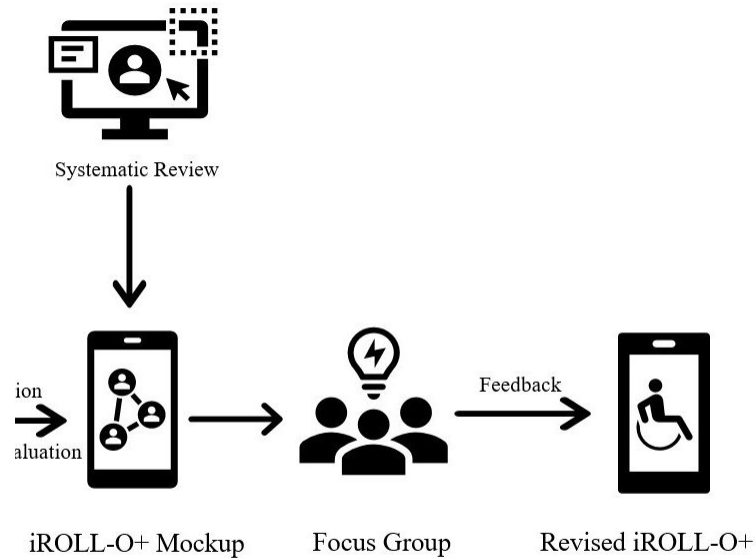


Methods

- **Systematic review**
- Studies of all designs which
 - Population: people who used wheelchairs/scooters
 - Addressed mobile interventions
 - Focused on health behavior change.
- Alpha version of the app was developed.



Methods



- **Focus group with end-users**
- Inclusion criteria:
 - 18 years or older
 - Have diagnosis of MS/SCI
 - Used wheelchair for more than 75% of mobility.
 - with ≥ 1 fall in the last three years
- Participants reviewed an alpha version of app and provided feedback
- Thematic analysis of the transcripts by 2 independent researchers.

Results

- The literature search yielded 2119 studies; A final of 9 studies were included.
- 9 participants with SCI/MS (63 ± 7 years, 67% male) engaged in two focus groups.
- **Findings from the literature review and focus group:**
 - **Features supporting mHealth usability and user satisfaction :**
 - Intuitive navigation and design
 - Clear instructions
 - Meaningful Icons
 - Opportunities for peer and/or coach collaboration.
 - Including a participant pre-intervention training.
 - Adding a search option + help desk
 - Accessibility considerations

Results from the Focus Groups

- Feedback on the iROLLO+ mockup:

iROLL-O+ app's potential to expand the fall prevention program **reach** and facilitate **flexible access**:

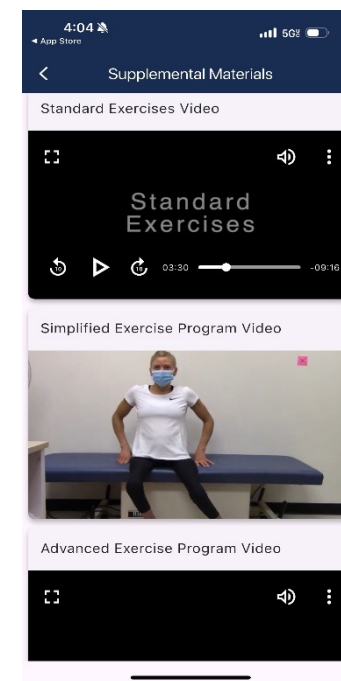
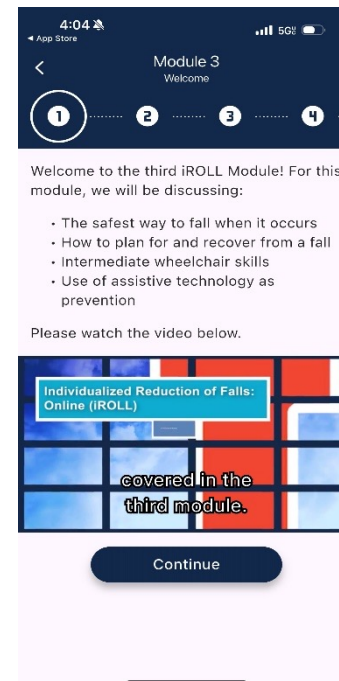
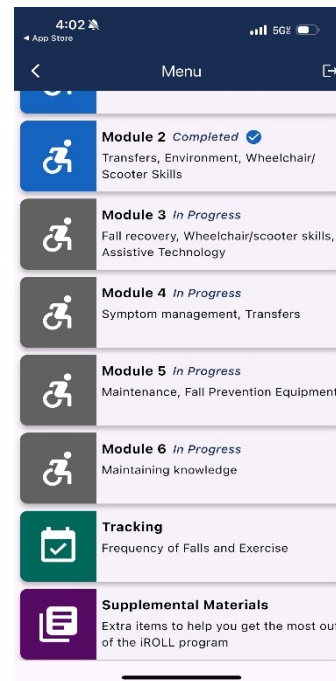
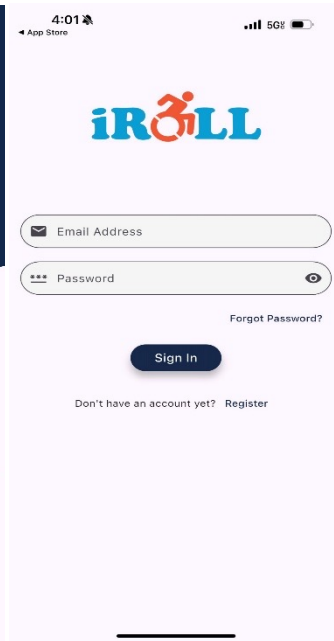
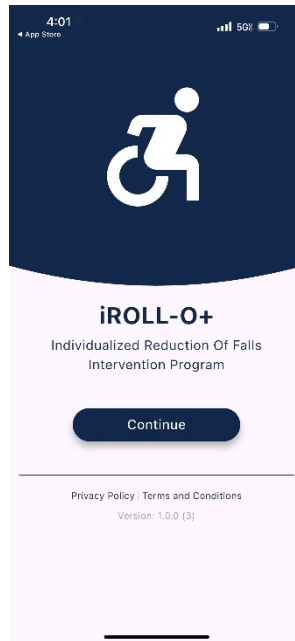
“I see use it on my tablet because I carry it around pretty frequently, and it's easier than being tied to the desk. You can put the information on and make it accessible.”

Participant 4

iROLLO+ App Structure

- **Six** core modules (one module per week).
- Supplemental modules containing additional resources:
 - The fall frequency tracking for users to self-assess their progress.
 - Expanded exercise programs.
 - Additional educational resources for participants who wish to learn more
 - Ongoing efforts are to add a message board to the app

iROLL+ app pages



Conclusion

- The iROLL-O+ application has good potential to support iROLL's effectiveness.

Thank you!

For more information regarding iROLL, please
contact the research team at
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Reference cited

- Abou, L., Qin, K., Alluri, A., Du, Y., & Rice, L. A. (2022). The effectiveness of physical therapy interventions in reducing falls among people with multiple sclerosis: a systematic review and meta-analysis. *Journal of bodywork and movement therapies*, 29, 74-85. <https://doi.org/10.1016/j.jbmt.2021.09.015>
- Bandura, A. (1998). Health promotion from the perspective of social cognitive theory. *Psychology and health*, 13(4), 623-649.
- Calder, C. J., & Kirby, R. L. (1990). Fatal wheelchair-related accidents in the United States. *Am.J.Phys.Med.Rehabil.*, 69(4), 184-190. PM:0002383378
- Forslund, E. B., Jorgensen, V., Franzen, E., Opheim, A., Seiger, A., Stahle, A., Hultling, C., Stanghelle, J. K., Roaldsen, K. S., & Wahman, K. (2017). High incidence of falls and fall-related injuries in wheelchair users with spinal cord injury: A prospective study of risk indicators. *J Rehabil Med*, 49(2), 144-151. <https://doi.org/10.2340/16501977-2177>
- Friedman, S. M., Munoz, B., West, S. K., Rubin, G. S., & Fried, L. P. (2002). Falls and fear of falling: which comes first? A longitudinal prediction model suggests strategies for primary and secondary prevention. *Journal of the American Geriatrics Society*, 50(8), 1329-1335.
- Hochbaum, G., Rosenstock, I., & Kegels, S. (1952). Health belief model. *United states public health service*, 1.
- Lorig, K. R., & Holman, H. R. (2003). Self-management education: history, definition, outcomes, and mechanisms. *Annals of behavioral medicine*, 26(1), 1-7. https://doi.org/10.1207/S15324796ABM2601_01



Reference Listed-Continued

- Khan, A., Pujol, C., Laylor, M., Unic, N., Pakosh, M., Dawe, J., & Musselman, K. E. (2019). Falls after spinal cord injury: a systematic review and meta-analysis of incidence proportion and contributing factors. *Spinal Cord*, 57(7), 526-539. <https://doi.org/10.1038/s41393-019-0274-4>
- Larsen, D. (2018). Planning Education for Long-Term Retention: The Cognitive Science and Implementation of Retrieval Practice. *Seminars in Neurology*, 38(04), 449-456. <https://doi.org/10.1055/s-0038-1666983>
- Lindhiem, O., Bennett, C. B., Rosen, D., & Silk, J. (2015). Mobile technology boosts the effectiveness of psychotherapy and behavioral interventions: a meta-analysis. *Behav Modif*, 39(6), 785-804. <https://doi.org/10.1177/0145445515595198>
- McArthur, A. R., Peterson, E. W., Sosnoff, J., Backus, D., Yarnot, R., Abou, L., Kish, J., Steinkellner, S., Sandhu, A., & Rice, L. (2023). Online delivery of the individualized reduction of falls intervention for persons with multiple sclerosis who use a wheelchair or scooter full-time: a pilot study. *International journal of MS care*, 25(2), 82-90. <https://doi.org/10.7224/1537-2073.2022-044>
- Moein, S., Peterson, E. W., Li, Z., Morris, J., Van Denend, T., Sosnoff, J. J., Backus, D., Pramod, J., Hawari, L., Nguyen, M., & Rice, L. A. (2025). Engaging wheelchair and scooter users in the co-design of an mHealth application for fall prevention and management: thematic analysis of focus group research. *Disabil Rehabil Assist Technol*, 20(4), 957-968. <https://doi.org/10.1080/17483107.2024.2422391>



Reference Listed-Continued

- Rice, L. A., Ousley, C., & Sosnoff, J. J. (2015). A systematic review of risk factors associated with accidental falls, outcome measures and interventions to manage fall risk in non-ambulatory adults. *Disabil Rehabil*, 37(19), 1697-1705. <https://doi.org/10.3109/09638288.2014.976718>
- Rice, L. A., Peterson, E. W., Backus, D., Sung, J., Yarnot, R., Abou, L., Van Denend, T., Shen, S., & Sosnoff, J. J. (2019). Validation of an individualized reduction of falls intervention program among wheelchair and scooter users with multiple sclerosis. *Medicine (Baltimore)*, 98(19), e15418. <https://doi.org/10.1097/md.00000000000015418>
- Rice, L. A., Yarnot, R., Sung, J., Sosnoff, J. J., Backus, D., Abou, L., Shen, S., & Peterson, E. W. (2022). Pilot study of a fall prevention and management intervention program for people with multiple sclerosis who use a wheelchair or scooter full-time. *Archives of rehabilitation research and clinical translation*, 4(4), 100225. <https://doi.org/10.1016/j.arrct.2022.100225>
- Rice, L. A., Yehya, M., Yi, J., Koziel, S., & Peterson, E. W. (2024). Translation, extension, and evaluation of usability, usefulness, and safety of a fall prevention and management program for people living with spinal cord injury and multiple sclerosis who use wheelchairs or scooters full time. *Front Rehabil Sci*, 5, 1406938. <https://doi.org/10.3389/fresc.2024.1406938>



Reference Listed-Continued

- Van Denend, T., Moein, S., Niec, P., Peterson, E. W., Morris, J., Backus, D., Sosnoff, J. J., Brunskill, A., Hawari, L., & Rice, L. A. (2025). mHealth learning strategies to support behaviour change in individuals using wheelchairs and/or scooters: a systematic review. *Disabil Rehabil Assist Technol*, 20(3), 510-520. <https://doi.org/10.1080/17483107.2024.2394814>
- Van Denend, T., Peterson, E. W., McArthur, A. R., Yarnot, R., Kish, J., Steinkellner, S., Sandhu, A., & Rice, L. A. (2022). A process evaluation of an on-line fall prevention and management program for individuals who use wheelchairs or scooters living with multiple sclerosis [Original Research]. *Frontiers in Public Health*, 10. <https://doi.org/10.3389/fpubh.2022.1042668>
- Van Denend, T., Peterson, E. W., Sung, J., & Rice, L. A. (2022). Process evaluation findings of a fall prevention and management program for wheelchair and scooter users with multiple sclerosis. *PEC Innovation*, 1, 100081. <https://doi.org/https://doi.org/10.1016/j.pecinn.2022.100081>
- Zanotto, T., Sosnoff, J. J., Backus, D., Yarnot, R., Abou, L., Peterson, E. W., & Rice, L. A. (2023). Characteristics and consequences of falls among people with multiple sclerosis who use wheelchairs or scooters: differences between injurious and non-injurious falls. *Multiple sclerosis and related disorders*, 73, 104631. <https://doi.org/10.1016/j.msard.2023.104631>
- Schoene, D., Heller, C., Aung, Y. N., Sieber, C. C., Kemmler, W., & Freiberger, E. (2019). A systematic review on the influence of fear of falling on quality of life in older people: is there a role for falls?. *Clinical interventions in aging*, 701-719.

