Acceptability of an AI-Powered Wearable Ring Sensor for Upper Body Mobility in Individuals with Cognitive Impairment: A Pilot Study

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Holly Shannon

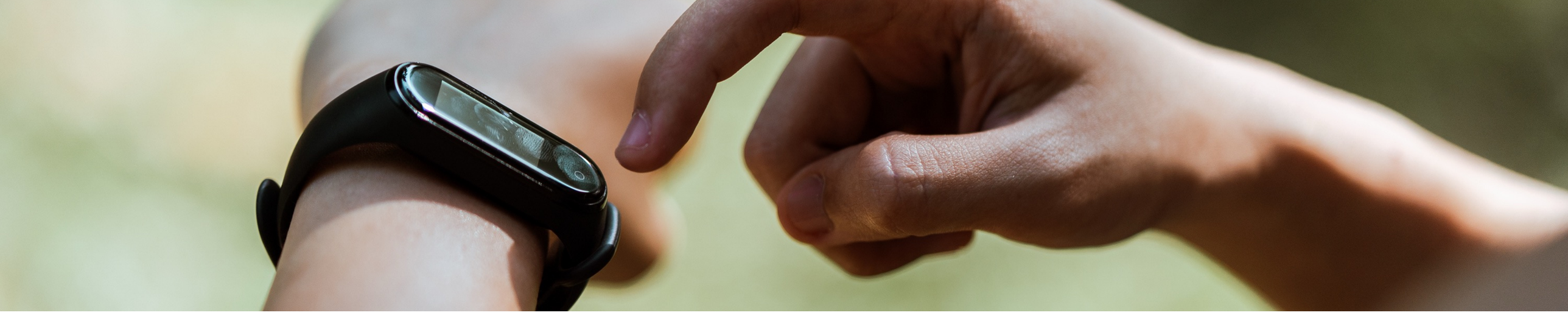
- Holly received a Master’s degree in Neuroscience at Carleton University in 2020. She is currently a doctorate student in the Department of Neuroscience at Carleton University.

- Her research interest lies in digital health, more specifically how digital technologies impact mental and physical health.

Dementia

- Dementia affects memory, thinking, behaviour, impacting daily activities.
- 35.6 million people worldwide live with dementia. This is expected to **triple** by 2050.
- Historically individuals with dementia have been excluded from research.

[1-4]



Wearable Technology

- Wearable devices provide real-time, non-invasive health monitoring
- Used to track physiological & movement data for personalized care
- Kinematic wearable technology (accelerometers, GPS) → Assess mobility & function

Artifitical Intelligence & Wearable Technology

- Real-time non-invasive tracking for personalized health insights
- AI classifies daily activities, detects anomalies & provides real-time insights
- Machine learning identifies movement changes
- This provides improve mobility tracking, enhance independence, and support to dementia care

XO RING

Aims

To assess the feasibility, usability, and acceptance of a wearable ring, powered with AI, designed to track upper body movements in individuals with dementia.

Methods

Mixed-methods design to explore feasibility, usability, and acceptability of the ring sensor in older adults with dementia.

Eligibility Criteria

- 65 years of age or older
- Dementia diagnosis
- Residing in the long-term care facility
- Exclusion criteria: significant mobility restriction or medical conditions affecting sensory use (ex. arthritis, hand tremors, etc.)

Measures

- Should movement metrics: flexion, extension, abduction, adduction, and rotational movements.
- Technology Acceptance Questionnaire
- User Acceptance Questionnaire
- Focus group, 1 week post-intervention

Quantitative Results

5 participants

- Cognitive status (from MMSE) ranged from 5 to 30 (+/- 8.84)

Feasibility

- All participants used the device correctly
- None requested removal of the device

TABLE 1: CHARACTERISTICS OF STUDY PARTICIPANTS

Category	Dementia (n=5)
Gender	
Female	4 (80.0%)
Male	1 (20.0%)
Duration (in seconds)	1703.00 ± 348.00
Ethnicity	
White	5 (100.0%)
Other	0 (0.0%)
Highest Level of Education	
High School or Equivalent	4 (80.0%)
Other	1 (20.0%)
Engaged in Recreational Activities Involving Shoulder Exercises Today?	
No	0 (0.0%)
Yes	5 (100.0%)
Expressed Shoulder Pain Today?	
No	4 (80.0%)
Yes	1 (20.0%)
Expressed Discomfort with the Device?	
No	4 (80.0%)
Yes	1 (20.0%)
Age (Mean ± SD)	78.60 ± 81.60

Quantitative Results: Usability and Acceptability

Technology Acceptance Questionnaire:
Mean score of 52.2 (SD ±38.4)

User Acceptance Questionnaire:
Mean score of 87.8 (SD ±66.2)

Qualitative Results

Themes

Theme 1:
High Ring Comfortability

“I mean, I’ve had a ring on my finger for years; I just put it on top of this one.”

Theme 2:
Low Ring Significance

“I didn’t even really know what the ring was going to do”

Theme 3:
Low Ring Impact

“It was very easy. You can wash with it on and shower. Go outside. And it's perfect for me”.

Conclusions & Future Directions

- This study demonstrated feasibility of an artificial intelligence powered wearable ring device in individuals with dementia, for measuring shoulder movements.

- Moderate usability and acceptability was found, with participants reporting high comfortability and low impact to their daily activities.

- A larger sample with a more diverse dementia population should be explored.

Thank You

University of Manitoba
UFC
DALHOUSIE UNIVERSITY
Université de Montréal
Carleton University
IARIA

References

[1] World Health Organization. "Dementia." https://www.who.int/news-room/fact-sheets/detail/dementia.

[2] G. Livingston et al., "Dementia prevention, intervention, and care: 2024 report of the Lancet standing Commission," (in eng), Lancet, vol. 404, no. 10452, pp. 572-628, Aug 10 2024, doi: 10.1016/s0140-6736(24)01296-0.

[3] J. Taylor, S. Demers, E. Vig, and S. Borson, "The Disappearing Subject: Exclusion of People with Cognitive Impairment and Dementia from Geriatrics Research," Journal of the American Geriatrics Society, vol. 60, pp. 413-9, 01/30 2012, doi: 10.1111/j.1532-5415.2011.03847.x.

[4] J. S. Yi, C. A. Pittman, C. L. Price, C. L. Nieman, and E. S. Oh, "Telemedicine and Dementia Care: A Systematic Review of Barriers and Facilitators," (in eng), J Am Med Dir Assoc, vol. 22, no. 7, pp. 1396-1402.e18, Jul 2021, doi: 10.1016/j.jamda.2021.03.015.

[5] A. C. Cote, R. J. Phelps, N. S. Kabiri, J. S. Bhangu, and K. K. Thomas, "Evaluation of Wearable Technology in Dementia: A Systematic Review and Meta-Analysis," (in eng), Front Med (Lausanne), vol. 7, p. 501104, 2020, doi: 10.3389/fmed.2020.501104.

[6] I. C. Rocha et al., "Monitoring Wearable Devices for Elderly People with Dementia: A Review," Designs, vol. 8, no. 4, doi: 10.3390/designs8040075.

[7] A. Carnevale et al., "Wearable systems for shoulder kinematics assessment: a systematic review," (in eng), BMC Musculoskelet Disord, vol. 20, no. 1, p. 546, Nov 15 2019, doi: 10.1186/s12891-019-2930-4.

[8] J. Qi, C. Wu, L. Yang, C. Ni, and Y. Liu, "Artificial intelligence (AI) for home support interventions in dementia: a scoping review protocol," (in eng), BMJ Open, vol. 12, no. 9, p. e062604, Sep 21 2022, doi: 10.1136/bmjopen-2022-062604.

[9] S. Shajari, K. Kuruvinashetti, A. Komeili, and U. Sundararaj, "The Emergence of AI-Based Wearable Sensors for Digital Health Technology: A Review," (in eng), Sensors (Basel), vol. 23, no. 23, Nov 29 2023

[10] XO Ring. https://www.xotechnology.ca/

[11] F. D. Davis, “Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology.” MIS Quarterly, vol. 13, no. 3, 1989, pp. 319–40. JSTOR, https://doi.org/10.2307/249008.

[12] A. Spagnolli, E. Guardigli, V. Orso, A. Varotto, L. Gamberini, " Measuring User Acceptance of Wearable Symbiotic Devices: Validation Study Across Application Scenarios.” In: Jacucci, G., Gamberini, L., Freeman, J., Spagnolli, A. (eds) Symbiotic Interaction. Symbiotic 2015. Lecture Notes in Computer Science(), vol 8820. Springer, Cham. https://doi.org/10.1007/978-3-319-13500-7_