Feasibility of an AI-Driven Wearable Ring for Shoulder Mobility Monitoring in Older Adults with and without Dementia

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***Abstract*—Wearable technologies powered by artificial intelligence (AI) can offer a non-invasive method to enhance health monitoring. However, the implementation of such wearable kinematic technologies among older adults with cognitive impairment remains underexplored. This study aims to evaluate the feasibility, usability, and acceptability of a wearable ring sensor powered by AI in long-term care (LTC) residents with and without dementia. A mixed-methods study was conducted with ten LTC residents (five with dementia and five without). Participants engaged in structured shoulder mobility exercises while continuously wearing an AI-integrated ring sensor for one day. Feasibility, usability, and acceptability were assessed through various questionnaires. A post-study focus group was conducted with 6 of the participants, followed by reflexive thematic analysis to identify qualitative themes. No significant differences in feasibility were found between groups**

for device usage adherence, exercise frequency and intensity. Similarly, quantitative data revealed usability, and acceptability did not significantly differ between dementia and non-dementia participants. However, participants without dementia reported a significantly more positive attitude toward the technology. Thematic analysis identified three key themes: high ring comfortability, low ring significance, and ease of use. The AI-integrated wearable ring sensor was well accepted across varying degrees of cognitive impairment, highlighting the non-intrusive nature. Our findings suggest feasibility, usability, and acceptability of the wearable ring device in a LTC setting. Future research should explore its usability in a larger population of individuals with varying cognitive impairment and assess its clinical utility for movement monitoring in older adults.

Keywords—Wearable Devices; Artificial Intelligence; Dementia; Feasibility; Aging; cognitive impairment, Remote Movement Monitoring, Long Term care.

I. INTRODUCTION

This is an extended version of the paper published at AIVR 2025 [1]. The current manuscript presents data from the full sample, allowing comparisons between individuals living with and without dementia.

Dementia affects memory, thinking, behavior, and the ability to perform daily activities. The World Health Organization identifies dementia as a critical public health and social care issue of the 21st century [2]. Currently, 35.6 million people worldwide live with dementia, and this number is projected to double by 2030 and triple by 2050 [2], [3]. Historically, people with dementia and cognitive disabilities have been systematically excluded from geriatric research, reflecting a broader pattern of ableism that has marginalized individuals living with dementia [4]. However, this paradigm has started to shift over the past decade, with growing awareness of the importance of addressing these biases and including diverse populations in health technology research to promote equitable opportunities for access, utilization, and benefits from technological advancements [5][6][7][8].

This shift toward inclusivity is especially significant in the context of advancing technologies like wearable devices, which have the potential to improve care for dementia populations [9]. Advancements in kinematic technology, such as accelerometers, GPS trackers, gyroscopes, and motion detection tools integrated into mobile platforms, present a cost-effective means to assess disease burden and deliver personalized care [5]. Likewise, these innovative kinematic technologies enable minimally invasive and real-time monitoring for tailored delivery [9]. Wearable devices (WDs), capable of continuously monitoring physiological metrics in real-world settings such as a patient's home (i.e., smartwatches), provide insights that surpass those of traditional in-clinic assessments [10].

Wearable devices, including smart bracelets, rings, belts, necklaces, glasses, watches, earphones, headbands, and clothing with built-in sensors, are generally used to measure physiological parameters (e.g., heart rate, breathing rate, etc.) or to monitor physical movement [9][11]. Wearable devices for tracking physical movement such as range of motion, are increasingly being used, especially for individuals with neurological or musculoskeletal impairments [12]. These wearable technologies support rehabilitation and address the needs of aging populations, by providing real-time data which informs strategies to help preserve mobility and daily functioning in older adults [12]. Tracking upper body movements can contribute to maintaining mobility and activities of daily living (ADL) in older adults [13].

Various research on the use of wearable technologies for monitoring movement, including upper body functioning, has evolved alongside advancements in the field of kinematic technology. Early studies focused on inertial measurement unit (IMU)-based devices, accurately tracking shoulder joint angles during ADLs [14][15]. With the introduction of smartwatches in subsequent years, research expanded to include wearable IMU-based devices, leveraging their ability to monitor movements and assess rehabilitation progress in real-life situations and over a longer period of time. Wearable IMU-based devices are widely used to assist in tracking movements, making them integral tools in health monitoring [16]. Studies exploring the use of smartwatches using upper extremity rehabilitation exercises measure shoulder function indirectly [17]. Wearable technologies such as wearable rings have emerged as a potential alternative. However, research on the use of wearable rings has largely focused on other health monitoring applications, such as measuring blood pressure or tracking action-planning impairments [18][19].

Artificial intelligence (AI) is significantly changing healthcare, offering innovative solutions for managing dementia [20][21]. AI-driven tools, such as wearables, assistive robots and telepresence systems, provide cognitive support, medication reminders, and opportunities for social interaction, improving both the well-being of patients and the lives of their caregivers. These technologies have demonstrated benefits, including reduced caregiver burden, enhanced patient engagement, and improved mental health [20].

Healthcare services for disease diagnosis and monitoring are often expensive and limited in accuracy, driving interest in wearable health technologies based on flexible electronics. These devices offer benefits such as reduced costs, non-invasive implementation, and real-time access to health data, enabling personalized health monitoring through the accurate measurement of physical and biochemical signals [22]. AI algorithms enhance the functionality of these wearables, analyzing movement patterns and enabling precise tracking of motor activity, early intervention, and tailored care [20]. AI may improve data accuracy, with the potential to facilitate real-time decision-making and promote inclusivity in research through seamless and accessible monitoring [22]. Expanding on these advancements, AI-powered wearable devices, such as a ring sensor designed to monitor shoulder

movements, present a novel approach to supporting individuals with dementia. However, the feasibility, usability, and acceptability of such AI-powered wearable devices have not been extensively studied in older adults, especially when considering individuals living with dementia.

This study aims to assess the feasibility, usability, and acceptability of a wearable ring powered with AI designed to track upper body movements, comparing individuals with and without dementia in a long-term care (LTC) facility. It focuses on evaluating how well the device meets the specific needs of both groups and identifying factors that influence its usability and overall acceptance.

II. METHODS

A. Study Design

This pilot study employed an explanatory sequential mixed methods to assess the feasibility, usability, and acceptability of wearable sensor technology for older adults in LTC facilities [23]. The initial phase involved using quantitative methods to document feasibility, usability, and acceptability. This provided information into the practicality and potential success of the intervention. Following the quantitative phase, qualitative methods, including a focus group, were used to explore participants' experiences and the factors influencing the adoption of the technology.

B. Participants

Participants were recruited from a LTC facility in a rural area of Nova Scotia, Canada. Convenience sampling was used to select 10 participants, ensuring variability in functional abilities, cognitive function, and health status. Older adults (aged 65 and above) residing in the LTC facility were included if informed consent was obtained, either directly from the resident or from their substitute decision-maker when appropriate. Exclusion criteria included: 1) significant mobility restrictions, or 2) medical conditions that could interfere with sensor use. These conditions included severe hand arthritis, hand tremors, Raynaud's disease, skin conditions (such as dermatitis or eczema), and hand injuries (previous hand injuries or surgeries). Participants with motor impairments were excluded as it would limit their ability to perform the upper body movements required for tracking, preventing meaningful data collection. The potential for discomfort or confusion from using the device could also lead to distress, affecting participant well-being. For these reasons, these individuals were excluded to ensure accurate data collection and to prioritize participant comfort and safety.

C. Intervention

Participants were asked to wear the AI-driven ring sensor to monitor upper-body movements during the one-week intervention period. The LTC facility site coordinator provided instructions to participants to ensure proper use and maintenance of the device, supporting its functionality throughout the study. Participants with dementia were instructed to wear the sensor continuously for one day from 8:30 am until 3:30 pm. This approach was used to assess the feasibility of continuous wearing of the ring device to determine if participants could maintain wearing the device, without removal. Participants without dementia were instructed to wear the device only during exercise or recreational activities and to remove the ring afterwards. This contrasting protocol was implemented as part of a later phase of the study aimed to explore capabilities of the ring device. The site coordinator monitored the residents' use of the device and reviewed collected data daily to assess progress and address any concerns. The intervention prioritized accurate data collection while ensuring participant safety and comfort.

D. Intervention

Each participant was provided with a ring device by XO TECHNOLOGY©, along with information regarding its use [24]. However, the primary focus was on assessing the feasibility, usability, and acceptability of wearing the ring, so participants did not interact with the app themselves during the study period. The XO HEALTH© app, which displayed details such as Participant ID, Start and End Period, Last Data Sync, Average Wear Time, Device ID, and Device Status, was installed on Android tablets running the Android operating system or Apple iPads on iOS. A personal account was created on the XO HEALTH platform for each participant, enabling the device to collect and store data. The software platform utilized AI algorithms and data collection to monitor and analyze everyday shoulder movements. Data collected includes the angle of shoulder flexion, extension, abduction, adduction, internal rotation and external rotation, along with the number of repetitions for each. The collected data are processed by a neural network in order to classify various types of daily activities and quantify the frequency and intensity of these shoulder activities. Employing machine learning techniques, the platform could identify anomalous data points and deliver actionable insights, possibly enabling early detection of potential issues and facilitating proactive health risk mitigation. Further exploration into the ring device capabilities will be addressed in a later phase of the study.

E. Quantitative Data Collection and Measures

Data collection was conducted from October 21st to 25th, 2024, by a research assistant, with support from the site coordinator. Demographic information and cognitive status were obtained from the participant's medical record at the start of the study visit. The demographic questionnaire captured the age, gender, medical history, and functional status of all participants. The Mini-Mental State Examination (MMSE) was used to assess cognitive impairment [25]. Through a data-sharing agreement, the most recent MMSE scores (i.e., within the last 6 months) were obtained for each participant via their records at the LTC facility. For this

study, "dementia" classification refers to participants with MMSE scores consistent with up to moderate Alzheimer's disease, using a cutoff of ≤20, whereas "non-dementia" refers to those scoring ≥21. These thresholds align with the following ranges: normal cognition (≥25), mild Alzheimer's disease (21–26), moderate Alzheimer's disease (10–20), and moderately severe Alzheimer's disease (10–14) [25]. Feasibility was assessed by tracking adherence to device usage and monitoring shoulder exercises between participant groups via the observational checklist. These measures allowed for an evaluation of the technical and operational feasibility of the device by recording the time and exercises performed. Usability and acceptability were documented after completing the intervention using the Technology Acceptance Questionnaire (TAQ), and the User Acceptance Questionnaire (UAQ) [26], [27]. The TAQ consists of 12 items on a 7-point Likert Scale and focuses on both perceived usefulness and perceived ease of use of the sensor. The UAQ involves 26 items on a 6-point Likert scale, that comprehensively assess acceptance based on a range of questions about comfort, enjoyment, effort expectancy, attitude toward technology, etc.

F. Qualitative Data Collection and Measures

Approximately one week after the intervention period (November 5, 2024), participants who had completed the intervention were invited to participate in a semi-structured focus group conducted at the LTC facility with a trained staff member. A focus group was used to foster interaction among participants and encourage their expression of their perceptions of the sensor. A research assistant joined the focus group online using Zoom (Zoom Video Communications Inc.) to facilitate participation, while the site coordinator asked predetermined questions to prompt discussion. Focus group questions were developed to explore further comfort, benefits, concerns, and the impact on daily activities (see Supplementary Material for the interview guide). The research assistant transcribed and anonymized the audio recordings of the focus group discussions on Zoom using the qualitative software QSR NVivo 14.

G. Statistical Analysis: Quantitative Analysis

All questionnaire data were presented as mean and standard deviation and initially assessed for normality using the Kolmogorov-Smirnov test. Since the data did not follow a normal distribution, comparisons between groups were made using the Mann-Whitney U test. Categorical variables were reported as absolute and relative frequencies, with group differences analyzed using Fisher's exact test. All statistical analyses were conducted with a 95% confidence interval using SPSS (version 28.0); IBM Corp, Armonk, NY) for Mac. Qualtrics data management system (Qualtrics International Inc.) was used for data capture. These methods were selected to ensure a robust analysis of differences between dementia and non-dementia participants, considering the small sample size and the distribution characteristics of the data.

H. Statistical Analysis: Qualitative Analysis

The qualitative data was analyzed following the Braun and Clarke (2019) reflexive thematic analysis methodology [28]. Our approach followed a constructivist epistemology and an experiential orientation, whereby the three authors (HS, LY, MR) first read all transcripts to become familiar with the full dataset. The authors engaged in reflexive journaling and independently generated initial codes through an approach driven mainly by a latent-coding perspective and inductive analysis. Finally, themes were then generated and refined through discussion among these authors. Our reporting adheres to the Standards for Reporting Qualitative Research (SRQR) guideline, previously done by O'Brien et al. [29].

III. RESULTS

There were no significant differences between participants with dementia and those without dementia across several characteristics, as illustrated in Table 1. In terms of cognitive status, scores on the Mini-Mental State Examination ranged from 5 to 30, with a mean score of 20.90 (SD ±8.84). Both groups had a similar biological sex distribution, with 80% females and 20% males in each group.

TABLE 1: SOCIODEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS

Category	Dementia (n=5)	Non-Dementia (n=5)	P-value
Gender			
Women	4 (80.0%)	4 (80.0%)	1.000
Man	1 (20.0%)	1 (20.0%)	
Ethnicity			
White	5 (100.0%)	5 (100.0%)	1.000
Other	0 (0.0%)	0 (0.0%)	
Highest Level of Education			
High School or Equivalent	4 (80.0%)	4 (80.0%)	1.000
Other	1 (20.0%)	1 (20.0%)	
Age (Mean ± SD)	78.60 ± 81.60	81.60 ± 80.10	0.917

Note. P<0.05 indicated statistical significance based on the Mann-Whitney test (mean±SD) or Fisher's exact text (n,%).

Regarding participation in recreational activities involving shoulder exercises, 100% of non-dementia participants and 80% of dementia participants were involved. The majority of participants in both groups reported no shoulder pain or discomfort with the device (*see Table 2*). Overall, the lack of significant differences in these variables suggests that they did not influence the comparison between dementia and non-dementia participants in this study. The participants did not report adverse events.

TABLE 2: RING WEARING CHARACTERISTICS FOR PARTICIPANTS

Category	Dementia (n=5)	Non-Dementia (n=5)	P-value
Duration (in seconds)	1703.00 ± 348.00	1025.00 ± 348.00	0.251
Engaged in Recreational Activities Involving Shoulder Exercises?			
No	0 (0.0%)	1 (20.0%)	1.000
Yes	5 (100.0%)	4 (80.0%)	
Expressed Shoulder Pain Today?			
No	4 (80.0%)	5 (100.0%)	1.000
Yes	1 (20.0%)	0 (0.0%)	
Expressed Discomfort with the Device?			
No	4 (80.0%)	5 (100.0%)	1.000
Yes	1 (20.0%)	0 (0.0%)	

Note. P<0.05 indicated statistical significance based on the Mann-Whitney test (mean±SD) or Fisher's exact text (n,%).

A. Feasibility: Shoulder Exercises

The feasibility of the device was demonstrated, as no residents removed or requested to remove the ring during the intervention period. However, an issue arose when the ring sensor size was too large for one participant, causing it to fall off. For most shoulder exercises, no significant differences were observed between the two groups (*see Table 3*).

TABLE 3: COMPARISON OF SHOULDER RANGE OF MOTION EXERCISES BETWEEN PARTICIPANTS

Type of Shoulder Range of Motion	Dementia (n=5)	Non-Dementia (n=5)	P-value
Shoulder Flexion – Number of Sets	1.33 ± 1.67	1.67 ± 1.50	0.796
Shoulder Flexion – Number of Repetitions per Set	10.00 ± 9.00	9.00 ± 9.56	0.699
Shoulder Extension – Number of Sets	1.00 ± 1.33	1.33 ± 1.17	1.000
Shoulder Extension – Number of Repetitions per Set	5.00 ± 7.50	7.50 ± 6.11	0.519
Shoulder Abduction – Number of Sets	1.67 ± 1.33	1.33 ± 1.50	0.796
Shoulder Abduction – Number of Repetitions per Set	8.00 ± 6.50	6.50 ± 7.33	0.502
Shoulder Internal Rotation – Number of Sets	1.33 ± 1.00	1.00 ± 1.17	0.317
Shoulder Internal Rotation – Number of Repetitions per Set	8.60 ± 5.00	5.00 ± 7.25	0.055
Shoulder External Rotation – Number of Sets	1.33 ± 1.00	1.00 ± 1.17	0.317
Shoulder External Rotation – Number of Repetitions per Set	6.60 ± 5.00	5.00 ± 6.00	0.121

Note. P<0.05 indicated statistical significance based on the Mann-Whitney test (mean±SD) or Fisher's exact text (n,%).

Specifically, the number of sets and repetitions for shoulder flexion, extension, abduction, and external rotation showed no significant variation, with p-values ranging from 0.317 to 0.796. However, the number of repetitions for shoulder internal rotation approached significance, with a p-value of 0.055, suggesting a potential trend where participants with dementia performed slightly more repetitions than those without dementia. Despite this, none of the differences reached the standard threshold for statistical significance ($p<0.05$), indicating that overall, the frequency and intensity of shoulder exercises were similar between the two groups

B. Usability and Acceptability

Overall, for usability, the results of the UAQ (*see Table 4*) indicate that there were no significant differences between the two groups for the total score and most of the questions ($p > 0.05$). However, one notable exception was found in UAQ_6 (attitude towards technology), where participants with dementia reported a significantly more positive attitude ($p = 0.018$). These findings suggest that while there may be minor variations in specific areas, the overall technology acceptance and user experience were similar between participants with and without dementia.

TABLE 4: COMPARISON OF THE USER ACCEPTANCE QUESTIONNAIRE BETWEEN PARTICIPANTS

Type of Shoulder Range of Motion	Dementia (n=5)	Non-Dementia (n=5)	P-value
UAQ_1: Ease of use	4.60 ± 4.75	4.75 ± 4.67	0.524
UAQ_2: Usefulness	5.40 ± 4.25	4.25 ± 4.89	0.602
UAQ_3: Perceived usefulness	3.80 ± 2.75	2.75 ± 3.33	0.197
UAQ_4: Likelihood of usage	2.80 ± 2.50	2.50 ± 2.67	0.897
UAQ_5: Interction satisfaction	4.40 ± 4.00	4.00 ± 4.22	0.107
UAQ_6: Attitude toward technology	**4.80 ± 3.50**	**3.50 ± 4.22**	**0.018***
UAQ_7: Interest in future use	2.40 ± 1.75	1.75 ± 2.11	0.618
UAQ_8: Overall satisfaction	2.00 ± 1.75	1.75 ± 1.89	0.694
UAQ_9: Perceived value	1.60 ± 2.50	2.50 ± 2.00	0.530
UAQ_10: Intention to continue use	2.60 ± 2.75	2.75 ± 2.67	0.700
UAQ_11: Likelihood of recommending	3.00 ± 1.00	1.00 ± 2.11	0.121
UAQ_12: Use in future	3.00 ± 3.25	3.25 ± 3.11	0.694
UAQ_13: Usefulness in daily life	2.60 ± 1.75	1.75 ± 2.22	0.521
UAQ_14: Impact on quality of life	2.40 ± 3.75	3.75 ± 3.00	0.258
UAQ_15: Technology frustration	1.20 ± 2.25	2.25 ± 1.67	0.302
UAQ_16: Engagement with technology	2.60 ± 2.00	2.00 ± 2.33	0.706
UAQ_17: Comfort using the technology	4.80 ± 4.25	4.25 ± 4.56	1.000
UAQ_18: Willingness to recommend	4.40 ± 4.75	4.75 ± 4.56	0.893
UAQ_19: Ease of learning technology	5.20 ± 5.25	5.25 ± 5.22	1.000
UAQ_20: Ability of troubleshoot	1.60 ± 2.25	2.25 ± 1.89	0.434
UAQ_21: Overall technology confidence	4.00 ± 4.75	4.75 ± 4.33	1.000
UAQ_22: Understanding of technology features	3.00 ± 3.00	3.00 ± 3.00	1.000
UAQ_23: Motivation to use technology	3.00 ± 2.25	2.25 ± 2.67	0.455
UAQ_24: Technology fits with needs	4.80 ± 5.00	5.00 ± 4.89	0.418
UAQ_25: Satisfaction with technology design	4.00 ± 4.25	4.25 ± 4.11	0.500
UAQ_26: Frequency of use	3.80 ± 2.50	2.50 ± 3.22	0.266
Total UAQ Score	87.80 ± 66.20	66.20 ± 77.00	0.465

Note. P<0.05 indicated statistical significance based on the Mann-Whitney test (mean±SD) or Fisher's exact text (n,%).

For acceptability, there were no significant differences between dementia and non-dementia participants for most of the TAQ items. For example, the ratings on the ease of use (TAQ_1), usefulness (TAQ_2), perceived usefulness (TAQ_3), and other items like interest in future use (TAQ_7) and overall satisfaction (TAQ_8) showed no significant differences between the two groups. Some items had slightly higher or lower scores in one group compared to the other, however, these differences did not reach statistical significance. For instance, participants with dementia rated "ease of use" and "likelihood of usage" slightly higher than those without dementia, but the p-values (0.197 and 0.193, respectively) indicated that these differences were not statistically significant. The overall total TAQ score was also not significantly different between the two groups, with a p-value of 0.251. This suggests that, despite minor variations in individual responses, the overall technology acceptance between participants with and without dementia was similar.

C. Participant Experiences

The focus group comprised six participants, with a mean age of 78.5 years (SD ±10.97). In terms of gender identity, 66.7% identified as women (n=4), and 33.3% identified as men (n=2). All participants (100%) identified as Caucasian. The qualitative analysis yielded 3 themes (see *Figure 1*). No privacy or security concerns were raised during the focus group. Only one participant identified having prior experience with using a wearable device for health or fitness monitoring.

Figure 1. Schematic summary of themes derived from the qualitative analysis.

Theme 1: High Ring Comfortability

A crucial part of using wearable devices is how comfortable they are for the individual wearing them. A major factor contributing to the comfort of the ring device is its familiarity with the participants. *"I mean, I've had a ring on my finger for years; I just put it on top of this one (P1)."* Many participants said that the device's design closely resembled that of a conventional ring they were used to wearing in everyday life. This resemblance made the device non-intrusive while also allowing participants to adjust to wearing it quickly. While some participants expressed worries about swelling, it did not appear to influence general comfort. Many participants expressed *"It didn't bother me, I was comfortable with it (P2)."* However, size difficulties did arise. One individual stated that the ring felt uncomfortable since it was too large for their finger, pointing out the need to make size adjustments for the best fit.

Theme 2: Low Ring Significance

A theme that participants consistently demonstrated was a perceived low ring significance. One participant noted, *"I couldn't see any difference when I had it on (P3)",* underscoring the lack of discerned impact and benefit from the ring. Additionally, participant 2 stated, *"Think I need more information on it,"* when asked how important having a ring to track their shoulder movements and exercises was to them. This statement demonstrates a recurring trend among respondents, as many did not feel they had sufficient information to decide if the ring made a personal difference. Furthermore, several individuals involved in the focus group expressed that they felt the ring had low significance in their lives, as they did not notice a tangible difference after using it. Participant 1 reported, *"I didn't even really know what the ring was going to do and what we were supposed to do"*, illustrating that multiple participants were under the impression it would provide observable results after completion of the study.

Theme 3: Ease of use

The final emerging theme centered on the ease of use of the ring sensor in participants' daily lives. Several individuals reported that they often forgot they were wearing the ring, which enhanced their confidence and comfort in moving through daily routines without feeling as though they were part of a study. "*It was very easy. You can wash with it on and shower. Go outside. And it's perfect for me*". Participants were able to complete daily activities like exercising, showering, and recreational activities without any interruption from the ring. Participant 8 explained; "*I don't feel it had any real impact. I used it for most things."* Overall, the ring did not have any negative outcome on participants.

IV. Discussion

This mixed-methods study assessed the usability and acceptance of an AI-powered wearable ring sensor designed to track upper body movements. This study introduces the novelty of assessing a wearable ring device among individuals with dementia compared to those without, whilst evaluating feasibility, usability, and acceptability. We evaluated how well the device met the specific needs of individuals with and without dementia in a LTC facility. We identified factors that influence its overall usability and acceptance. No significant differences were observed in shoulder exercises between the two groups based on the frequency or intensity of the exercises. Similarly, there were no significant differences in the total scores from the technology acceptance or user acceptance questionnaires. However, when examining the specific questions, attitudes towards technology significantly differed, whereas participants with dementia reported a more positive attitude. Prior literature has identified motivation and positive attitudes as key factors when implementing new technologies for older adults [30]. Furthermore, positive attitudes toward active aging have been found to influence learning and

technical skills associated with the implementation of new devices in older adults [31][32]. Recognizing positive attitudes and motivation among participants can be a strength to build on, enhancing feasibility and engagement with wearable technologies.

Prioritizing the assessment of feasibility, usability, and acceptability provides a necessary foundation for the successful integration of new technologies into healthcare and rehabilitation for the aging population. Even if a device demonstrates strong technical performance in later stages, it will not be adopted if it is not considered acceptable to users, practical to implement, or easy to use across diverse populations. Focusing first on these dimensions allows researchers to identify barriers to adoption, cultural or contextual concerns, and potential design improvements that enhance user experience. These outcomes ensure that future research builds on a device that is not only technically promising but also aligned with the lived experiences and needs of its intended users. Understanding differences in adoption and usability between these groups is crucial, as cognitive and functional impairments may influence the device's practicality.

Feasibility, usability, and acceptability were also demonstrated in participant experiences, with three emerging main themes, 1) high ring comfortability, 2) low ring significance, and 3) low ring impact. By integrating both quantitative and qualitative results, this approach enhances the potential for real-world application and informs future advancements in wearable health technologies tailored to individuals with varying cognitive abilities.

Regarding feasibility, both dementia and non-dementia participants wore the ring sensor without removing the device. While the outcomes of this study indicate the high feasibility of implementing such a device among LTC residents, there is still room for improvement regarding the communication of study expectations and end goals between researchers and participants. Based on focus group feedback, it is evident that participant understanding would have been greatly improved had they received more information on the ring's function, as confusion on this front was the primary reported concern. Although the authors note moderate cognitive impairment in this population could contribute to a misunderstanding of the details of the ring sensor, future research should better target digital literacy in older adults [33][34][35]. Nonetheless, the findings indicate that the wearable ring device is a feasible technology for individuals with cognitive impairment, including dementia [1]. Even in the absence of full understanding, passive compliance was maintained, whereby participants still displayed a high willingness to wear the device. These results align with findings reported by Rocha et al., affirming the use of wearable ring devices in older adult populations [9].

Individuals with dementia frequently have cognitive impairment, which might restrict their ability to utilize and accept wearable technology. As a result, while developing such devices, it is critical to prioritize aspects such as ease of use, adaptability, and intuitiveness [5]. In this study, these core aspects were integrated into the ring's design, which significantly enhanced the acceptability of the technology. In this population, individuals often remove or avoid using devices that feel out of place or obtrusive [5][9]. The participants were so comfortable with the ring that after putting it on, they were unaware of wearing it throughout the day. The ability to put the ring on the finger and monitor movements without needing constant adjustments makes the technology highly beneficial in this population. Such simplicity reduces the cognitive load, ensuring that the user does not feel overwhelmed or frustrated [5]. These aspects enhance user acceptability and support sustained use of the device among individuals with dementia.

These findings have important implications for telerehabilitation, particularly for older adults in rural, remote and underserved settings where in-person monitoring is limited. Evidence from recent rapid reviews supports the feasibility and effectiveness of wearable and sensor-based monitoring in delivering remote rehabilitation to populations with limited access to in-person care [36]. The high comfort and acceptability of the AI-powered ring among residents with varying cognitive abilities suggest that similar wearable technologies could be integrated into remote rehabilitation programs to support continuous, unobtrusive movement monitoring. Such integration would enable clinicians to receive real-time data on upper limb mobility without requiring complex user interaction, addressing barriers related to geography, mobility limitations, and cognitive impairment, and thereby promoting equity in access to rehabilitation services. From an ethical perspective, the deployment of AI-powered wearables in these contexts must ensure that data collection, storage, and use respect privacy, autonomy, and informed consent, particularly for individuals with cognitive impairment, while also avoiding the risk of exacerbating digital health inequities [37].

A. Limitations and Future Directions

This study had some limitations that should be acknowledged when interpreting the results. First, individuals with significant mobility restrictions or medical conditions that could interfere with sensor use, such as severe hand arthritis, hand tremors, Raynaud's disease, skin conditions, or previous hand injuries, were excluded. These exclusions were made to ensure the accuracy and reliability of data collection, as these conditions could compromise participants' ability to use the wearable ring effectively or lead to discomfort and distress. As a result, the study's findings may not fully represent the experiences of individuals with more advanced physical impairments, limiting the generalizability of the results to a broader population of people with dementia. Additionally, a key limitation of the study was the lack of data from the wearable ring's app and sensor outputs. Although this data would have enhanced the study by offering insights into the device's effectiveness, this study focused on evaluating user

experience, comfort, and acceptance of wearing the ring device. Validation of the AI-driven functionalities of the ring device, including AI accuracy, kinematic data reliability and user interactions with the app interface, will be examined in future work. The ring wearing protocol was intentionally designed to explore device capabilities in terms of continuous versus fragmented use of the ring. The dementia group partook in sustained ring use, to assess feasibility, given the potential challenges with adherence. However, we acknowledge that this difference in the ring wearing protocol limits direct group comparisons and therefore should be interpreted cautiously. Finally, as a pilot feasibility study, the small sample size limits statistical power and generalizability; therefore, the findings should be interpreted as preliminary. Future studies should consider a larger sample size of individuals with varying cognitive disabilities to assess how wearable technology can be adapted for their needs, including the use of wearable technology interfaces (i.e., applications). This would expand the generalizability of findings and better address the diverse experiences of people living with dementia. The limitations related to the missing data and exclusion criteria are important to consider but do not detract from the study's contribution to understanding the practical application of wearable technology in dementia care. Furthermore, while this pilot study focused primarily on the feasibility of ring wearability, future work should explore the integration of AI to enhance dementia monitoring capabilities more in depth. Although AI was not directly applied to this study, its potential in wearable data could significantly improve personalized intervention strategies.

V. CONCLUSIONS

This study evaluated the feasibility, usability, and acceptability of an AI-enhanced wearable ring for tracking upper-body movements in participants with and without dementia. No significant differences were observed between the two groups in demographics, device-related adverse events, or technology acceptance. Both groups reported similar satisfaction with the device, highlighting its non-intrusive nature and minimal impact on daily routines. Integrating AI capabilities enhances the device's ability to accurately track movement patterns and provide reliable data, making it a valuable tool for real-time monitoring. Given the small sample size, these findings should be interpreted as exploratory, as this pilot study was designed to assess feasibility rather than draw definitive conclusions about group differences. In conclusion, the wearable device was found to be acceptable for both groups. The study underscores its potential for improving care delivery, particularly in dementia care, by leveraging AI-driven data to guide clinical decisions, monitor disease progression, and personalize interventions in LTC facilities.

VI. ETHICS

This study received ethical approval from the Carleton University Research Ethics Board-B (CUREBB). Ethics Clearance ID: Project # 12138. All residents and Substitute Decision Makers (SDMs) involved will provide written informed consent to participate in the study and share their personal XO HEALTH account information with LTC staff.

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IX. CONFLICT OF INTEREST

We have no conflict of interests to declare. *XO Technologies* provided the ring device for the study intervention; however the company did not provide any direct financial support to the study.

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