

Older Adults' Perception of Remote Health Management Technology with ADL Recognition

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Abstract

Activities of Daily Living (ADL) monitoring systems have the potential to facilitate Aging in Place among older adults and decrease the burden of care of caregivers. However, limited work has investigated how older adults might perceive the implementation of such technology. To that end, in this work, we conducted semi-structured interviews with older adults living in a Continuing Care Retirement Community (CCRC) before and after they participated in a week-long implementation of a simulated ADL monitoring system. We describe the thematic analysis of these interviews, finding that residents are open to such a system but have significant concerns over privacy and the specifics of its implementation. Based on this analysis, we present considerations designers should take into account when developing intelligent user interfaces that leverage ADL monitoring.

Keywords

aging in place, older adults, semi-structured interviews

1. Introduction

As of 2022 there were approximately 771 million individuals over the age of 65 globally, a number that is expected to rise to 994 million by 2030 and 1.6 billion by 2050. Their proportion within the global population is also expected to rise from its current level of 10% to 12% in 2030 and 16% in 2050 [1]. This population increase will likely overwhelm caregivers without improving the current healthcare paradigm, as nearly 70% of older adults depend on some form of caregiving, and the “caregiver support ratio”, or the number of potential caregivers aged 45–64 for each person aged 80 or older, is expected to drop from 7-to-1 in 2010 to 4-to-1 in 2030 and 3-to-1 in 2050 [2, 3].

Often, the level and type of assistance older adults require can be determined by how much assistance they require to perform Activities of Daily Living (ADLs), which are fundamental activities people do on a daily basis [4, 5]. ADLs can be divided into two categories: *Basic* and *Instrumental*. Basic ADLs, characterized by care and movement of the body, consist of personal

hygiene and grooming, bathing/showering, toileting, dressing, eating & feeding, functional mobility, personal device care, and sexual activity. Instrumental ADLs, characterized by more complex daily interactions, consist of activities such as health and home management, driving and community mobility, child rearing, meal preparation and cleanup, medication management, and shopping [6]. Generally, if an individual can perform all but one or two instrumental ADLs, they can live in independent living communities. When individuals have more serious physical or cognitive conditions preventing them from performing more ADLs, the individual may choose to live in *assisted living communities* or in the most serious cases need to reside in *skilled nursing facilities*. These communities provide more regular nursing care to aid with the difficulties in performing ADLs. *Continuing Care Retirement Communities (CCRCs)* are a combination of all three of these living options, allowing residents to transition between the types as their ability to perform ADLs and the corresponding need for assistance changes.

In addition to being an indicator of the level of assistance required, ADL performance is noticeably affected by the onset of conditions such as lethargy, weakness, and decreased appetite, which are clear predictors for the presence of an acute illness [7]. Studies have also shown that as individuals begin to require higher levels of assistance with an increasing number of ADLs, they have a higher likelihood of not getting the assistance they need and are at an increased risk of hospitalization, hospital re-admission, and have a higher mortality rate [8].

Currently, the performance of ADLs is predominantly

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tracked manually and directly [9]. Caregivers, family members, or individuals themselves need to explicitly notice a difference in the person’s physical or cognitive abilities for a realization to be reached that the type or level of care required needs to change. Thus if the performance of ADLs could be monitored, it could alleviate this caregiving bottleneck, facilitating aging in place for older adults: both alleviating the burden of care on caregivers and enabling them to provide more person-centered care, and reducing the overall cost of healthcare [10, 11, 12, 13, 14, 15, 16, 17, 18].

In recent years, researchers have explored the use of human activity recognition as a means of automatically recognizing ADL performance. While much of the literature in this space has focused on recognizing the ADL performance of the working-age population, several studies have looked at recognizing the activities of older adults [19, 20, 21, 22]. A few studies have taken this a step further and tested these systems in long-term care facilities, e.g., the Center to Stream HealthCare In Place at the University of Missouri has done a significant amount of work in this space [23, 24, 25].

If actualized, human activity recognition could serve as the foundation of intelligent user interfaces that allow older adults to age more independently, safely, and comfortably and reduce the burden of care on caregivers. However, for these systems to see widespread adoption, it is crucial to properly understand the perspective and opinions of the older adults who would use this technology. To that end, we conducted a user study with residents at a CCRC involving interviews before and after a week-long simulation of participating in a remote ADL monitoring system. In this work-in-progress, we share the results of thematic analysis from these interviews to understand how such technology might be received and what design considerations are necessary to improve chances of successful adoption.

2. Related Work

Designing and developing technology to support older adults has long been an area of interest for researchers. In many cases, the goal of these technologies is to support “Aging in Place”, which entails older adults retaining as much of their independence as possible as they age. These tools can be broadly classified into Personal Emergency Response Systems (PERS), Monitoring, and Check in Systems [26]. Of these groups, PERS are the most commonly used by older adults, generally taking the form of a device that can be worn that has a button users can press in the case of emergencies (e.g., falls). Despite their prevalence, these systems are not popular with older adults. Consequentially, much of the research that has looked at older adults’ opinions on technology

has looked at PERS, with little work investigating the viability of monitoring and Check in Systems [27, 28, 29].

Studies have found that while there are notable benefits to tools to support health management, significant barriers remain that prevent their widespread adoption. Benefits include increasing safety, increasing confidence, providing a support network, increasing social interaction, and providing enjoyment and leisure. Barriers on the other hand include concerns over usability, cost, the need for specialized training, security risks, potential for over-reliance, and privacy concerns [30, 27, 31, 32, 33, 34, 35, 28, 29, 36, 37]. In addition, studies have found that people prefer traditional healthcare caregivers [38] and, in a similar vein, found that people had concerns over the lack of human contact such devices might engender [31, 33, 39].

In this work, we explore the viability of an ADL monitoring system that leverages smartwatches as the sensing medium. We focus on older adults living in personal care, a population that is understudied when it comes to understanding the views of assistive technology among older adults. Furthermore, smartwatches are an attractive medium for providing assistance, as general-purpose systems are generally better accepted than devices dedicated for specific aging assistance purposes [26].

3. Methodology

We conducted a study with five residents living in personal care within a CCRC in the Northeastern USA. These resident’s demographics can be seen in Table 1. The study consisted of a pre-interview, a week-long period during which residents wore smartwatches on both wrists and logged their activities in a written log, and a post-interview. Both pre- and post-interviews were semi-structured and were recorded and subsequently transcribed for analysis.

For this study, we used two Polar M600 smartwatches, one worn on each wrist. We collected accelerometer and gyroscope data from these watches; however, analysis of the data collected from these sensors are not reported in this work. Participants did not have to directly interact with the smartwatches with the exception of putting them on in the morning and taking them off at night; i.e., the data collection happened passively without participant interaction. A researcher visited participants every night of the study to ensure that the watches were charged overnight.

3.1. Pre-Interviews

The goals of the pre-interviews were to understand participants’ current experience using technology and

Table 1
Demographics of Nurses and Nursing Assistants Interviewed

Participant	Age	Gender	Years in Assisted Living
P1	91	M	22
P2	88	F	0.5
P3	92	M	5
P4	91	F	10
P5	66	F	1.16

to gauge their potential acceptance of a technology designed to monitor their ADL performance. To that end, we began the interview by asking participants what types of technology they used, what they liked and disliked about technology, how their use of technology has changed after moving into personal care, if and how they use technology to manage their health, and how they think technology could possibly support them through the aging process. In the last portion of the interview we asked them to imagine that a system was put in place within their facility that recognized their ADL performance and allowed caregivers to monitor that performance. Then we asked them how they would feel about the use of such a system and how it could both benefit and disadvantage both residents and caregivers.

3.2. Post-Interviews

The goal of the post-interviews was to understand how participants felt about the experience of wearing smartwatches over the course of one week and what impact it had, if any, on their opinions of using technology for health management. To that end we asked residents what they liked and disliked about wearing the smartwatches on a daily basis, if their opinion on technology use to monitor ADLs has changed, and what they think older adults in general might think about such a system.

4. Results

We analyzed the interview data using thematic analysis. Three computer science researchers independently coded the interviews, discussed the extracted codes, and settled on final themes. These themes can be found in Table 2.

5. Pre-Interview Themes

Through our interviews, we found that most participants used some level of technology on a daily basis, typically in the form of specific apps and functionality on smartphones and/or tablets. Participants used technology to communicate with their friends and family members,

read the news, shop online, and assist in maintaining an exercise routine. Participants did not use technology to track their own health, with the exception of P3 who tracked a number of health metrics using a combination of their iPhone and Apple Watch. P3 was by far the most comfortable with technology, actively seeking out and learning new technologies to use in their personal life. By contrast, one participant, P1, had no ability to use technology at all. When asked about his technology use he explained:

“I try to limit it [my use of technology] because my ability is not very good for technicalities and stuff like that. They’re not in my heart and mind. [...] Anything that’s really new, I don’t even attempt to do. I stay away from it.”

In general, participants had no desire to learn or use unfamiliar technologies, regardless of their reported comfort level with using technology. Participants either felt that they were too old to learn how to use new devices or expressed that they were content with their daily life and saw no need for new technology. For instance, P2 noted that a close relative bought her an expensive laptop but that she could not get used to it. When asked why she explained:

“If I had gotten to it maybe two years ago I probably would have been fine. But I just did not want to bother with; I was at a loss [as] to how things worked. Now maybe if I was more interested in technology, I would have spent the time to do it. It’s too late for me because I’ve come to technology so late.”

Participants currently use some assistive technology within the facility, most notably an emergency pendant that is worn around the neck. None of the participants liked wearing the pendant, considering it ugly and noting that it has a very limited range. P4 attributed her unwillingness to wear the pendants to personal dislike of the process:

Table 2
Themes from Resident Thematic Analysis

Pre	Post
Selective technology competencies	No issues wearing smartwatches
Strong opinions regarding technology	No change in opinion regarding technology
Criticisms of existing technology	Desire to remain independent
Conscious of health management	Acknowledged utility of remote health tracking

“I don’t, no. That’s just stubbornness. I have it and they keep checking it [...] I believe at least every two months or something they make sure everything works. I don’t wanna hang it around.”

On the subject of health management, participants were generally aware that they were being monitored by caregivers. The most noticeable form of monitoring to them was location during meal times, as caregivers are required to ensure that residents are present in the cafeteria during meals. Other participants noted that caregivers would come around and check vital signs regularly, ensure that residents took medications at appropriate times, and would have a staff meeting in the mornings presumably to discuss residents’ statuses. Participants had mixed feelings about the potential implementation of an ADL-monitoring system. On the one hand, P1 noted that if it was done, he was confident that it would be done for a good reason:

“If it’s important to have it done, then I have it done. [...] Whenever they ask for something this, that, and the other thing, it’s important.”

P5 echoed this idea: although initially comparing such a system to Big Brother, she followed up by noting that it could be beneficial for many of the older adults living within the facility as well as their caregivers. On the other hand, a couple of the participants were against the idea, feeling as if it was too much of an invasion of privacy.

6. Post-Interview Themes

Despite asking residents to wear smartwatches on both wrists, participants had no major complaints with wearing the watches on a daily basis. P1 went as far as to note:

“I didn’t have any feeling one way or the other, they became a part of me. [...] Well the first day I had this difficulty in [using them], but after that it was very easy, then

they were excellent really. Yep, I had no problem with it.”

However, participants did bring up minor issues they had, noting they would like different options for watches as they were a little too big for their wrists, an ugly color, or difficult to put on given their poor eyesight.

When asked if their opinions regarding the implementation of an ADL-monitoring system had changed, participants largely echoed their initial viewpoints, albeit with the added emphasis of wanting to maintain their independence. Both participants who had felt that the system was a step too far noted that they were okay with using such a system but still had reservations about the specific implementation and the privacy implications. P4 was perhaps the most apprehensive about the widespread implementation of the idea, noting:

“I know at our eating table, there are four of us, and we change often with other people, but I know one in particular. I think she was asked but she didn’t want any parts of it because it’s, she feels technology knows enough about her. So, I think that’s a big hurdle for tech people.”

While P3, who already wears a smartwatch daily, expressed that he would be amenable to having his activities tracked and was unsure of how others might react. However, he did offer a potential way of implementing such a system:

“Well, I think people would raise the issue of privacy. I don’t know, I just really don’t know how other people would feel about that. They may feel that the nurses are acquiring too much information. But they can also be motivated to keep up somewhat of a daily routine. You know, if you know you’re being watched you might be more motivated to perform. [...] It might be what difference does it make how much activity I [do]? It’s not the nurse’s business. So I think they have to be oriented to the fact that what you eat, what you do, and activities [you do are] the institution’s business. That’s why you’re here.”

Despite these opinions, participants acknowledged that such a system would be useful for caregivers. P5 provided the following example use case:

“So, let’s say somebody was getting weaker and [...] all of a sudden, you’re not seeing them going around and doing their laps. That I could see, it would help because they’re getting older every—and they’re sitting more during the day. And these people aren’t necessarily talking with their friends on the phone or on the iPad.”

7. Discussion

Intelligent user interfaces that leverage human activity recognition algorithms could be a powerful means of both facilitating aging in place and reducing the burden of care; however, this work shows that older adults will not be convinced to utilize these systems without thoughtful design. In this section, we discuss how these findings can help inform the design of ADL monitoring technologies.

7.1. General-purpose systems are more likely to be accepted

Going into the study, we expected participants to dislike wearing smartwatches on both hands every day, especially considering that the Polar M600 is bulky compared to most watches in general. However, residents’ responses were uniformly non-negative or directly positive, with several even noting that they didn’t normally wear watches but found themselves using the smartwatch just as a watch at times during the study. This attitude represented as a contrast to perception of the fall pendants, which were a source of complaints from all participants. This outcome confirms findings by Caldeira et al., where older adults mentioned they would prefer smartwatches to PERS [26]. Smartwatches also represent a passive monitoring system, as they require no technical interaction to function; this design allows older adults with limited to no technical literacy to successfully use these devices. In summary, it is recommended that the device have utility outside of its health management purpose in order to make the device appealing even to someone who uses little technology in their daily life.

7.2. Allow older adults to customize their personal system

Although participants were broadly positive about wearing the watches, they did have minor issues that could be rectified by offering more options for personalization. An application designed for popular

smartwatch OSs such as Apple’s watchOS or Android’s Wear OS would allow older adults to choose from a number of different watches with a variety of customization options. This design choice creates opportunities for ecosystem synergy with other devices the older adults may own and for selecting a more comfortable watch band. To generalize, providing freedom of choice enables the older adults to pick a watch that matches their personal aesthetics and preferences, providing implicit incentive to wear the watch. Additionally, using commercially available products allows the possibility of loved ones giving the device itself or accessories as a gift, creating an emotional attachment.

7.3. Participation in ADL monitoring should be voluntary

Given the mixed feelings residents had towards the use of ADL monitoring, usage of such systems should be voluntary. This takeaway was even suggested verbatim by one of the participants. As supported by the literature and the analysis from this work, older adults strongly value their own independence and autonomy. While participating in these systems is beneficial to practicing proactive health management, making these systems mandatory will likely lead to resistance and noncompliance. A standout example is the current paradigm of wearing fall alert pendants: several participants flatly refuse to wear them due to negative perception of what they can imply about their current health status. However, this distaste can be mitigated by making the device appealing to use, as discussed, and involving the older adults in the design of the overall system so that they feel actively involved in their own health management. To give specific examples, older adults and/or their family members should be informed what data is being collected, who would have access to that data, and how that data would be utilized. Thus, older adults could decide whether or not they are willing to allow caregivers to have the additional knowledge of their daily activity. As such, the older adults can endorse wearing the device instead of being explicitly required to wear it.

8. Limitations and Future Work

This work represents an initial exploration on this topic due to a small sample size. To strengthen the contribution of these findings, this experiment will need to be repeated at other facilities with more participants.

9. Conclusion

While ADL monitoring systems offer a powerful means of ensuring that older adults are able to age comfortably, independently, safely, work still needs to be done to ensure that these systems are broadly accepted by older adults. To that end, in this work we present the results of a thematic analysis on semi-structured interviews conducted with older adults living in a CCRC before and after they were asked to wear smartwatches daily for a one-week period. We find that while older adults are amenable to such systems, they have significant concerns over their intrusiveness into their day-to-day lives and the implementation of such systems. Based on these findings, we describe key considerations for designers of ADL monitoring systems.

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