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Review article

Aging barriers influencing mobile health usability for older adults: A literature based framework (MOLD-US)

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ABSTRACT

Background: With the growing population of older adults as a potential user group of mHealth, the need increases for mHealth interventions to address specific aging characteristics of older adults. The existence of aging barriers to computer use is widely acknowledged. Yet, usability studies show that mHealth still fails to be appropriately designed for older adults and their expectations. To enhance designs of mHealth aimed at older adult populations, it is essential to gain insight into aging barriers that impact the usability of mHealth as experienced by these adults.

Objectives: This study aims to synthesize literature on aging barriers to digital (health) computer use, and explain, map and visualize these barriers in relation to the usability of mHealth by means of a framework.

Methods: We performed a scoping review to synthesize and summarize reported physical and functional age barriers in relation to digital (mobile) health applications use. Aging barriers reported in the literature were mapped onto usability aspects categorized by Nielsen to explain their influence on user experience of mHealth. A framework (MOLD-US) was developed summarizing the evidence on the influence of aging barriers on mHealth use experienced by older adults.

Results: Four key categories of aging barriers influencing usability of mHealth were identified: cognition, motivation, physical ability and perception. Effective and satisfactory use of mHealth by older adults is complicated by cognition and motivation barriers. Physical ability and perceptual barriers further increase the risk of user errors and fail to notice important interaction tasks. Complexities of medical conditions, such as diminished eye sight related to diabetes or deteriorated motor skills as a result of rheumatism, can cause errors in user interaction.

Conclusions: This research provides a novel framework for the exploration of aging barriers and their causes influencing mHealth usability in older adults. This framework allows for further systematic empirical testing and analysis of mHealth usability issues, as it enables results to be classified and interpreted based on impediments intrinsic to usability issues experienced by older adults. Importantly, the paper identifies a key need for future research on motivational barriers impeding mhealth use of older adults. More insights are needed in particular to disaggregating normal age related functional changes from specific medical conditions that influence experienced usefulness of mHealth by these adults.

1. Introduction

The extensive functionalities of current smartphones, tablets and other devices allow the development of mobile health applications (mHealth) to thrive; it is estimated there are 259,000 mHealth apps in the major app stores from 2016 onwards [1–3]. This boost in innovation finds its foundation in the potential of mHealth to assist patients in self-management of diseases and independent living [4,5]. For the older adult patient population, this advancement is especially important as risks for functional decline and loss of independence increase with normal aging and accumulation of chronic diseases, approximately from the age of 50 and onwards [6]. MHealth apps may provide medication assistance by prompting alerts, provide self-care advice to patients, facilitate self-monitoring of various biometrics or educate patients on disease outcomes [1,7]. These mHealth advances align well with the upcoming interest of older adults to integrate technologies into their own health care [1,2].

Despite the interest and intention of older adults to use mHealth, studies report that actual usage and adoption of mHealth amongst this patient population is low and inconsistent [4,8,9]. When mHealth is aimed at older users, it is important to understand specific facilitators and barriers potentially impacting acceptance of mHealth by this population. Prominent technology acceptance models such as the Unified Theory of Acceptance and Use of Technology (UTAUT) and the Senior Technology Acceptance Model (STAM) provide a theoretical basis for this [4,10]. These models define usability and usefulness as important constructs impacting user acceptance, as well as age as a moderator of these constructs.

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Yet these models fall short in defining which age-related barriers and facilitators influence usability and usefulness of technology, and how. Furthermore, several studies on older adult acceptance of mHealth emphasize the importance of user-centered interface design and clear user instructions [2,5,11]. However, these studies do not disaggregate the specific aging characteristics and barriers faced by older adults related to the encountered usability issues that influence their acceptance of mHealth. A more detailed understanding of how aging characteristics of older adults' affect mHealth usability and usefulness is thus valuable to facilitate mHealth adoption – as well as to ensure safe and effective use of mHealth by this population [9].

For almost two decades it is known that older adults interact differently with information technology compared to younger people [12,13]. In 2000, design guidelines to enhance website interfaces and desktop computer usability attuned to older adults' cognitive abilities were published [14]. Smith et al. have likewise reported motor control barriers in relation to older adults' performance of computer mouse tasks [15]. At the same time, literature on this topic remains fragmented across different domains, and mostly focusses on older technologies (such as computer desktops) that preceded the introduction of smartphones, tablets and other modern devices.

Design issues related to user data entry and screen size of these earlier technologies cannot automatically be applied to mobile devices. Although aging barriers experienced by older adults may remain the same, the effect of these aging barriers differs for the use of modern devices compared to preceding technology use. Research on touch screens for example, shows a reduction of cognitive and physical workload of older adult users because the interface on the display can be directly controlled with one's fingers [9]. The direct input on the interface of large touch screen devices, such as an iPad, make the software installed on those devices easy to use for older adults [16]. Certain design aspects of mobile devices may have the opposite effect and hamper, instead of support, older adult usage. To recognize icons and interpret their functionality as buttons within the interface of apps is problematic for older users since they may be more familiar with website interfaces having different and larger buttons. Therefore, they might fail to locate relevant information that is only visible after clicking an icon [17].

Age is not only associated with normal physical decline that poses a barrier to effective mobile device use, it is also associated with the development of multiple chronical diseases and related impairments [18]. Developers of apps for diabetes patients for instance, should be aware that diabetes is most prevalent in people aged 65 years old and above and more prevalent in low literate people than in high literate people [19]. Furthermore, one of the complications of diabetes is a diminished eye sight [20]. Designers should thus be aware of these kinds of complexities of user populations and take these into account in developing mHealth apps. At present, these disabilities and complexities of older adults (with chronic conditions) are often overlooked. This results in mHealth apps that consist of many hard to understand features, thereby decreasing their usability for the older adult target group [7,8] and are more susceptible to induce user errors and thus to comprise patient safety [21].

This fragmentation of knowledge on aging barriers across various medical domains combined with knowledge gaps regarding mHealth design in the context of older (chronically ill) adults, pose a key barrier to improving (safe) use and adoption of mHealth by these user groups. This paper aims to synthesize and centralize knowledge on aging barriers in mHealth by relating complexities of medical conditions to their influence on mHealth user experience. We conduct a structured scoping review to synthesize and explain aging barriers to usability of mHealth by older adults. To map and visualize the review results we suggest a framework of these barriers and complexities associated with chronic diseases, and their potential impact on specific usability aspects of mHealth. The framework aims to support designers of mHealth and to improve analysis of usability evaluation studies.

2. Methods

We performed a scoping review as such a review provides a rigorous and transparent method for structured mapping of a certain research domain [22]. This is important because existing literature on aging barriers influencing mhealth usability is fragmented across technologies, health concerns and age groups, and lacks a comprehensive and up-to-date synthesis for older adults. We first identified and examined key literature on aging barriers that may hamper hardware and software use by older adults by prominent authors in this field. Based upon this key literature and the snowballing method, we identified (common) medical conditions related to specific aging barriers. We then performed a literature search to assess if the aging barriers were addressed in articles on older adults' user experience of healthcare systems, including mHealth usage. We searched four databases – PUBMED, EMBASE, ScienceDirect and WebofScience – for relevant publications using the following search terms related to aging barriers and digital user experience: *aging, elderly, older adults, usability, experience, adoption, barrier, barriers, eHealth, mHealth, mobile health* and *computer (use)*. We reviewed the identified articles based upon their relevancy to usability and usefulness of consumer healthcare hardware and software. Studies were included in which: 1) study participants = > 50 years; and 2) aging barriers were mentioned related to interface design/usability of computers, eHealth or mHealth. Studies were excluded if they reported on 1) participants < 50 years old or if mean age was below 50 years old; and 2) adoption/acceptance of eHealth/mHealth by older adults without mentioning usability issues. Author GAW screened for title and abstract. Full text reviews were independently performed by authors GAW and LDP, any disagreements on inclusion of articles were discussed until agreement was reached.

We performed a thematic analysis to capture and synthesize the data from the included studies. To map reported user experiences of older adults to aging barriers categories, we used the five usability aspects that influence user experience, as defined by Nielsen: learnability; efficiency; memorability; errors; satisfaction [23]. Finally, we developed a framework to visualize the aging barriers, and medical conditions related to those barriers, and their possible influence on usability aspects of mHealth.

3. Results

3.1. Aging barriers for mHealth user experience

Four aging barrier categories were identified in key literature of Holzinger, Rogers & Fisk, Cjaza as well as the W3C [24–27], which we use to organize our findings: (1) cognition; (2) physical abilities; (3) perception; (4) motivation. Appendix A shows the 23 included studies of the scoping review. Information regarding prevalence of age related barriers is mostly described in literature for the elderly age cluster (65+ years old); therefore we provide prevalence numbers for this target group only. Tables 1–4 list the diminishing age dependent abilities and their impact level on usability per aging barrier, and include relevant (common) medical conditions related to each specific barrier. These medical conditions involve diminished cognitive, physical, perceptual or motivational capacities as a complexity of a medical condition.

3.1.1. Barrier 1: cognition

Cognitive aging barriers are related to a reduced capacity of working, prospective, semantic and procedural memory as well as attention [28–34], which may all negatively influence software use. Moderate to severe impairments affects 15% of men aged 65+ and memory impairment affects 11% of women aged 65+ [35]. The impact of age is that older people can process fewer discrete information bits in a given time, and recall also decays faster [28]. For example, recall of future based time-based tasks (such as taking a pill after 4 h) becomes more difficult [28,36]. In addition, older people need more time to learn new skills [24,25,28]. Mentally transforming spatial information becomes more difficult with age and influences computer task performance negatively [28,36,37]. In addition, a decline in numeracy and representational fluency hampers older adults in understanding content specific to eHealth and mHealth interventions, such as tables and charts on biometrics [33,38,39]. Cognitively impaired older adults showed a significantly smaller percentage of task success than