A Comprehensive Review of Mobile User Interfaces in mHealth applications for elderly and the related ageing barriers

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Abstract

Purpose:

The adoption of mobile health technology can assist in enhancing the quality of life of elderly people. Over the last few years, though mHealth research has expanded, the usage of mHealth applications among elderly is still minimal. This study aims to evaluate mobile User Interfaces in mHealth applications and elicit the key ageing barriers that limit the use of such apps amongst the elderly.

Methods:

The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) technique was used whereby 28 papers were identified and examined out of 742. In addition to the systematic review, an experiment of using 5 existing mHealth apps, was conducted with 10 individuals within the age-group of 60-79 to determine additional ageing barriers and usage challenges. The Questionnaire for User Interface Satisfaction (QUIS) approach was used to prepare a questionnaire to assess the overall system satisfaction and was provided to participants after one week of usage.

Results:

In this work, issues with the user interface that impact the elderly have been highlighted. Three important ageing barriers hindering the use of mHealth among the elderly have been identified via PRISMA, namely: physical, cognitive and perspective. Empirical findings from the experiment carried out further consolidate the findings obtained from the PRISMA approach.

Conclusion:

This study's investigation emphasised on the performance of older persons with mHealth apps, their needs, and the challenges they confront when adopting mHealth technologies. As a result,

technology designers will benefit from this information when developing and designing mHealth apps and services that are suitable for older adults.

Keywords: mHealth app, ageing barriers, User Interface, elderly care, usability

Statements and Declarations

On behalf of all authors, the corresponding author states that there is no conflict of interest.
Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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1. Introduction

Increasing population ageing has become a global phenomenon in recent years [1]. People aged 60 years or over are considered as ‘old’ [2]. Globally, in 2020, there were 727 million people aged 65 and up. This part of the population is expected to grow from 9.3% in 2020 to approximately 16% in 2050 [3], with 80% of them residing in low- and middle-income areas [1, 4]. The world's population is anticipated to reach 8.5 billion people by 2030 [3]. Generally, senior people suffer from a variety of health issues due to ageing. Age-related illnesses, including poor mental health, can cause depression or anxiety [2]. One of the common age - related diseases is cognitive ageing barriers, which result in a decreased working memory ability. As a result, they struggle to recall and can only process a limited amount of information at a time. Physical ability is another prevalent barrier, where a decline in motor abilities makes it challenging for them to use a mobile phone. Perception is a third ageing barrier: as people age, their eyesight and hearing abilities also deteriorate [20]. In comparison, today's elders have a higher life expectancy [3] as they have access to better health-care services than their ancestors did. The development of information and communication technology also adds to the improvement of elderly people's well-being [4, 5]. With this growth in elderly population, it has become increasingly vital to create a good sustainable existence for the elderly's well-being [1].

As the population ages, digital health tools and mobile health (mHealth) applications are becoming more common to help older people live independently and maintain their health [6, 7]. For senior

people, using mHealth applications is more convenient than regularly scheduling appointments with doctors. The risk of cross-contamination brought on by close contact can be decreased by mHealth applications by limiting appointments. Additionally, it might increase access for elderly individuals who cannot afford to visit doctors due to displacement, which might be inconvenient for them, or other health issues [52]. The huge increase in the number of senior citizens emphasises the necessity to create technologies specifically for this group in order to meet their health needs [8, 9]. mHealth applications have the ability to enhance the lives of the elderly and provide effective care, allowing seniors to be more self-sufficient and autonomous in their health management [4, 10, 11]. mHealth services can help elderly individuals maintain their health if they are adopted and used by their intended audience [7, 12].

The World Health Organisation defines mHealth as the delivery of medical services and information using mobile devices such as smartphones, tablets, wearable monitoring devices, and other wireless devices [12 - 15]. mHealth is a technology that uses mobile communication technologies to provide healthcare support [4, 12]. They provide a variety of benefits to aged people and can improve their lives by helping them to live independently for longer periods of time [15]. The scope and availability of mHealth have risen rapidly in recent years, thanks to the growing availability of mobile devices and internet access [13 - 16]. There are over 250,000 mHealth applications currently available to consumers since 2016 [13 - 15].

Regardless of the fact that mHealth is becoming more widely available, certain areas in mHealth applications for the elderly require more attention, for example more flexible User Interfaces for elderly users. Due to the specific barriers associated with ageing that the older population faces, the design of current mHealth applications may limit the adoption of mHealth in this population [14]. Adults aged 65 and older are frequently excluded from these studies. As per recent studies, individuals over the age of 65, adopt lesser new technology compared to younger adults [15, 14]. Despite the fact that mHealth applications are available and have potential advantages, their adoption among the elderly is still low [10, 17, 18]. *Although technology adoption/acceptance among older adults is not a new topic, studies on mHealth adoption among older people are far fewer than those on general technology adoption among older people* [51]. Despite having 95% smartphone ownership, [51] came to the conclusion that older people's adoption of mHealth is less than 50%. The study carried out by [11] shows that only 13% of the participants chose to use a health related app. Although an increase in equipment possession and usage among the elderly is recorded, mHealth usability and engagement have stayed at an average level, and older adults' adoption of technology constantly lags below that of younger people [4, 14, 15, 19]. Just owning a smartphone is not sufficient to assure mHealth adoption from the elderly. Many constraints specific to older persons, as well as current smartphone design, may hinder mHealth adoption in this group [14]. When reviewing the usability of mHealth for older persons, ageing obstacles must be taken into account, as these have a significant influence on the UI challenges they face [20]. According to the European Union (EU) Commission's 2021-2027 Health Programme, the existing

mHealth industry lacks user-friendly software and applications, particularly for older persons who have usability issues with mHealth use [7, 21]. The views of the elderly on the usage of mobile applications for health-related objectives are still to be thoroughly explored.

Having mHealth apps more acceptable to older persons is essential, considering that the ageing population has become a worldwide concern [11] and mHealth applications can promote healthy ageing of elderly [16]. When it comes to connecting with mobile applications, older individuals face numerous barriers. As the population ages and seniors' usage of technology grows, the usability of mobile interfaces for older persons becomes increasingly important [22, 23]. As such, it is crucial to investigate old users' perceptions towards mHealth apps user interface (UI), so that researchers and app developers may better design future mHealth apps that are usable, effective, and acceptable by aged people [9]. However, developing an interface that is well-accepted by the older population has proven to be difficult [14].

The current work explores the user interface challenges experienced by the elderly, as well as the ageing barriers impacting their utilisation, by examining existing literature and taking into consideration the rising relevance of mHealth that can serve older persons in today's digital age. The data acquired will be conducive towards improving the design and development of applications for senior citizens. The rest of the paper is structured as follows. The study's major objectives are described in Section 2. Section 3 presents the research methodology. A research background is presented in Section 4. Section 5 includes an assessment of the studies evaluated as well as an experiment carried out with 10 participants. The interpretation of the data from Section 5 is detailed in Section 6. The findings are discussed in Section 7. The conclusion is presented in Section 8.

2. Objective

Today, the number of elderly people is growing globally, and they require assistance in their daily life. With the advancement of technology, an mHealth app may indeed be able to support the elderly in the future. However, it is necessary to have mHealth apps which are adopted for continuous usage. Studies have been conducted in the past, however, this study differs from other PRISMA studies, as this one is focused on mHealth apps for the elderly. The study identified dominant UI issues, usability elements and ageing barriers preventing older individuals from adopting current mHealth apps. For this study the following objectives have been set:

- To identify the most dominant mobile UI issues;
- To identify the ageing barriers affecting the elderly use of mHealth applications;
- To identify the most influential usability elements for elderly users.

3. Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 review is a mixed-methods systematic review, which includes both quantitative and qualitative studies, was used to conduct a review on the existing mHealth applications. PRISMA has been chosen as it has been devised mainly for systematic reviews of studies evaluating the effectiveness of health interventions, regardless of the design of the included studies [24]. PRISMA criteria were used for the selection, information, and analysis of research papers. In order to further consolidate the findings from the review, an evaluation of User interfaces was carried out with 10 participants. QUIS questionnaire has been used to obtain their responses. The experimentation process is elaborated in detail in Section 5.2.

PRISMA was chosen as it demonstrates a transparent review. Moreover, PRISMA has a checklist which helps reviewers to identify the key points and establish the study's replicability [54]. Also it includes both quantitative and qualitative studies [24]. There are other review methods, such as Kitchenham [55], however for this study PRISMA seemed to be more appropriate.

3.1 Search Strategy

Studies have been identified in two digital libraries namely, ACM and Google scholar, utilising a combination of search strings with the operands OR and AND. The search strategy included the use of terms relevant to the study's objective. These terms were then applied for searching the abstracts of the articles and the search results were restricted to the years from 2012 to 2022.
On Google Scholar, the keywords were searched in quotes, in order to receive papers relevant to that topic only. Google Scholar was selected as it allows searching papers that are available on various platforms, such as Science Direct and Taylor & Francis [25]. ACM has been chosen as it provides multiple types of publications, including journals and conference proceedings and has papers related to the topic being reviewed [26].

Table 1: Number of Papers obtained

Search Terms	Number of Results obtained
ACM	
mHealth application AND User Interface AND elderly	217
mHealth application AND User Interface AND elderly AND mobile app	44
mHealth app AND elderly AND user interface design	25

mHealth app AND elderly AND user interface AND ageing barriers	10
Google Scholar	
"User Interface" + "mHealth app" +"elderly" +"aging barriers"	13
"Aging barriers" + "mHealth app"	41
"mHealth application" AND "User Interface" AND "elderly"	261
"Usability elements" AND "User Interface" AND "elderly" AND "mHealth"	7
"Barriers to mHealth Adoption"+ "Older Adults"	95
"mHealth app" + "User Interface design" + "elderly people"	29

3.2 Study Selection

The study selection was conducted using the PRISMA flow diagram and articles were selected according to the following inclusion criteria:

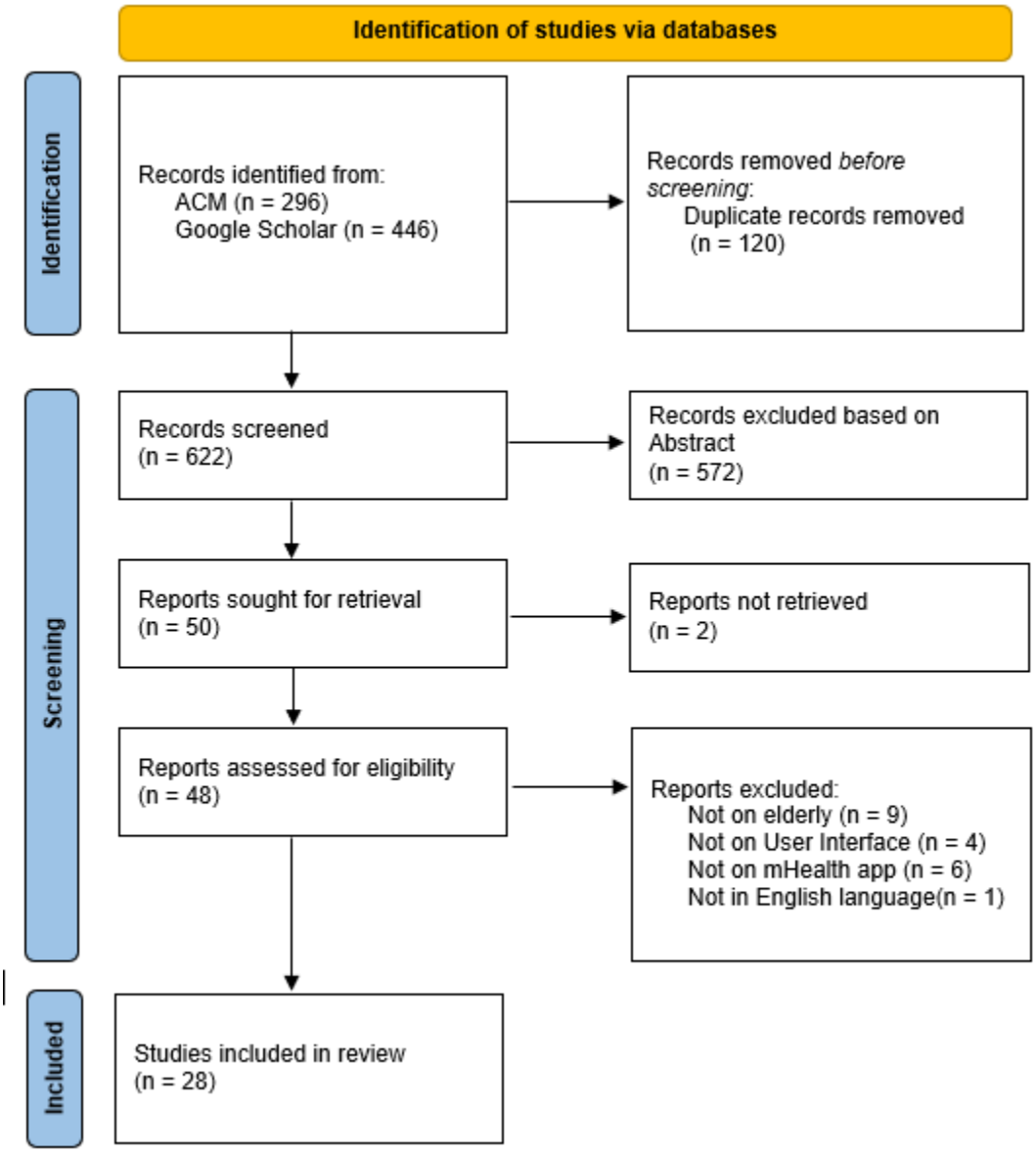
- The studies are in the context of mobile User Interfaces for mHealth;
- Papers include mHealth applications for elderly people;
- Studies published from 2012 to 2022;
- The Papers written in English language.

Duplicates of the same studies were removed, and the abstract of the selected papers were reviewed and those which did not meet all the inclusion criteria were rejected. Bias has been removed by applying the first two inclusion criteria in the abstract section, where the paper must be related to User Interfaces for mHealth in the context of elderly users. The full text of the selected papers was then self-reviewed and during the review, any paper which seemed to be irrelevant to the study was excluded. Self-review was opted as we are more familiar with the topic and might be able to reach more conclusive results than independent reviewers. Also, taking part in the review process enriches our perspectives and this helps in the evaluation experiments carried out. The possibility of bias has been reduced owing to clear defined objectives, which have made it easier to avoid missing out publications and information that may be useful. All aspects of user interfaces, mHealth and elderly were taken into account during the review, and both positive and negative

outcomes were considered with corresponding references so as to avoid any bias. Moreover, all findings were taken into account while drawing the conclusion in order to avoid bias. In total, 28 papers have been selected after the review of the full papers.

Figure 1 presents a flowchart of PRISMA for the paper selection process.

Fig. 1 *PRISMA paper selection flowchart*

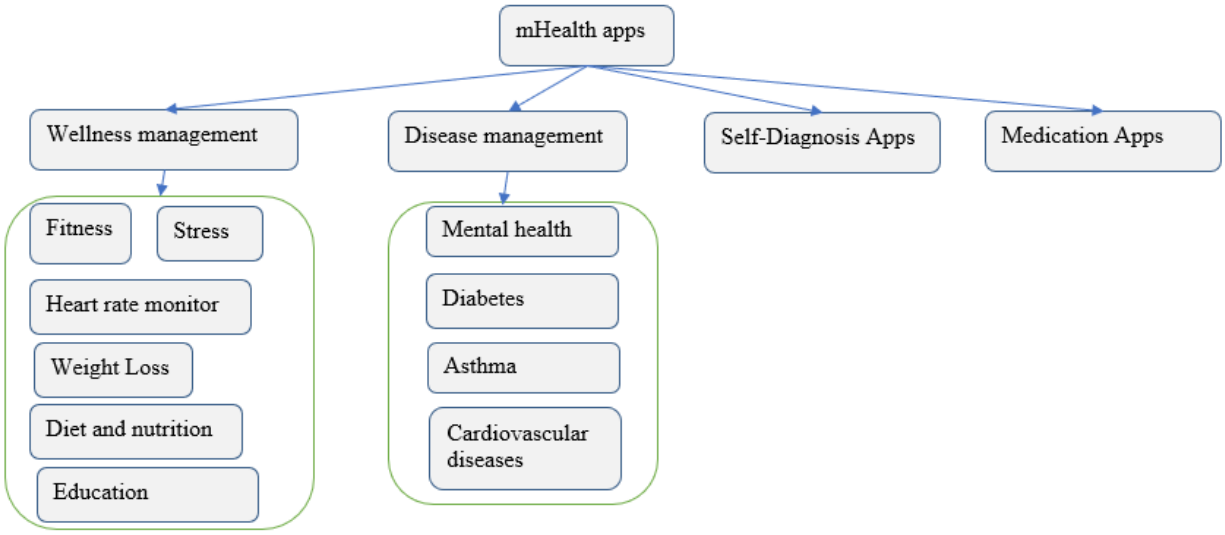


4. Research Background

Today, smartphones are important for health-related aspects, especially for older individuals [4]. Mobile health, commonly known as mHealth, is described by the Global Observatory of eHealth survey (GOe) as the health practice of the medical field and the general population [4]. The use of mHealth applications has the potential to enhance the health of older adults. These applications are designed to enhance a person's health attitudes as well as their overall health, allowing them to be more self-sufficient and autonomous in their health management [4, 27]. However, as compared to younger age groups, the usage of smartphones is proportionately fewer in the population over 60 years old [28]. According to the World Health Organisation (WHO), in today's society, an individual's life expectancy has increased, and by 2050, the world's older adult population is expected to increase to 16% of the total population [3]. mHealth applications can assist the elderly to live independently and manage their health [7, 16].

There are numerous categories of mHealth applications which have been identified from the review of several papers, where the most common and repeating ones are illustrated in Figure 2 [16, 29]:

Fig. 2 *mHealth apps Categories*



Wellness management applications include apps related to diet and nutrition, fitness and weight loss amongst others. The use of these applications has shown to have a favourable influence on encouraging a healthy lifestyle for the users. However, when it comes to the usefulness of these applications there are varied results, since not all of them appear to be of high quality based on results of several previous systematic reviews. One of the rising areas of interest in mHealth applications is disease management applications. These applications are available for a variety of diseases, including diabetes, asthma, and mental health. Self-diagnosis applications can be

particularly useful during emergencies. They allow consumers to describe their symptoms in the attempt to have a preliminary diagnosis without having to see a doctor. Medication has been a common health care concern, as many patients forget to take their medication in time and as a result are hospitalised. Medication applications allow users to enter details related to their medication and the respective schedules and the users are notified when they are required to take their medication [16].

In recent years, more user-friendly interfaces, tools, and usability features have been created to reduce the UI challenges that the elderly encounter and to also encourage them to utilise these technologies. However, there is still a gap that has to be filled in order to persuade the elderly to utilise mHealth applications. There are quite a variety of factors that prevent them from using the application, including cultural challenges, learning difficulties, and ageing barriers such as physical and cognitive limitations [28].

[30] proposed the idea of mid-air gestures as a potential solution to touch gesture issues. Elderly users suffering from dexterity issues may encounter some pain when using touch gestures. This technology, however, is still in its early stages and lacks robustness and user-friendliness. Furthermore, it appears that this technology only works under specified environmental working conditions.

Usability, related to the user interface, appears to be one of the essential criteria for older people's adoption of technology. According to the European Union (EU) Commission's 2021-2027 Health Programme, the existing mHealth environment lacks user-friendly tools and services, and especially elderly individuals, have usability issues while using mHealth [7].

Ageing is a continuous process that starts in adulthood and results in physiological, cognitive, and emotional decline. The elderly's health is closely connected to their capacity to manage their own lives or care for themselves, and it is dependent on four functional domains: cognition, humour, mobility and communication. In addition to physical and cognitive impairments, older users struggle with involvement in seemingly basic tasks like reading text or clicking on an image [28]. When designing the UI for an mHealth elderly app, these factors must be taken into account, since they have a significant influence on the usability issues that the elderly face [7]. Moreover, mobile devices present their own obstacles and constraints, such as a tiny screen, restricted input possibilities, processing resources, and battery supply [28].

5. Evaluation

The current section contains findings pertaining to the objectives of the study and is divided in 2 sub-sections namely, the literature review and the experimental evaluation. The literature review consists of the findings related to the aims/objectives of this study, obtained from the review of

the 28 papers selected using PRISMA. The experimental evaluation depicts the details of the experiments that were carried out with the elderly.

5.1 Literature Review

The literature review is based on the 3 core objectives (defined in Section 2) for this study and is divided into three subsections accordingly.

5.1.1 The most dominant mobile User Interface issues

According to [31], older people prefer numerical applications over animated apps. They expressed satisfaction with the use of Numeric rather than diagrammatic representations. Their research also found that applications should consider the user needs and be visually appealing to attract a broader audience [31].

[32] presented a prototype based on participant responses to a survey focusing on the use and design of mobile applications. The authors used a total of eight criteria to consider in their prototype, in order for it to have a higher preference among the elderly. The criteria considered were: font size, visual media to communicate information, simple and clear language, additional content to help understand, key information centralised, presentation links, menu options with enough space between them, colour contrast and information overload [32].

[33] compiled a summary of existing design guidelines for older users, including web and touchscreen interfaces. For the evaluation, they combined the guidelines they had collected. The collection of guidelines was then assessed by four experts in the fields of usability and user interface design, who reworded, merged, or rejected the guidelines. This procedure was repeated until all of the experts reached a consensus. After the procedure, 111 guidelines were confirmed. A total of 68 experts were then approached for a review of the selected guidelines, however only 7 examined the whole list. They found that 44 of the 111 criteria were more significant. Those deemed more important were the ones with large icons, legible fonts, easy navigation, colours, and clear messages.

[34] carried out a usability test on three popular Thai job applications with the elderly. They obtained common findings, that owing to the complexity of the UI design, which comprises various factors such as text size, navigation, and visual design, most senior people have difficulty utilising an app. The authors concluded that the words should be spaced evenly, with a line spacing of 1.5. Furthermore, there should be more contrast between the text and the background colour and simple navigation systems should be employed. They also stated that these factors, if adopted, will reduce the user interface challenges faced by the elderly.

[35] investigated Human-Computer Interaction (HCI) among the elderly as an overall experience as technology users. Some individuals were chosen to do certain activities in order to better understand their issues. One common issue encountered was the size of the keyboard, where the letters are too small and too close together for them, so they require larger icons.

The choice of colour and contrast in user interfaces influences the preferences of the elderly. It is advised to employ a high-contrast mix of bold colours [15]. Most people with little experience with mobile devices will miss the available links or icons. Designs should be interpretative, concrete, and straightforward [36].

The following are some suggestions for the design of mHealth apps for the elderly [22]:
1) The navigation must be simple, clear, consistent, and simple to grasp;
2) Give explicit and clear directions for each phase of the procedure;
3) The font, button, and icon sizes should be large enough for end users to interact;
4) Refrain from using scrolling and spinner;
5) Use of high contrast colour to allow for ease of use and legibility of information.

These design recommendations have the potential to improve the adoption of mHealth among the elderly.

[1] highlighted certain factors that impede the adoption of mHealth applications among the elderly. For instance, it is difficult for an elderly person to view small text on a small screen and it is not advisable to use tiny icons. The absence of colour contrast between the text and the background is unappreciated aesthetically. The elderly have a preference for simple apps that cater to the reality that they are individuals who are not experienced with technology. Thus, having a complicated app with numerous functionalities is an obstacle for them. [1] mentioned that the elderly also had difficulty altering or customising the user interface to meet their needs. Furthermore, user engagement is boosted when the UI design adheres to the needs of the elderly.

[37] discovered mHealth obstacles as well. A two-conference and an online survey were conducted. The major hurdle, according to their results, is the User Interface. The user interface is not suited for senior citizens as the text and screen are too tiny for them. To assist the interaction of elderly people with the app, the authors suggest employing bigger text, auditory feedback, and notification systems [37]. [13] suggests integrating recent voice assistants systems in mHealth applications, such as Siri and Alexa, as it will be easier for older populations to communicate their actions vocally.

[38] analysed elements of prior work of senior user experience evaluation in digital health technology and then developed a research design plan for this study. Any app interface should be customised to the preferences of senior users, such as having larger buttons and text, an uniform layout, a simple font type and icon, and high contrast colours. The terminology must also be chosen carefully to guarantee that it is not confusing and that the elderly can grasp it. All digital health applications should avoid providing unnecessary information that might clutter the screen and be useful and simple to use for the aged. Several studies stress the necessity of creating digital health technology with simplicity in mind, since this may better suit the needs of senior users. In addition, the application should feature easy actions that the elderly may learn on their own.

Table 2: UI issues and observations

References	UI Issues	Observations
[22, 32- 34]	Complex and unclear navigation	Prefer to have clear directions, simple and consistent navigation
[10, 22, 32, 34, 37, 38]	Font size/Text size not large enough for readability	Words should be spaced evenly, with a recommended of at least 1.5 line spacing for end users to interact. Difficult for an elderly person to view small text on a small screen, larger text are preferred.
[32, 33, 38]	Language/clear message	Simple and clear language. The terminology must also be chosen carefully to guarantee that it is not confusing or ambiguous.
[10, 22, 33, 38]	Small icons/buttons	It is advisable not to use tiny icons The button, and icon sizes should be large enough for the elderly to be able to click on it.
[33, 38]	Non-legible fonts	Simple font type is recommended for easier readability
[15, 22, 33, 34, 38]	Colour combination	More contrast between the text and the background colour is required. Employ a high-contrast mix of bold colours for ease of use and legibility of information.

5.1.2 Ageing barriers affecting the elderly use of mHealth applications

Ageing is a normal and ongoing process that begins around the age of 30 and becomes more intense over time [28]. These changes occur on three levels: biological, psychological, and societal. It is clear that the elderly have limits while interacting with technology equipment, mostly due to age-related concerns such as vision, hearing, motor, cognitive, and haptic disorders [35].

One of the key factors influencing the usage of mHealth apps among the elderly is age-related cognitive impairment [15, 18]. This barrier is associated with decreased capacity of working, prospective, semantic, and procedural memory capacity, as well as focus, all of which may have a detrimental impact on software use. The impact of ageing is that older persons can process fewer discrete information pieces in a given amount of time and recalling declines quicker as well. These individuals demand more time to accomplish a task and find it more difficult to complete successfully. Some 15% of males aged 65 and up have moderate to severe impairments [20]. According to recent standards, cognitive load should be decreased in order to meet the needs of older persons by providing interfaces with features such as easy navigation. One strategy for this is to employ fewer steps wherever feasible and to automate some of them [15]. According to [39], participants are more likely to adopt mHealth if it is simple to use, with only a few steps. So, in order to improve the learning process of older adults and boost mHealth adoption, mHealth technology should be designed to be simple to use and take just a few basic steps to function [39]. Elderly also reported difficulty in remembering passwords and new information [10, 37]. Large amount of information is perceived to be overwhelming [1]. In a usability research, cognitively impaired older persons had a much lower proportion of task success than unimpaired older adults. This was mostly due to the use of ambiguous wording [20]. The constant use of terminology is advised since it may prevent misunderstanding among the elderly who are unfamiliar with technological terms [15]. Because the elderly lack experience and understanding in terminology and may not use as many slang words as the younger generation, so the user interface should consist of familiar language and has a direct meaning. An application that provides clear and familiar terms for the elderly can assist them in performing successfully [36].

Physical ability is a second major barrier that has a negative impact on software adoption. These age-related problems, such as reduced motor skills, make clicking on small buttons on interfaces more difficult, and rheumatoid arthritis can make holding a device in one hand painful [13, 14, 20] Simple task moves are advised to be designed for these users [14]. Indeed, the aged have slower movement and reflexes, tighter muscles and joints, and decreased balance as they age. According to the Center for Disease Control and Prevention, more than 75% of Americans aged 65 and over have trouble with functional ability. These limitations may have an impact on learning duration, performance speed, and even failure rate [20]. Due to their declining motor abilities, the elderly favour having all icons on a single screen with no need to scroll. Such icons should be large enough

to allow for less accurate motor control. However, more insight is needed, to balance the functionality and simplicity of mHealth applications for older persons [15].

Design must take into account the fact that the elderly confront age-related visual changes such as decreased visual acuity, reduced contrast sensitivity, decreased capacity to concentrate on near and distant objects, and glare issues [15, 20, 36]. It is claimed that 21% of the American population over the age of 65 have a visual impairment, such as macular degeneration or bifocal glasses, making viewing a digital screen challenging [15, 20]. Age-related macular degeneration is a kind of vision loss caused by retinal damage. As a result, a shadowy void appears in the middle of a patient's field of vision [15, 40]. Older individuals require more light to see clearly, their motion estimation and peripheral vision are impaired (tunnel vision). According to The Royal National Institute for the Blind (RNIB), 15.8% of elderly aged 65-74 years have eyesight impairment which affects their daily life [20]. To engage this sort of user, a display with appropriate lighting and colours must be implemented [36]. Elderly with decreased visual acuity find the size of icons and texts on mobile apps difficult to read and recommend that their size be raised or that the contrast between the text and the background be increased to allow for ease of reading of information [15, 22, 39]. In a study carried out by [41], 46.8% of the participants reported that they find it difficult to use smartphone screens due to eye strain. Some studies propose the zoom option, which allows the user to adjust the text or image for better visibility [15]. According to [15], older people with eyesight problems prefer to utilise voice navigation. A voice assistant, such as a screen reader, may also help people complete activities or even to navigate [15]. As per [40], audio guides and speech recognition can be used instead of written guidance and text fields to submit data for those with low vision. The app voice, on the other hand, must convey its speech clearly, slowly, and loudly [15].

Hearing abilities often deteriorate with ageing, which has an influence on overall satisfaction with mHealth. When compared to individuals without hearing problems, older persons with moderate to severe hearing impairments used the internet less [15]. According to the Royal National Institute for Deaf Persons (RNID), the number of deaf people in the UK begins to rise dramatically around the age of 50, and by the age of 60, 55 % are deaf or hard of hearing [20].

Other age-related barriers exist as well, such as motivation, lack of knowledge and confidence when using mHealth applications [10,15], as well as attitude [18]. However, for this study only the most common and prominent ones found in multiple publications have been emphasised, namely: cognitive, physical, and visual barriers.

Table 3: Ageing barriers impact

References	**Ageing barriers**	**Impact/Difficulty**

[10, 15, 18, 20, 37, 39]	Cognitive impairment	Working memory and focus capacity drops, allowing for the processing of fewer discrete information pieces in a given length of time, as well as shorter recall. These people require more time to finish a task and find it more challenging to accomplish effectively. To match the requirements of older people, cognitive load should be reduced by offering interfaces with elements such as easy navigation. Interfaces should be designed to be simple to use and require just a few primary steps to operate.
[13 - 15, 20]	Physical ability	Clicking on small buttons on interfaces is more challenging with a reduction in motor skills, and rheumatoid arthritis can make handling a device in one hand uncomfortable. As they get older, they have slower movement and reflexes, tighter muscles and joints, and less balance. These constraints might affect learning time, performance speed, and indeed the failure rate. The elderly prefer having all icons on a single screen without any need to scroll owing to their deteriorating motor ability. The icons should also be big enough to allow for less accurate motor control.
[15, 20, 22, 36, 39]	Visual impairment	Visual acuity, contrast sensitivity, ability to concentrate close and far, and glare difficulties all decline with age. To see clearly, older people require additional light, and their motion estimation and peripheral vision are reduced. It is essential to set up a display with adequate lighting and colours. They find the size of icons and texts difficult to see and suggest that they be increased in size or the contrast between the text and the background be increased to make information easier to read. A voice assistant, such as a screen reader, can also help them in completing tasks or navigating.

5.1.3 The most influential usability elements for elderly

The success of any form of application is determined by how successfully it is utilised by the user, in other words usability, and how well it is tailored to the user's needs based on their prior experience [23]. [15] did an assessment of the hurdles related to mHealth utilisation in the elderly population. If an mHealth application is simple and easy to use, older adults are more likely to continue using it [15].

[28] conducted an in-depth interview with a gerontology expert in order to gain a better understanding of the constraints and potential ways to interact with the elderly in terms of technology. They created an app based on the experts' suggestions and conducted usability testing with the elderly using the Think aloud approach. One common issue faced by the elderly was when the contents of the screen change as the device rotates.

Using a user-centered approach, [42] created a reminder application. They analysed five current reminder apps before building the app to discover relevant features and functionality for their prototype. When creating the application, they also took into account the criteria revealed in their literature analysis. They additionally conducted a face-to-face interview with 35 older people prior to building the application. The questions were multiple choice, and participants chose their preference for a specific item, such as the position of the home symbol. Based on the responses and elderly design principles, the design was produced. In the examination of the application's usability, 15 people took part. They noticed that the elderly's usefulness of this application is three points greater than that of current apps since they implemented the elderly's proposals.

[43] argue that existing design recommendations do not address the ageing hurdles that older users confront while using touchscreen-based mHealth apps. They used two established usability methodologies to discover usability concerns that the elderly confront. They prioritised the concerns based on the Nielsen severity classification, which ranges from 0 to 4. The most serious issue discovered is connected to the app's confusing navigation. Cognitive and motivational concerns were both assessed as important, and the most prevalent age-related usability issues were physical impairments and perception barriers that impact 'longer learning time' and 'visual acuity.' As a result of cognitive decline, issues such as ambiguous interface features and a lack of user feedback may be especially challenging for older persons. Furthermore, because the navigation structure was irregular, motivational hurdles such as a lack of smartphone literacy would weaken the App's ease of use for older individuals.

[7] did another recent case-study approach to numerous interactions challenges that older individual may have when utilising mHealth. Think Aloud (TA) was employed to acquire a better understanding of the usability concerns. According to Nielsen's severity categorization, the found usability concerns were prioritised using a severity value ranging from 0 to 4. Usability concerns were categorised by determining where the issue happened in the app and at what stage of the task it happened. The authors then debated on the usability issue and classification until they gained complete consensus. The MOLD-US framework was used to categorise these issues. One of the highest severity scores was motivational barriers, with the highest frequencies of inadequate computer literacy and low faith in a patient's own capacity to use the technology. Cognitive barriers were the second largest type of intrinsic ageing obstacles adversely affecting app use, with the elderly experiencing a loss in working memory. Users also missed important icons or feedback notes and struggled to understand the tiny font language in applications. Furthermore, users experienced difficulty choosing the scroll bar and clicking on minor interface elements. As a result, user-interface design aspects such as text size and button size should be tailored to the older adult audience. The authors found that existing information from user interface standards on perceptual, cognitive, and physical ability obstacles in older persons is not being used to its full potential in mHealth interfaces.

[23] aimed to overcome the elderly's reluctance to utilise mobile apps through a research of both older user experiences and user interface design of an mHealth application, as well as an examination of the relationship between them. Mobile applications for older persons must be interesting, engaging, simple to use, and useful in order to be adopted. Six individuals took part in a user experience test conducted by the authors. Questionnaires were employed, with evaluations ranging from 1 to 5 on a Likert scale. The majority of the elderly preferred minimal navigation and only one button to view. And they liked to have assistance before attempting to use the app, or even a video outlining all of the app's functionalities. Their findings suggest that when adjustments to the user interface are made to accommodate the needs of the old, the user experience of the elderly improves significantly.

[9, 44] evaluated Arab senior users' attitudes on utilising mHealth apps with culturally oriented user interfaces. Poor cultural features in UI design frequently result in poor user engagement and, as a result, lower user acceptability and satisfaction. According to the researchers, interfaces should be more convenient and acceptable to each cultural trait. They created a mHealth app with a user interface inspired by Arab culture. Arabic language, as well as the colours of Arab culture and Islam, were employed in the interface. Furthermore, the layout was right to left, with a font size of 12pt. Out of 150 surveys, they evaluated 134 where according to the findings, senior people are more at ease when dealing with interfaces that are related to their own culture. As a result, it is possible that a UI based on a culture will be accepted by the elderly, as their intention to use mHealth is increased. However, since most elderly are not confident in using an mHealth app, the authors concluded that these elderly are generally satisfied with the health information they obtain

via different sources and hence do not intend to adopt mHealth. Creating an app for each culture, on the other hand, does not appear to be practical.

[4] conducted a review of existing research publications. They hoped to emphasise older persons' behaviour, needs, and challenges to utilising mHealth technology. Understanding the obstacles that prevent the elderly from utilising the mHealth app allows system designers and developers to further optimise the mHealth apps for older adult usage. According to the authors, before building any mHealth app, a user requirements elicitation should be undertaken. This might provide a more precise notion of what older adults want in terms of usability features, functionalities, user interface, colours, fonts, amongst others. Moreover, mHealth applications can incorporate senior-friendly and amusing features.

[40] created and tested a smartphone app for older people suffering from age-related macular degeneration. They tested their prototype with senior individuals and received feedback from them. The user interface was modified to accommodate patients' physical and cognitive limitations. They concluded that the same human interface rules do not take into account the very specific limitations of patient groups such as poor eyesight, cognitive impairment, or limited motor skills. Designers of mobile medical apps should bear in mind end-users' physical and cognitive restrictions.

The focus of [36], was on the establishment of a conceptual model for analysing persuasive systems in mobile healthcare for the elderly. The writers formulated a series of categories to consider. One category is reduction, which attempts to make the system appear easier to use in order to complete a task, particularly when the elderly are using mobile devices with which they may be unfamiliar in their everyday lives. A second category is tunnelling, which is a method of directing individuals through a process step by step to achieve the target. Another category is tailoring, in which the system may be adjusted to meet the demands of each individual. Due to the general limitations imposed by their age, the elderly confront various challenges [36].

According to [41], proper instruction for the elderly on how to utilise the mHealth application is necessary. Half of their participants stated they did not get enough help learning how to use the app. Their findings demonstrate that increasing these people's confidence and enlightening them about the app's benefits will aid in its adoption and use.

[11] attempted to understand the elderly's view on mHealth. They examined the data collected through surveys, interviews, and workshops. Their findings reveal that the interface's design has a direct impact on the elderly's perceived ease of use. They are not used to technical/complex words due to the generation gap, and instead choose simple words that they are acquainted with. They also found that low reliability and the possibility of privacy leakage had an impact on usability. The authors suggest utilising a participatory design approach to include older people in the application development process. Health care experts can also be consulted throughout the

development of health information to ensure that the information is presented in an understanding way for the elderly.

Elderly persons have a number of functional impairments as a result of ageing [22]. [39] attempted to identify possible facilitators and barriers to mHealth adoption among the elderly. These senior citizens favoured a large display, audible feedback, and automated data transfer [39].

Table 4: Usability elements impact

References	**Usability elements**	**Impact/Difficulty**
[28]	Contents of the screen change as the device rotates	They prefer having the content fixed.
[23, 43]	Ambiguous interface features	Engaging features are preferred. Interface's design has a direct impact on the elderly's perceived ease of use.
[23, 43]	Irregular navigation structure	Simple and consistent navigation are easier to use
[7, 39]	Struggled to understand the tiny font language	Design aspects such as text size and button size should be tailored to the older adult audience
[7]	Difficulty selecting the scroll bar	Prefer having all contents on one screen only, avoiding the need to scroll
[7]	Difficulty clicking on minor interface elements	Large element designs are easier to select
[9, 44]	Poor cultural features in UI design frequently result in poor user engagement	Including culture aspects in UI design might have a positive impact on the adoption
[11]	Too much technical/complex words due to the generation gap	Choose simple and familiar words that elderly are acquainted

5.2 Experimentation

The aim of the experiment was to gather feedback on the UI issues and ageing barriers that the elderly currently encounter with existing mHealth applications. The feedback obtained should be in line with the objectives of the study.

The experiment was carried out with 10 elderly persons, to complement the findings obtained from the systematic review. From a total of ten participants identified to conduct this experiment [11, 23], 6 were in the age group 60-69 and 4 in the age group 70-79. The criteria for selection was to be aged 60 or over and to own and use a smartphone.

From the findings previously presented (Section 4, Figure 2), 4 different categories of mHealth applications have been found. At least 5 mHealth apps were selected, covering all the 4 categories. For each category, an mHealth app was searched in Play Store using the category in the search bar. The applications have been searched in Play Store as the elderly were all using Android phones. The top 10 free apps results were then considered for review, following which, only the ones with reviews greater than 3.5 and having a high number of downloads were selected.
The participants were then briefed about the survey and the purpose of it. Assistance was provided to the users to download and install these 5 applications. Then, they tried to use these applications for 1 week. The time span of one week was chosen so that the elderly can learn to use the app at his/her own pace. After one week, they were then subjected to answer a questionnaire.

Table 4 provides a summary of the apps selected.

Table 4: Summary of existing apps chosen

Category	App Chosen	Reference	Description	Reviews	Number of downloads
Wellness (Fitness)	Senior Fitness - Home workout for old and elderly	[46]	This app is a daily workout routine for the elderly people, intended to increase their flexibility at home itself	3.7	50K+
Wellness (Stress)	Anxiety – Stress Relief Helper	[47]	This app is intended to reduce stress and be stress free	4.8	10K+

Disease (Heart)	Heart Diseases & Treatment	[48]	This app provides details about heart diseases, along with description, causes, symptoms and treatment.	4.4	10K+
Medication	myTherapy Pill Reminder	[49]	This app is a medication tracker for all medications	4.8	5M+
Self-Diagnosis	WebMD:Symptom Checker	[50]	This app allow to check symptoms, to learn about the potential conditions	4.4	10M+

The QUIS (Questionnaire for User Interface Satisfaction) was used to obtain the perspective of elderly. As such, this will help in identifying the strength and weakness of the elderly. Moreover, the results of this empirical study will be compared with the findings from the literature review.

QUIS is an interface evaluation method for assessing user satisfaction with the different aspects of Human-Computer Interface. This technique employs the notion of psychological testing by analysing the overall usefulness and sub-elements that are divided into attributes. Examples of attributes are: character readability, contrast, icon size amongst others. One benefit of QUIS is the ability to collect explicit quantitative assessments of user satisfaction with the system interface.
The QUIS approach comprises a questionnaire that assesses overall system satisfaction as well as particular variables of interface-related characteristics. A Likert scale with values of 0 to 9 is available in the answer section. Evaluation on these scales is analysed by user ratings for the attributes such as character readability, contrast, font, and spacing for the scale of character readability [45].

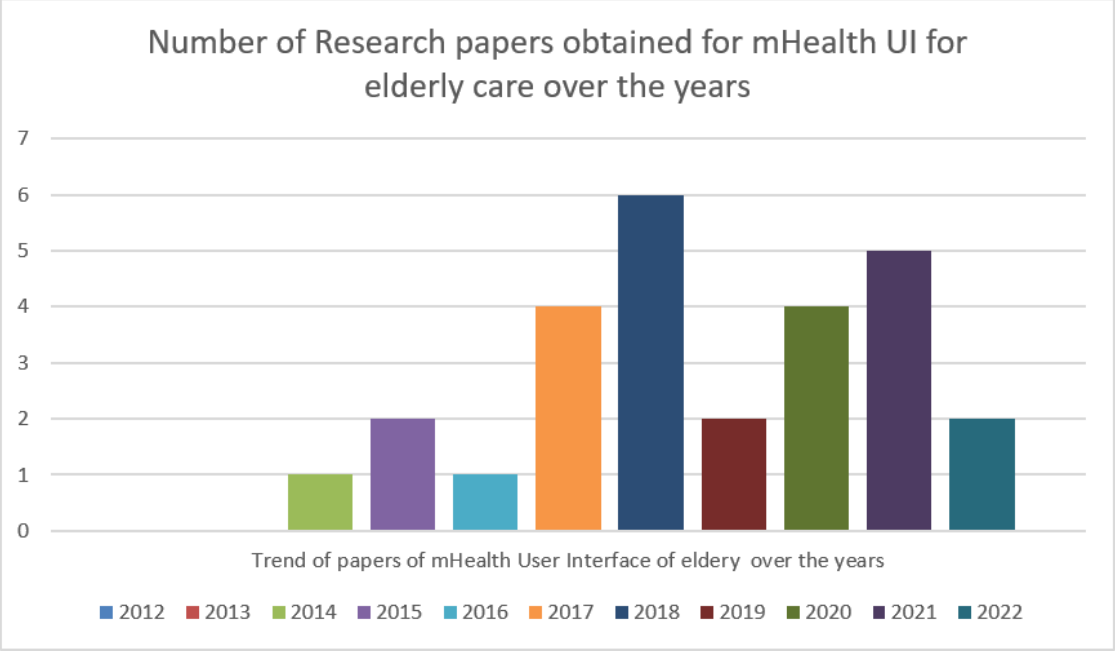
The same questionnaire was employed for this study as it suited the research purpose and was appropriate for collecting the views of the respondents for this experiment. The questionnaire's layout was slightly modified to make it simpler for the elderly to read, and at the end, an open question of suggestions was included to have the views of the aged person.

6. Interpretation of Results

This section contains the results from the reviewed papers and results from the experiment carried out with the elderly. The answers to the objectives of the study are obtained. From the results, it can be seen that the experiment results match with that of the review, confirming the effectiveness of the findings from the review.

The following chart (Figure 3) depicts the trend of papers over the last 10 years.

Fig. 3 *Number of Research papers over the last few years*



6.1 The most dominant mobile User Interface issues

From the literature review, different User interface issues have been prescribed. Findings show that the most dominant UI issue is the complexity of the User interface which consist of several factors. These factors are legible fonts, text and icon size, colours, clear message, and easy navigation. Some participants suggested that the word spacing should be at least 1.5 for easy readability. The contrast between the text and background should be appropriately chosen considering the elderly in mind, it is recommended to use high contrast with bold colours. Some aged persons also stated that they would prefer the size of the keyboard alphabets to be of larger size, as indeed they are too small and too close for them to see and tap. The design of the app should be simple to use and manipulate. The use of small icons or links should be avoided as these are often missed by the eyesight of the elderly. Unwanted or unnecessary information should not be displayed as this will overload the screen and as a result. A simple design catering for the preferences of the elderly will eventually help in the adoption of mHealth apps among the elderly.

The following is a list of guidelines derived for User Interfaces design:

- Text size and icon size should be large enough, five of the papers reviewed cited difficulties in viewing small text;
- Use of clear language;
- Easy and simple navigation, the problems that the elderly confront when navigating a complex environment were mentioned in eight of the studies assessed;
- Use of appropriate colour for background and text: 9 articles found that present apps do not use colour that is suitable for the elderly, and this group demands bold colour with high contrast;
- Consistent use of terminology;
- Avoid use of scrolling.

Only design element issues faced by the elderly have been emphasised, certain design features such as audio preferences, notifications and alerts have not been included.

6.2 Barriers affecting the elderly use of mHealth applications

Ageing barriers hinder the adoption of mHealth applications among the elderly. From the review, 4 kinds of ageing barriers have been identified. The most dominant one is age-related visual change, followed by cognitive barriers, physical barriers and hearing ability. For hearing ability, there seems to be less information compared to the others, indicating there is still more research to be done in this domain.

1) Cognitive barriers: Cognition is related to memory, where the process time and recall decays with age. People having these issues find it more difficult to operate an mHealth application. Previous papers show that aged people prefer having less steps along with clear navigation. Moreover, the consistent use of terminology is also suggested, as this will reduce confusion caused due to unfamiliar terminology terms and hence there will not be too much info for the memory to process.

2) Perception barriers: Visual impairment, like macular degeneration and bifocal glasses affects more than 20% of elderly users. These users face difficulties while viewing any digital screen, they basically require more light to see effectively. Moreover, a decrease in visual acuity hinders the ease of readability, as these people find the size of text to be too small to read. For this issue, some researchers recommend the implementation of a zoom feature or a voice assistant.

3) Physical barriers: Physical barriers such as motor skills have a great influence in the adoption of mHealth apps among the aged. With time, people have slower movement accompanied with stiffer muscles or joints, making it difficult for them to click on small buttons or links. Elderly users prefer having all icons or options on a single screen, avoiding the need to scroll down the screen. The use of large icons is recommended as this will increase the precision. There is a need for this barrier to be considered in the development of any mHealth app for elderly users, as more than 75% of American elders have physical impairments.

4) Hearing abilities: This barrier is mostly concerned with the overall satisfaction of mHealth. According to the Royal National Institute for Deaf People (RNID), in the UK 55% of people over 60 are deaf or hard of hearing.

Other ageing barriers exist, however they are not really outlined or discussed in existing studies. Such barriers include motivational barriers, which relate low computer literacy and low trust in an elderly's own ability to use the application. Adoption of an app is also based entirely on the individual's desire to do so. There have been few studies looking into these barriers to promote senior mHealth use.

Table 5 presents the ageing barriers identified.

Table 5: Ageing Barriers

Barriers	Impact	Issues faced by elderly	Propositions
Cognitive	Working memory Memory attention Reasoning Numeracy	- Difficulty to recall steps - Takes more time to perform a task - Issue when navigating in a complex navigation - Confusing terminology	- Include only few steps - Simple and clear navigation - Use of consistent familiar terminology
Physical	Slower Movement Stiffer joints/muscles Balance Slower reflex Grip strength	- Difficulty to click on small icons/buttons - Issue when scrolling - Speed of performance	- Make the icon/button large enough - Try to add all info/icons on one screen only to avoid the need of scrolling
Perception	Visual acuity Colour vision	- Small text and icons - Incorrect contrast and colour	- Large text and icons - Zoom feature - Voice assistant - Appropriate colour and contrast

6.3 Influential usability elements for elderly users

Usability elements influencing the adoption of mHealth applications from the elderly are listed below in three different categories. These elements are user-centred, i.e. the perception of the user and their intention to use an mHealth application depends on the user him / herself and is based on certain factors affecting the decision to adopt an mHealth app or not.

1) Ease of use: The elderly found it easier to use the app when the app is designed taking into account their suggestions. Motivational barriers, such as lack of smartphone literacy and lack of one's own ability to use technology weakens the ease of use of these applications by the elderly individuals. One study revealed that elderly people expressed their satisfaction with numeric to diagrammatic representations. Another study result showed that elderly users have difficulty in using applications due to the text size, navigation and visual design, therefore it is recommended to use a line spacing of 1.5. Studies suggest using appropriate contrast between the text and the background for the elderly eyes. A high-contrast mix of bold colours is also recommended. These can increase the ease of use among the elderly. Moreover, elderly users preferred having all information displayed on a single screen without no need for scrolling. Simple and clear steps make the system easier to use.

2) Learnability, memorability:
A loss in working memory negatively affects the usage of applications. Several studies pointed out that elderly people prefer having to follow only a few straightforward steps, as they have difficulties in recalling the steps. A simple navigation structure can encourage them to use the app frequently, as it will be easier for them to learn and remember it next time. Respecting the knowledge level of an elderly person, the terminology has to be correctly chosen, as they may not be familiar with technical or complex terms and should not be confusing to grasp them. Easy actions which do not exert too much on the memory are recommended, as they will find the action easy and hence will be encouraged to learn on their own.

3) User perception: According to certain elderly users, if their needs are considered and the UI is visually appealing to them, this will attract them to use these apps. In one study, feedback from some elderly users concerned the keyboard size, where the letters icons were too close and small for their finger, which was the default keyboard of the mobile device and not part of the UI of the application. However, this can be addressed using a zooming feature. Elderly refrain from using mHealth apps if they do not find it beneficial or is too difficult for them to use. The provision of guides, for example step by step guides on the screen or even a video, can be useful during the initial learning process as they will know exactly how they can use the applications. As the applications become increasingly familiar, they may no longer require the guides.

Culture is another element that appears in one of the papers reviewed. Having an app that is tailored to one's culture can help the elderly adopt the app. However, not all elderly users would enjoy a UI design based on culture.

6.4 Experimental findings

This section includes a summary of the findings from the experiments that have been conducted with the participants. The findings are divided into two age groups, 60-69 and 70-79, with 6 individuals in the first group and 4 in the second, respectively.

The results of the QUIS questionnaire show that even though some of e the participants can use the applications after some trial and error, they are in general unlikely to use them.

Regarding the Stress app, participants aged 70-79 found the characters quite hard to read and preferred larger characters, only 36.7% found the applications' characters easy to read. They also mentioned that they would not be able to read these characters without their spectacles. The characters in the Stress app were indeed small and the font was grey on a white background, making it more difficult for the elderly to read.
Moreover, they found the number of steps to be excessive, particularly in the diagnostic app, where all participants answered the same: "too many steps". When there are too many actions, the user loses interest, becomes bored, and is discouraged from using the app again. It also becomes time consuming for them. Overall, 56.7% of the elderly aged 60-69 and 40% of those aged 70-79 found there were too many steps in the applications.

The use of colour plays a vital role in the adoption of an app by the elderly, therefore colour must be chosen carefully. According to the Stress app's results, all seniors aged 70-79 rated the colour as unappealing, with a range below 5. The seniors did not like the Stress app since it had characters in pale colours, which disturbed their eyes. Both groups found the Medication app to be less appealing where the background colour was black, and the text was blue. Only 40% of those aged 60-69 and 25% of those aged 70-79 found the applications to be attractive.

Elderly individuals prefer clear instructions so they can carry out tasks quickly and effortlessly. According to the findings, existing applications for older persons still lack clear instructions. Elderly individuals with more expertise will find it easy to follow the directions, however those with less application experience will find it difficult and confusing. Overall, 20% of the participants found the applications' instructions to be very confusing.

The elderly expressed their recommendations in the Suggestions section of the questionnaires. In total, seven stated that the characters should be larger, and one stated that he/she would want to be able to use the app without having to look for and wear his/her spectacles. One of the participants even stated that a zooming feature would be useful so that the text may be expanded to his or her preference. Some 50% said they would like an app with a simple navigation flow that is clear and to the point. Too many steps take too much time and are inconvenient for them. Three of the respondents expressed their dissatisfaction with the English language utilised, stating that it is difficult and unfamiliar to them, while one suggested that, owing to the difference in our accents, the English voice on the app would not be understandable to everyone.

7. Discussion

Different various elements were found to be linked with User Interface issues, the most pertinent one being the size of the text. Due to a decrease in visual acuity, elderly users have difficulties in reading the standard size of text in applications. They prefer to have larger text. Even the experiment's results show that some users, especially those aged 70 and above, find the characters hard to read. Having a zooming feature implemented where the user can adjust the character's size

to his/her preference can be helpful, since all seniors do not have the same level of visual acuity. Another major element impacting the User Interface adoption among elderly users is the colour combination. A high contrast with bold colours is preferred since this combination provides them with easier readability. Regarding the experiment Results, the participants found the Medication app's colour combination to be unattractive. The colour used in the application was a black background with pale blue characters, the characters were difficult to read and the colour combination was not pleasing.

Elderly users prefer a simple and easy navigation. For ease of use, fewer steps are to be designed. In all 5 apps, at least one participant found the steps to be too many, and in the self-diagnosis app all participants found the steps to be too many. Too many steps are required to be completed to have the results of the self-diagnosis and an aged person does not have patience to wait and go through all the steps. A simple design will promote the usage of mHealth apps. It can be observed that the fitness app has had multiple scores of '9', especially for ease of reading and colour combinations. This indicates that fitness apps seem to be designed in a way that is easy to read and attractive for the elderly in terms of colours . The reason behind this could be that fitness apps have a high demand and are very popular, and that probably why they have been designed in a way that is more usable to elderly. The perception of a user is individual, all elderly might not have the same perception on the User Interface. Some might find the colour pleasing and some might not. As revealed by [9, 44], Arab seniors found the application's colours, related to Arab culture of application, to be satisfying however this does not mean that other seniors might like the colour.

Ageing barriers can indeed hinder the adoption of mHealth apps though if these barriers are addressed in the UI, the possibilities of adopting mHealth apps can be increased. Four ageing barriers have been found, namely Cognitive, Perception, Physical and Hearing abilities. However, studies on ageing barriers address mainly the first three barriers listed, hearing abilities are rarely included in the studies. Very few findings were found with regards to this barrier, one of the reasons might be because elderly having hearing issues do not use mHealth applications and hence there has been no feedback/information obtained from this kind of group. Designs have been recommended to cater for these three major barriers, and if these recommendations are implemented, the issues they face due to ageing barriers, might be reduced.

Nowadays, almost everyone, including elderly people, own a mobile phone. As a result, having access to a mobile phone is no longer an issue for them because they already use one to keep in touch with relatives and friends on a regular basis. Even though there may be benefits to mHealth applications for older users, utilisation of these applications is currently quite low in this user group [53]. There exist digital inequalities regarding the use of digital devices among the elderly and young. As opposed to younger people, elderly people use digital devices differently. Thus, designers should consider the difficulties and limitations when designing mHealth applications, as

these are frequently overlooked [20]. It has proven difficult to develop an interface that is well-accepted by the elderly population [14].

There is a need to investigate technologies that might help to increase the adoption of mHealth applications in elderly care. Having an elderly - friendly app will render it more accessible to older users. In the future, new interactive methods can be investigated so that the mHealth apps are more usable and engaging to the elderly. Emotion-aware mHealth applications with adaptive UI and using affective computing to detect the user's current emotion, could be one of the ways forward. An emotion - aware mHealth app could be a potential solution for increasing adoption in elderly.

8. Conclusion

Even though mHealth applications have a lot of potential to help the elderly with self-management and well-being, the adoption of mHealth apps by older users is subject to human factor design issues due to ageing barriers. Usability concerns that older individuals have when using mHealth apps have been reported in existing literature. According to the findings of this study, there are three main ageing barriers that hinder senior people's usage of mHealth: cognitive, perceptual, and physical barriers. Because mobile application adoption by senior users is still low, existing knowledge from user interface standards on perceptual, cognitive, and physical ability limitations of older persons is not being fully addressed in mHealth interfaces. The experiment conducted in this study has offered insights on the UI challenges that elderly people are experiencing with current mHealth apps. This research has shed further light on the UI challenges that the elderly confront, as well as the kind of UI that they prefer. The elderly should be able to interact with the mHealth app for a long time. Suggested recommendations from elderly users will help in designing an app that is easy for them to use. Taking these suggestions into consideration will improve senior users' satisfaction and adoption. As such, this study can be used as a foundation for future research on mHealth usability issues affecting older users.

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