

A scoping review about the adoption and adherence of physical activity mobile applications by older people

Uma revisão de escopo sobre a adoção e aderência a aplicativos móveis de atividade física por pessoas idosas

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Introdução: Uma estratégia para promover a prática de atividade física (AF) é o uso de aplicativos. Entretanto, pessoas idosas podem enfrentar dificuldades no uso dessas tecnologias. Revisar a literatura relevante pode apoiar o desenvolvimento de aplicativos mais acessíveis. **Objetivo:** Mapear os fatores relacionados à adoção e aderência de aplicativos móveis de AF por pessoas idosas. **Métodos:** Os estudos foram pesquisados em cinco bases de dados e duas estratégias adicionais foram realizadas. Foram pesquisados termos sobre adoção, aderência, fatores, aplicativos móveis, AF e pessoas idosas. Foram incluídos estudos disponíveis desde 2010 em inglês, português ou espanhol. Análises descritivas e análises temáticas indutivas foram realizadas. **Resultados:** Doze estudos foram incluídos, a maioria publicada após 2017. Todos os participantes da pesquisa usaram pelo menos um aplicativo de AF. Os principais fatores encontrados acerca da adoção foram fatores pessoais relacionados ao indivíduo, como atitudes, fatores psicológicos e preferências, e para a aderência foram fatores técnicos relacionados ao aplicativo, como funções, complexidade, diversão, feedback e aprendizado. Os fatores apareceram como barreiras e facilitadores. **Conclusões:** Esta revisão identificou fatores que podem auxiliar no aprimoramento de aplicativos de AF para pessoas mais velhas, destacando a importância de desenvolver tecnologias acessíveis para aumentar a aderência dos usuários.

Palavras-chave: Envelhecimento Saudável. Exercício físico. E-saúde. Dispositivo móvel.

Background: One strategy to promote physical activity (PA) practice is the use of mobile apps. However, older people may face difficulties using these technologies. Reviewing relevant literature can support the development of more accessible apps. **Objective:** To map the factors related to adoption and adherence of PA mobile applications by older people. **Methods:** Studies were searched in five databases and two additional strategies were performed. Terms about adoption, adherence, factors, mobile applications, PA and older people were searched. Studies available since 2010 in English, Portuguese or Spanish were included. Descriptive analysis and inductive thematic analysis were performed. **Results:** Twelve studies were included, the majority published after year 2017. All research participants used at least one PA app. The main factors found in relation to adoption were personal factors concerning the individual, such as attitudes, psychological factors and preferences and for adherence were technical factors related to the app, such as functions, complexity, fun, feedback and learn to use. The factors appeared as barriers and facilitators. **Conclusions:** This review identified factors that can assist in the improvement of PA apps for older people, highlighting the importance of developing accessible technologies to increase user adherence.

Keywords: Healthy Aging. Physical Exercise. E-health. Mobile Device.

Introduction

The aging process can generate physical, psychological and social changes. Many problems that occur with aging are related to an unhealthy lifestyle, thus, successful aging can prevent diseases and promote health (Estebsari *et al.*, 2020). One important behavior for a healthy lifestyle is the practice of physical activity (PA), which can generate benefits for the entire population, including older people, such as disease prevention, improved mental health, physical performance and emotional well-being (Izquierdo; Duque; Morley, 2021).

However, despite the importance of PA practice, in a study carried out by Guthold *et al.* (2018) with 1.9 million individuals from 168 countries, it was identified that, in 2016, about a quarter (27.5%) of the global population did not perform the recommended minimum of PA, in addition, PA levels tend to decline throughout the individual's life.

A strategy to promote and maintain regular physical activity (PA) and combat inactivity risks is the use of mobile applications. Regarding the effectiveness of these applications, a systematic review identified that applications on mobile devices are capable of promoting effectiveness in interventions to promote physical activity in all age groups (Nazaruk; Rouser, 2021). Also, a review developed by Chen, Or and Chen (2021) to examine the effects of technology-supported exercise programs (e.g. using mobile apps), found significant results in improving knee pain and quality of life.

However, older people may face barriers using these technologies, in addition to other factors that can influence individual behavior, such as psychological, biological, occupational, social and environmental factors (Aranha *et al.*, 2021; Sallis *et al.*, 2006). Therefore, it's important that applications incorporate feedback from the target audience to facilitate behavior change (Castro *et al.*, 2020).

A literature review is needed to identify factors influencing older people's use of these applications. Munn *et al.* (2018) state that a scoping review, which has a broad research question, aims to identify evidence and map factors related to a topic. Therefore, a scoping review on this topic will help identify factors specific to older adults. The objective of this review is to map the factors related to the adoption and/or adherence of PA mobile applications by older people.

Material and Methods

This scoping review was conducted in accordance with the PRISMA extension for scoping reviews (Tricco *et al.*, 2018) and following the Joanna Briggs Institute scoping reviews manual (Peters *et al.*, 2020). This review was registered in Open Science Framework, doi: 10.17605/OSF.IO/4578N and the review protocol with methodological details is published elsewhere (Lorenzi *et al.*, 2021).

For eligibility, the studies should have data on a mobile technology for PA (which may have other objectives as well) and include individuals over 60 years of age in the sample. The criteria for inclusion in the review were having reported or identified factors related to the adoption or adherence of

PA mobile applications by individuals over 60 years of age, being an article or review, in Portuguese, English or Spanish and being published from 2010 to the date of the search. There was no restriction on the study design. Policy documents, technical reports and articles for which a full copy of the text could not be obtained, even after attempts to contact the authors, were excluded.

To be considered as factors related to adoption, they must be factors that present positive or negative aspects, that facilitate or hinder, for the individual to be able or for it to want to download that application. In order to be considered as factors related to adherence, they must be factors that present aspects that facilitate or hinder/inhibit the individual to continue using an application that it has already downloaded and has already started using.

Searches were carried out in the databases Web of Science (Clarivate Analytics), PubMed (NCBI), Scopus (Elsevier), Lilacs (BVS) and Scielo, based on a search strategy carried out with the terms adoption, adherence, factors, applications, PA and older people, in addition to other related terms. The search strategy was adapted according to the characteristics of each database, including the use of MESH terms when necessary. Below is the search strategy used in the Scopus database:

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TITLE-ABS-KEY((adoption OR adhesion OR install OR access OR
download OR acceptance OR rejection) OR (adherence OR
nonadherence OR "sustained use" OR abandonment OR
persistence OR maintenance OR dropout OR attendance OR
compliance OR non-compliance OR noncompliance) OR (factor*
OR preference* OR characteristic* OR experience* OR
determinant* OR attribute* OR perception* OR development OR
barrier* OR facilitator*)) AND TITLE-ABS-KEY("mobile
application" OR app OR apps OR "cell phone" OR smartphone*
OR "mobile devices" OR m-health OR e-health) AND TITLE-ABS-
KEY("physical activity" OR "motor activity" OR exercise* OR
"physical training" OR fitness) AND TITLE-ABS-KEY(elder* OR
"elderly population" OR "older people" OR aged OR "ageing
population" OR "older population" OR ageing OR geriatric)
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This strategy was investigated in titles, abstracts and keywords. Two additional search strategies were carried out: the reference list of the articles that were included in the review from the databases was examined; and a Google Scholar search in which the first 150 studies according to the relevance algorithm were checked, in order to also verify gray literature searches such as dissertations and theses.

The selection of the studies was carried out in five stages. The first were the search in the five chosen databases using the search strategy developed, export of the studies titles to a table in Excel 2016 program and removal of duplicates by the independent reading of the titles in English by two reviewers. The second stage were the pilot test in which two reviewers independently verified the titles and abstracts of 25 randomized studies found in stage 1, to verify the agreement between them according to the eligibility criteria. The agreement rate was 76%, so the selection continued.

In the third stage, two reviewers independently read, in a double-blind manner, all titles and abstracts of the studies

found in stage 1, in order to verify if they would be selected according to the eligibility criteria. In the next stage, the full texts of the studies selected were independently verified by the two reviewers, double-blindly, according to the inclusion criteria. Disagreements between reviewers were resolved by a third reviewer. In the last stage the additional strategies were carried out, which were reading the list of references of those included and reading the first 150 searches found on Google Scholar, following steps 3 and 4.

Data from the included studies were extracted into a form described in the protocol (Lorenzi et al., 2021). This data included research design, methods, population, results, apps used and factors related to adoption or adherence. Two reviewers tested the form with two studies to ensure all relevant information was captured. They then independently extracted data from all studies. The only changes made to the form in the review protocol were adding the names of the apps used and the year of data collection.

Quantitative data were described narratively and reported using absolute and relative frequency, standard deviation, and mean. Study selection data were presented through a PRISMA flowchart and descriptive characteristics of the included studies, were also presented.

As several factors related to the adoption or adherence of PA mobile applications by older people were found in the included studies, in order to organize these factors, the three reviewers carried out an inductive thematic analysis and described the factors grouping them according to their themes, through topics and subtopics. These topics and subtopics were allocated in the following categories: barriers to download, reasons to download, barriers to use, behavioral intention to continue the use (reasons to keep using), reasons for giving up/abandoning use and sociodemographic factors.

The choice of terms used as topics and subtopics was based on two studies (Kuerbis et al., 2017; Yang et al., 2020), which respectively reported factors that improve or inhibit the use of mobile technology by older people and factors that influence adherence of the general population to PA apps. Based on the themes found in the adoption and adherence factors, the following topics and subtopics were identified:

a) Personal factors (related to the individual): attitudes towards this technology (pre-defined user attitudes about that technology); psychological factors (emotional state that affects the use of the application); individual preferences/perceptions (preferences and/or perceptions of the individual that helps or not to use the application); perceived benefit (benefit the individual believes that will achieve by using the application); and knowledge (previous experience that may or may not interfere in the use).

b) Environmental factors (related to the environment in which the individual is based), such as: cultural factors (user behaviors, traditions and cultural knowledge that may or may not interfere with the use of the application); and social

factors (social factors that may or may not interfere with the use of the app, such as the possibility of forming groups with other individuals in the app and sharing information or application data with other individuals).

c) Technical factors (related to the app/technology), such as: functions (functions that the application has that interfere positively or negatively for use); complexity/usability (facility or difficulty in using the application); learning to use the app (presence or absence of training and/or instructions for the use of the application that may interfere in the use of the application); feedback (presence or absence of feedback on the use of the app, e.g. feedback on the number of steps taken per day and how far to reach the goal); fun (influence of the fun on the use of the application); interface (aesthetics of the application that may or may not interfere with the use); and design (development and concept of the application that may interfere with use).

d) Contextual factors (related to the context of the individual), which is the research reason (the use of the application is related to having participated in the research).

Results

The search in the databases with the chosen strategy identified studies available in the three languages, 652 in Portuguese, 154 in Spanish and 2,171 in English. In total, 2,919 studies were found in the main search in the databases. In Google Scholar, the first 150 results were chosen in order of relevance. In the references of the studies included in the main search, 388 studies were identified. The results of the evidence selection are summarized in the PRISMA flowchart which is described in the Supplemental File 1 available in Open Science Framework, doi: 10.17605/OSF.IO/CJDTX.

Twelve studies were included in the present review, 11 of which came from the search in the databases and one from the additional strategies. The main reasons for exclusion were not reporting factors related to the adoption or adherence of PA mobile applications (25.1%) and not reporting adoption and/or adherence factors only in relation to older people (33.4%), the articles that were excluded for this reason, they reported data from a population of adults (>18 years) and not just people over 60 years old.

The total number of participants in all studies included in the review was 266 individuals (with the smallest sample of 8 individuals and the largest sample of 53), among which the overall mean age was 74.7 years (± 7.2) - three surveys did not report the mean age. The percentage of these participants who were female was 60.6% but one survey did not report the number of participants of each sex.

Most studies were published after 2017, being 41.7% in 2020. Half of the studies were carried out in Switzerland or the United States. Regarding the year of data collection, most studies did not report this, although it might be inferred from proximity to the date of publication. The surveys had different types of design, the most frequent being usability,

intervention, interview and product design and development. In addition, the qualitative approach was the most used (41.7%). Regarding the sample of studies, most (58.3%) had between 11 and 20 participants, half of the studies had between 50 and 59% of women in the sample and the average age of participants was between 70 and 79 years old in 33.3% of the studies.

Other descriptive data of the included studies are in Supplemental File 2 available in Open Science Framework, doi: 10.17605/OSF.IO/CJDTX, including title, authors/year of publication, inclusion criteria for participants, summary of methods used and outcome measures. All studies had as an inclusion criteria the individual being 60 years of age or older, except for one study (Henshall; Davey, 2020) which, although it was carried out with a sample of individuals over 18 years of age, it reported the results obtained from each participant with their respective age, so it was possible to extract data only from those over 60 years old.

In all studies, participants used at least one PA application, which was used for at least one week, except in one investigation (Smith; Argentina, 2020) in which participants used the application only during a session, for about 10 minutes. In addition, the techniques used to acquire the results were diverse, including questionnaire, interview, focus group, diary, application data and group discussions.

The categories related to the adoption of PA mobile applications by the older people were: barriers to download, which are the barriers that individuals faced to download the app, and reasons to download, which are the reasons that the participants had to download the app. While the categories related to adherence to these applications were barriers to using them, which are the barriers that the participants had to continue using the application (after they had already downloaded it and started using it), behavioral intention to continue the use, which are the reasons to continue using that app, and reasons for giving up or abandoning their use, which are the reasons to stop using the app.

The category of sociodemographic factors was related to both adoption and adherence and appeared only in one research (Ehn *et al.*, 2018), in which participants reported that a less vigorous older person could have limitations and difficulties in accessing and using the application. All the topics and subtopics of factors that emerged in each study included in the review are in Supplemental File 3 available in Open Science Framework, doi: 10.17605/OSF.IO/CJDTX.

Topics and subtopics appeared in positive and negative ways according to the categories in which they were identified: in the case of barriers to download or to use, and reasons for giving up or abandoning use, the factors were negative, because they hinder the individual from downloading or using the app; in the case of reasons to download or keep using it, the factors were positive as they facilitated the adoption and/or adherence to the PA application.

All studies presented factors in at least one category, being the one by Ehn *et al.* (2018) with the most subtopics of factors and the one by Danilovich *et al.* (2017) with the least ($n=1$). It is possible to verify that only six subtopics of factors among the 52 were related to the **adoption** of mobile PA applications by older people, being the majority personal factors (83.3%). One study had a contextual factor, which was that some participants reported that they downloaded the app just because they were participating in the research. About personal factors related to adoption, among the barriers to download, the factors were attitudes towards technology (eg. believing that they are already active enough and don't need the technology), psychological factors (eg. anxiety and fear to use the app) and individual preferences/perceptions (eg. participants consider that if they used the app, they would pay less attention to their own body). The reasons to download were also related to attitudes towards technology (eg. being curious about using this technology) and the perceived benefit (eg. the app would collaborate to make them healthier).

The factors related to the **adherence** of these applications were mostly (69.6%) technical factors (referring to the application itself). Regarding them, the factors related to barriers or reasons for abandoning/giving up the use were: functions (eg. the number of steps recorded does not represent what was actually performed), complexity/usability (eg. the app was too complicated for the participants to use), learning to use the app (eg. participants wanted better training and instructions on how to use the app), feedback (eg. some participants reported that there was too much feedback which caused annoyance), and design (eg. participants did not like the game concept). Factors in relation to behavioral intention to continue the use were: functions (eg. setting goals and reminders were considered important to keep using it), complexity/usability (eg. participants considered the app easy to use and understand), feedback (eg. participants felt motivated to have feedback on the PA they performed), fun (eg. individuals found the app fun to use), interface (eg. participants liked the aesthetics of the app), and design (eg. participants believed that the application had a clear structure and presentation).

Taking into account both adoption and adherence, the review found some important guidelines for the development or improvement of PA mobile applications for older people, that companies and other studies should take into account, which are: having social aspects, such as training groups and data sharing; generate benefits for users; take into account psychological aspects such as the fear of using and the user's attitude towards this technology; and factors related to the application itself, such as correcting or preventing malfunctions, being easy to use, having instructions on how to use, giving feedback on the activities carried out by the user (without being excessive), having functions such as reminders and goal setting, be fun to use, have a clear-to-understand and well-structured design, and be possible for

the user to customize the content of the application.

Discussion

This scoping review included 12 studies on factors influencing the adoption and adherence to PA mobile applications by older people. It presented descriptive data on the articles, applications used, and emerging factors. The main factors found in relation to adoption were personal factors referring to the individual, while for adherence the main factors were technical related to the application used.

In this review, most studies (58.3%) had 11-20 participants; 41.7% used a qualitative approach, and 33.3% used a mixed approach. According to Boddy (2016) qualitative research with a small sample size is acceptable and important because this type of investigation generates a deeper understanding of the participants and their opinions. This may justify the participant numbers and the depth of results in these studies, as these studies had reports of older people.

A study from Yang *et al.* (2020) found that the factors associated with adherence to PA mobile applications by the general population (no age restriction) were personal, contextual, and technological factors. In addition, another research (Cajita *et al.*, 2018), identified these same factors as facilitators and barriers to mHealth use among older adults. These categories of factors found by the authors are similar to those found in the present review, which identified personal and technical factors as factors of adherence to PA mobile applications in relation to the older population. However, the environmental factor as a reason for adherence was identified only in this review on the older population. Thus, it is possible to verify that personal, contextual and technological factors may be related to adherence to PA applications in both adult and older population.

Regarding the factors related to the adoption of PA mobile applications by older people, the personal factors identified were attitudes towards technology, psychological factors, individual preferences/perceptions and the perceived benefit; while the only contextual factor identified was the need to download the application in order to participate in the study. According to a research from Smith (2014), some barriers that individuals over 65 years of age face to adopt new technologies are physical difficulties, skeptical attitudes about their benefits and difficulty in learning new technologies. However, these individuals also have positive attitudes about the benefits they can generate in their lives. Thus, it is possible to verify that attitudes and perceived benefit were identified both in relation to technologies in general and in relation to PA applications and can be classified as barriers or motivators for their adoption.

It was verified that 69.6% of the factors related to the application adherence were considered technical factors. Jeffrey *et al.* (2019) found that barriers for older adults using type 2 diabetes apps included technological problems regarding to the application, such as failures at the time of use, the application not being user-friendly, difficulty in

navigation and font size. Facilitators such as clear designs, intuitive technology, ease of monitoring and technical features present in the application were also identified. In this way, technical factors can influence both positively and negatively the use of health apps by older people.

Integrating human factors, such as age, culture, language, perceived benefit and user's behavior, can promote better acceptance of technology by users. Furthermore, in addition to human factors, it is also important to check technical factors related to the technology itself, such as those found in this review, e.g. functions within the technology, complexity of use, presence of feedback, fun and user-based design. These factors can enhance technology acceptance and continued use by older people (Wang; Qi, 2021).

According to Amorim (2018), despite the benefits of health apps for older people, there is a need for studies that promote a theoretical basis for the development of these apps focused on the demands and preferences of this audience. Therefore, this review presents results that can assist in the development of mobile applications based on end consumers, taking into account the needs of older individuals in order to promote more accessible technologies.

The strengths of this review include: a) It is the first to present specific data on factors related to the adoption and adherence of PA mobile applications specific to older people, including both motivating factors and barriers; b) Five databases, references from included articles and gray literature were consulted in three languages; c) Two reviewers independently read all abstracts and full texts; and d) The review follows PRISMA-Scr guidelines.

One limitation of the study is that it only included data from individuals over 60 years old. Studies that reported adoption or adherence factors for the general population were excluded, thus, some data from older people may not have been included. We suggest that future reviews consider the average age of participants in each study.

Conclusion

This review found that older adults' adoption of physical activity (PA) mobile applications is influenced by personal and contextual factors, while adherence is affected by personal, environmental, and primarily technical factors. Identifying these factors can aid in developing and improving PA apps to promote greater adoption and adherence, and consequently, increase the practice of physical activity in this population. Additionally, the review can serve as a basis for conducting more specific systematic reviews on this topic, including quality assessments of the studies.

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