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Information and communication technologies for the improvement of cognitive function in healthy older adults: a systematic review protocol

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ABSTRACT

Introduction Mild cognitive impairment is one of the consequences of ageing, causing functional disability, a poor quality of life and an increased socioeconomic expenditure. Evidence shows that patients go through a long preclinical stage in which cognitive deficits appear subtly until they reach the threshold of dementia. Non-pharmacological interventions have been gaining ground as prevention of modifiable factors of cognitive decline such as obesity, diabetes, physical inactivity or social isolation. Along these lines, Information and Communication Technologies (ICTs) can be a tool for cognitive stimulation, cognitive training and cognitive rehabilitation. The main objective of the systematic review will be to review and analyse the use of ICTs for the improvement of cognitive functions in healthy older adult population aged 50 and over, for the prevention of cognitive impairment

Methods A systematic review will be conducted including randomised clinical trials in adults without diseases or accidents associated with cognitive impairment, and whom have used ICTs for the improvement of cognitive functions between 2010 and 2020 in English or Spanish. The articles that report data on cognitive function by domain, for example, memory or executive functions, or by test will be included. The databases Medline (PubMed), CinahlPlus, Scopus, ISI WoS, CENTRAL and IEEE Xplore will be searched. Studies that meet the inclusion criteria will be analysed according to the Cochrane RoB2 tool for risk of bias assessment.

Ethics and dissemination Ethical approval is not necessary as this is a systematic review. The results will be published in scientific journals, as well as in specialised congresses on the subject of study.

Strengths and limitations of this study

- The systematic review will follow the recommendations of the Peer Review of Electronic Search Strategies Statement.
- The systematic review will include adult population over 50 years with randomised controlled trials (RCTs) that are targeted by computerised cognitive training and/or computerised cognitive stimulation.
- All RCTs that meet the inclusion and exclusion criteria will be included regardless of the duration of the intervention and its follow-up to obtain a broader insight of the current evidence.
- Only studies written in English or Spanish will be included, that could cause a language bias.
- A comprehensive search in health, multidisciplinary and technological databases will be conducted.

INTRODUCTION

Quality of life (QoL) has multiple frameworks and according to Brown *et al*[1] it can be concluded as: 'QoL is inherently a dynamic, multi-level and complex concept, reflecting objective, subjective, macro-societal, and micro-individual, positive and negative influences which interact together'. When this concept is applied to elderly the domains 'Health perception', 'Autonomy', 'Role and activity', 'Attitude and adaption' and 'Relationships' are most covered by the majority of elderly population although other domains like 'Spirituality' and 'Financial security' are less covered but important by some elderly groups.[2]

Cognitive impairment is one of the consequences of ageing, its prevalence is increasing and it is often associated with a decline in functional capacity, indicator of QoL for the elderly and increased socioeconomic expenditure.[3–5] Thus, cognitive impairment is one of the most important problems in health systems and in our society. By 2018, 50 million people were living with some kind of dementia, a figure estimated to rise to 152 million people by 2050. This produced an economic expenditure of US$1 trillion in 2018 and is expected to rise to US$2 trillion by 2030.[6] This deterioration occurs particularly in the frontostriatal system which, being

connected to the medial temporal regions, implies an alteration in memory and executive functions.[7] Furthermore, an uptake in mild cognitive impairment (MCI) has been detected over the years. This can lead to some types of dementia with Alzheimer's disease being the most common.[8]

Clinical and epidemiological evidence has indicated that patients with Alzheimer's disease or dementia go through a long preclinical phase in which cognitive deficits remain subtle before the dementia threshold is reached.[9] Thus, MCI is considered to be a state of transition between the cognitive alterations characteristic of old age and dementia.[10 11] In a broad spectrum of the elderly population, MCI is underdiagnosed[12] and, moreover, the fact that drug treatments have been shown to have a limited effect[13] makes preventive measures against cognitive impairment and dementia particularly necessary. In this sense, non-pharmacological preventive measures have been gaining ground in the scientific community, especially bearing in mind the modifiable risks of cognitive deterioration in adulthood at the age of 45, which include obesity, diabetes, depression, physical inactivity or social isolation.[14 15] It has been shown that those individuals with greater participation in mentally and socially stimulating activities were related to less cognitive deterioration and a lower risk of Alzheimer's.[16]

Smart ageing is a term that is often used interchangeably with healthy ageing or active ageing[17] but it can be described as intelligently using modern biomedical, digital healthcare, computing and communication technologies.[18] Based on the review of Baraković *et al*[17] Information and Communication Technology (ICT) solutions that are designed for smart ageing contribute to 7 out of 9 smart ageing determinants of its framework: (1) physical activity, (2) new technologies, (3) long-term care, (4) environment and accessibility, (5) social inclusion and participation, (6) diet and nutrition and (7) access to services. For that reason, ICT solutions encompasses a series of technological tools, such as individual computers, video games, internet, applications and so on which offer an ideal resource for designing both stimulation interventions, designed to participate in activities to improve cognitive and social functioning,[19] and cognitive training interventions, designed as a guided standardised tasks to enhance particular cognitive functions.[19] It should be taken into account that these cognitive strategies are the most prominent ones for the prevention and treatment of cognitive impairment.[13 20–22] The use of computer programmes to carry out cognitive training is known as computerised cognitive training (CCT) and the scientific literature on CCT as a preventive measure of cognitive impairment is on the increase.[23] On the other hand, the use of technologies to achieve a general enhancement of cognitive and social functioning is known as computerised cognitive stimulation (CCS).[24] CCS programmes demonstrates that can improve episodic memory.[25] Furthermore, it has been shown that elderly people do not need to be experts in technology to complete or benefit from this training.[26] The use of video games and/or virtual reality are other very attractive tools, as they provide a cognitively stimulating environment, allow the simulation of more realistic situations and offer the opportunity to combine them with other preventive strategies for cognitive impairment, such as physical exercise.[27] The results found on the use of ICTs for the prevention of cognitive impairment seem to have similar or even better effects compared with more traditional cognitive training approaches, where a trained person is required to carry out the face-to-face sessions, with the consequent needs for travel, physical space and timetables among other requirements.[28 29] Those beneficial outcomes on CCT are shown in different studies, a prior systematic review (SR) with meta-analysis evidenced that CCT is effective at enhancing cognitive function in healthy older adults specifically for nonverbal memory, processing speed, working memory (WM) and visuospatial outcomes, but not for attention and executive functions.[23] A randomised controlled trial (RCT) showed improvements in cognitively unimpaired older adults with multiple dementia risks factors on memory and processing speed, and on global cognition.[30] And a recent RCT demonstrates that CCT provides benefits on executive functions, but when the CCT is combined with exercise it improved multiple cognitive processes of executive functions.[31] The type of interventions has varied as well as the duration of these said interventions, the SR of Lampit *et al*[23] evidenced that training sessions undertaken more than three times a week or sessions lasting less than 30 min may be ineffective. Moreover, the use of CCT can be directed to a specific cognitive function, it can be personalised to individuals, the use of gamification led to a more enjoyable and immersive experience, it can provide quantitative feedback immediately and it can be delivered on common and portable digital plaforms.[32]

This suggests that the use of ICT is a promising preventive alternative for cognitive impairment and dementia.[33–35] As a result, there has been an exponential increase in research in the last 10 years using different types of ICTs to prevent dementia in the healthy adult population or those at risk of cognitive deterioration.[33]

It is important to highlight the current COVID-19 pandemic, which has stressed global health systems and, in the case of people with some type of dementia, has caused a decrease of psychological well-being in both patients as well as caregivers, which may result in a decline of general health and QoL on both sides.[36] Some centres quickly opted for assistance through telemedicine replacing the face-to-face model,[37] therefore making it necessary to advance growth in digital technologies and telemedicine.[38] The aim of this review is to ascertain the scientific evidence on the use of ICT in a healthy adult population or one at risk of dementia for the prevention of cognitive impairment, in order to obtain high quality evidence through this SR of RCTs and future interventions could be designed.

OBJECTIVE

The main objective of the SR will be to review and analyse the use of ICTs for the improvement of cognitive functions

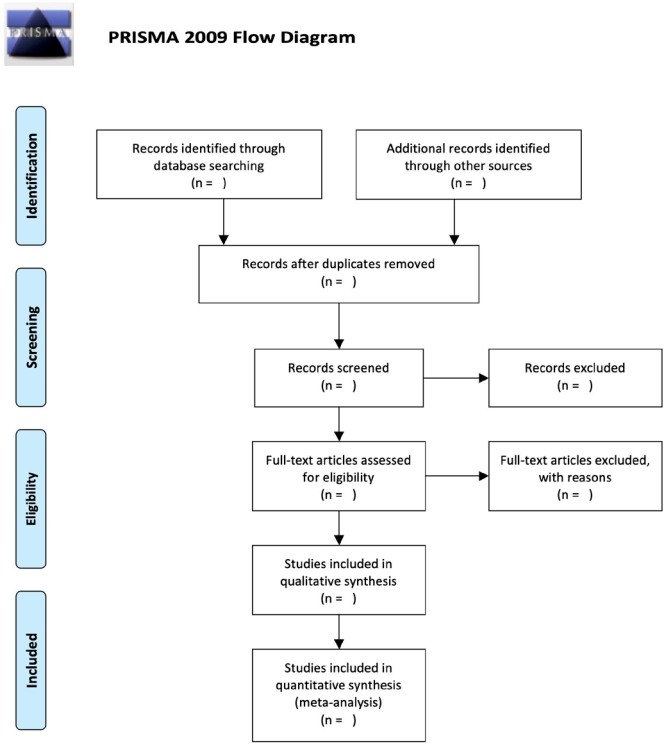

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram.

in healthy older adult population aged 50 and over, for the prevention of cognitive impairment not related to accidents or diseases associated with it.

METHOD AND DESIGN

Design

The present study is based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) guidelines.[39] The review will follow the planning to systematically evaluate and synthesise the data obtained from the RCTs in cognitive improvement using ICTs in adult users without a diagnosis of cognitive impairment or associated accidents. For the selection of studies, the PRISMA flow diagram will be applied (figure 1), for the SR, the PRISMA Statement will be applied.[40]

Inclusion and exclusion criteria

Participants

All studies with human adult participants 50 years and older will be included, as this is the age where aspects related to memory and its improvement for the prevention of MCI begins. Participants must not have been diagnosed with cognitive impairment or associated diseases or accidents, such as diabetes mellitus, circulatory problems or a mental illness. Studies using available ICTs to improve cognitive functions for cognitive stimulation or cognitive training will be included. Some of the different technologies that will be used are: specific applications and software for memory training used in mobile devices or computers, wearables for tracking and monitoring activities of daily living or exergames dedicated to improving the physical and mental function of people.

Design of the studies

RCTs will be included in all of the designs that use ICTs to improve cognitive functions to prevent MCI. Information obtained from books, master's or doctoral theses, conference papers, reports or scientific posters will be excluded.

Language and publication dates

Studies published in English or Spanish will be searched, as well as being limited in time: from 2010 until the date of the search.

Outcomes

Articles will be included that report data on global cognitive function measured through validated instruments such as the Montreal Cognitive Assessment (MOCA)[41] or the Minimental-State Examination (MMSE).[42] We will also considerate cognitive tests that measures specific cognitive function subdomains such as verbal memory, non-verbal memory, WM, processing speed, attention, language, visuospatial skills and executive functions.

Identification and selection of studies

The following databases will be searched, Medline (PubMed), CinahlPlus, Scopus, Embase, WoS, CENTRAL and IEEE Xplore, the search will be completed on ClinicalTrials.gov and Google Scholar, as well as a manual search, checking the bibliography of the eligible studies and the indexes of relevant journals, to ensure we do not lose any results. A specific sensitive filter will be used to retrieve RCTs. Finally, a manual and Google Scholar search will be performed to ensure that all relevant studies have been found. The search strategy for Medline (PubMed) will be designed (see online supplemental annex 1) and will follow the recommendations of the Peer Review of Electronic Search Strategies Statement.[43] The search was tested on July 2021. Once the authors have reached a consensus, the strategy will be transferred to the aforementioned databases, adapting it to the specific characteristics of each one (syntax and proximity operators). The references obtained will be downloaded in the EndNote V.X9.2 software,[44] which will also be used for the deduplication process.

Selection process

The unique results obtained after the deduplication process will be exported to the Covidence platform.[45] Through this platform, a first screening by title and abstract will be done by two independent reviewers according to the inclusion and exclusion criteria, with the premises of relevant, irrelevant or doubt. When there is no consensus, as well as in the case of doubts, a third reviewer, in discussion with the other two reviewers, will make the choice. Once this screening by title and abstract has been completed, the full texts of the articles will be searched, which will also be entered into Covidence,[45] the screening of the full text will be done by two independent

reviewers according to the criteria of inclusion and exclusion with the premises of relevant, irrelevant or doubt. At this level the reviewers will give the reason for the exclusion of the article. When there is no consensus either on the inclusion or exclusion, on the grounds of doubt nor on the reason for exclusion, a third reviewer, in discussion with the other two reviewers, will make the choice.

Evaluation of the quality of studies

Once the screening process by title and abstract and by full text has been completed, the quality of the articles included will be evaluated. Two independent researchers will analyse the quality assessment according to the revised tool for assessing risk of bias in randomised trials (RoB2).[46] This tool assesses the quality of the studies, which will be based on the study design and the outcomes. Depending on the response of the reviewers and the scoring algorithm, each study will be determined to have 'low risk', 'some risk concerns' and 'high risk' of bias. A third reviewer will resolve discrepancies in the quality assessment of the two main reviewers for a final decision.

Extraction of results

An adapted Cochrane form will be used to extract the relevant data from each of the studies included for the final synthesis. Two review authors will be involved in the data extraction, who will initially pilot a submaster of the included articles. The two reviewers will extract the data from this subsample independently as a means to check that the data are extracted correctly. Once the process has been agreed on, two independent reviewers will extract the data from the included articles. Once the process has been completed, the two reviewers will pool the extracted data in order to reach an agreement. The data to be extracted will be:

- Identification data of the study: authors, year of publication and country of publication.
- Study design data: sample size, recruitment strategy, inclusion and exclusion criteria, duration of the intervention, type of intervention and technology used in the intervention.
- Characteristics of the participants: average age and gender.
- Methodological aspects: quality assessment according to the RoB2 tool and limitations of the study.

Outcomes:

- Data on global cognitive function evaluated through validated instruments, for example, MOCA,[41] MMSE[42] among others.
- Data on specific cognitive function subdomains such as verbal memory, nonverbal memory, WM, processing speed, attention, language, visuospatial skills, and executive functions evaluated through validated instruments.

Synthesis of the data

A narrative synthesis of the results will be made, according to the objectives of each intervention and according to the characteristics described in the data extraction. The data will be presented according to the technology used for the improvement of the cognitive function taking into account age and gender of participants. Tables will be included to summarise the results of the interventions with the comparison groups and the outcomes used in the clinical trials.

If the outcome measures are sufficiently homogeneous or the scales used are the same to measure cognitive improvement, a meta-analysis will be performed.

Patient and public involvement

Patients, public and private institutions, and other entities are not involved in the development of the research question, outcome measures or study design. This research will not involve the participation of patients.

ETHICAL ASPECTS AND DISSEMINATION

The proposed SR is expected to be completed by January 2021. There are no ethical issues associated with this study. No patients will be recruited. The results of the research will be published in peer-reviewed academic journals.

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Contributors MG-S developed the research question and study methods. RP-P, HF-L and ERA drafted the protocol. RP-P and FB conducted the search strategy for the protocol. FB and JM-S contributed to the revision of the manuscript.

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