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# Willingness, Perceived Barriers and Facilitators in Adopting Mobile Applications for Health-Related Interventions among Older Adults: A Scoping Review Protocol



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# Willingness, Perceived Barriers and Facilitators in Adopting Mobile Applications for Health-Related Interventions among Older Adults: A Scoping Review Protocol

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## ABSTRACT

**Introduction:** Technology has brought a remarkable changes to the healthcare industry. Mobile healthcare applications has becoming increasingly popular crosses all ages and genders. The world's older population continues to grow at an unprecedented rate which in turn associated with higher morbidity and greater demand for specialised health services. Given the steady growth of mobile phones' usage, and its potential as a platform for improving the health of older adults, along with the projected growth of this subpopulation, it is important to identify current evidence of mobile applications use by older adults for health purposes. In this paper, we outline our scoping review protocol to

systematically review published literature specific to older adults' willingness, perceived barriers and facilitators in adopting mobile applications for health-related interventions.

**Methods and analysis:** Arksey and O'Malley's scoping review methodology framework will guide the conduct of this scoping review. We will search electronic databases (MEDLINE (Pubmed), EMBASE, OVID, COCHRANE, Google Scholar and Science Direct), grey literature sources and the reference lists of key studies to identify studies appropriate for inclusion. Two reviewers will independently screen all abstracts and full-text studies for inclusion. All bibliographic data, study characteristics and indicators will be collected and analysed using a tool developed through an iterative process by the research team. The extracted data will undergo a 'narrative review' or a descriptive analysis of the contextual or process-oriented data and simple quantitative analysis using descriptive statistics.

**Ethics and dissemination:** Since the data used are from publicly available sources, this study does not require ethical approval. Results will be disseminated through academic journals, conferences and seminars. We anticipate that our findings regarding older adults' perspectives towards mobile applications use will aid technology developers and health professionals working in the area of ageing and rehabilitation.

**Keywords:** Scoping review, mobile application, older adult, ageing, perception, barrier, facilitator.

## STRENGTHS AND LIMITATIONS

- This scoping review will capture current issues and opportunities related to technology-enabled mobile applications among older adults.
- The search procedures includes six online peer-reviewed databases and a wide range of bibliographical research sources outside of these databases.
- Findings from this review will provide valuable insights that will be used to target one or more identified key areas to better understand how technology can be utilised to bring positive health outcomes among older generations while inform the best practices in technology design.
- This scoping review protocol only considers material written in English where large number of publication in other language will be missed out.
- All the studies included will not undergo quality assessment as this is beyond the aim of a scoping review where the aim of this type of review is to produce broad insights of an emerging domain.

## INTRODUCTION

Technological innovations have enabled us to carry out tasks effectively and efficiently. The field of technology-supported health care is remarkably growing and provides new ways of self-management education and support. Mobile phones, for example, have been

used to bridge health disparities and serve as a platform for a variety of self-management tools, such as apps.

The number of mobile phone use is constantly increasing every year. It is reported the percentage of smartphone users in Malaysia rose from 68.7% in 2016 to 75.9% in 2017 and it is forecasted to continue rising in the next 10 years (1). This rapid growth of mobile phone use has led to a scenario where mobile phone are considered pervasive that crosses all ages and gender. Older adults may be viewed as technological laggards have also been using mobile phones at increased rates. According to the Hand Phone User Survey in 2017 by the Malaysian Communication and Multimedia Commission, nearly 20% of older adults aged 50 and above owned a mobile phone (1). The trend of mobile phone ownership within this subpopulation reported rose substantially from 2009 to 2014, with 11.8% to 14.4% respectively (2). Furthermore, the trend of using the internet through handheld devices such as mobile phones and tablets are currently viewed as a powerful medium to tackle various health challenges among the ageing population when compared to computers, laptops and other technology devices (3). Hence, this suggests that if system designers and/or health professionals were to choose a technology platform that

would reach the majority of older adults, mobile phones would be a perfect fit due to its high usage and penetrance rate.

The number of people aged 65 years and over in Malaysia has increased gradually since the 1970s (4, 5). This number is projected to grow briskly, will triple from 2.0 million today to more than 6.0 million by 2040 (4, 5). Apart from an increased in the older adults population, this subpopulation is also living longer as evidenced by an increase in life expectancy (4-7). This may result from advances in medicine, thorough control of infectious diseases, availability of safer foods, better sanitary conditions and other nonmedical social improvements (8). The elderly in general, are less healthy than the younger population which in turn associated with higher morbidity, higher use of health services (number of visits to doctors and hospitalizations) and greater demand for specialized services (9). All these factors will lead to an increase in the complexity of health services required and increased expenditure. These factors combined with the growth of mobile phone use among the older adult population, suggest that by employing mobile phone as a platform for health and/or disease management interventions may be a viable way forward.

Given the steady growth of mobile phones' usage, and its potential as a platform for improving the health of older adults, along with the projected growth of this subpopulation, it is important to identify current evidence of use of mobile phones by older adults for health purposes. Furthermore, it is crucial to understand the gaps and challenges in order to inform the design of future systems due to the ubiquity of mobile phones. Therefore, this review aims to identify older adults' willingness, perceived barriers and facilitators in adopting mobile phone for health-related interventions.

## METHODS AND ANALYSIS

### Patient and Public Involvement

No patient involved.

### Protocol Development

Methods for this study were developed based on Arksey and O'malley's scoping review methodology (10) and Levac et al's (11) methodological enhancement. According to this framework, there are five different stages in undertaking a scoping review which includes ;

(1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collating, summarizing and reporting the results. We will follow and adopt PRISMA reporting guidelines for systematic reviews (12) and use PRISMA-P checklist (12) to accurately report the results and analysis summary. The PRISMA-P checklist is attached as online supplementary Appendix 1. PROSPERO registration is not required as it is a scoping review.

**Stage 1: Identifying the research question.**

Arksey and O'Malley (10) describe the definition of a relevant research question as a crucial initial step that define and refines the chosen research strategy. The research questions for this review are :

1. What is the level of willingness to use mobile applications in monitoring health condition among older adults?
2. What are the potential barriers in using mobile applications in monitoring health condition among older adults?
3. What motivates older adults to use mobile applications in monitoring their health condition?

To be able to comprehensively map and synthesise a potentially fast-growing and fragmented volume of literature on the use of mobile applications among older adults, overarching research questions is defined as what is the current level of older adults' willingness in utilising mobile phone to manage and monitor their health condition as well as the perceived barriers and facilitators towards the use of such technology.

### Stage 2: Identifying relevant studies

The identification of relevant literature will consist of three-stage approach. The first stage is searching the electronic databases using standardized search terms adapted to the requirements of each respective database. MEDLINE (Pubmed), EMBASE, OVID, COCHRANE, Google Scholar and Science Direct will be systematically searched for relevant publications using predefined search terms. In order to achieve the level of comprehensiveness required for scoping review, we will also hand search key electronic journals, including the Journal of the American Medical Informatics Association (JAMIA), the Journal of Medical Internet Research (JIMR), the International Journal of Digital Healthcare, Digital Health (SAGE) and the Journal of m-health. The second stage involves searching the reference lists of literature that meets all inclusion criteria. The third and final

stage involves hand searching specific key publications such as identified white papers or conference presentations for any references we may have missed. We will search relevant grey literature databases (eg, Grey Literature Report, OpenGrey, Web of Science Conference Proceedings) to identify studies, reports and conference abstracts of relevance to this review.

Search terms from key words, subject heading and synonyms such as mobile application*, mobile app*, mhealth, mobile health, mobile health, telehealth, mobile technolog*, older adult*, elder*, ageing population, older population, aging, geriatric, perspective, view, attitude, mindset, willingness, readiness, barrier, limitation, difficulty, restriction, drawback, facilitate*, motivate*, promote*, help, ease, aid will be generated by the research team members in order to capture any potential resources from the databases. Table 1 outlines the initial keywords and search terms generated. Boolean operators (AND, OR, NOT) will be used to combine search terms within related keywords. An additional search will be carried out using updated search terms if there are any search terms were missing. Table 2 shows the search strings generated.

**Table 1** List of keywords and synonyms generated as search terms

| Mobile application | Older adults | Perspective | Barrier | Facilitates |
|---|---|---|---|---|
| Mobile app* | Elderly | View | Limitation | Motivate* |
| mHealth | Ageing population | Attitude | Difficulty | Promote* |
| Mobile health | Older population | Mindset | Restriction | Help |
| Telehealth | Aging | Willingness | Drawback | Ease |
| Mobile technolog* | Geriatric | Readiness | | Aid |



Table 2 List of search strings

| | |
|---|---|
| **Search string 1:** | "Mobile application*" OR "mobile app" OR "mHealth" OR "mobile health" OR "telehealth" OR "mobile technology" AND "Older adults" OR "Elderly" OR "Ageing population" OR "Older population" OR "Aging" OR "Aging" OR "Geriatric" |
| **Search string 2:** | "Mobile application*" OR "mobile app" OR "mHealth" OR "mobile health" OR "telehealth" OR "mobile technology" AND "Perspective*" OR "View" OR "Attitude" OR "Mindset" OR "Willingness" OR "Readiness" |
| **Search string 3:** | "Mobile application*" OR "mobile app" OR "mHealth" OR "mobile health" OR "telehealth" OR "mobile technology" AND "Barrier*" OR "Limitation*" OR "Difficulty" OR "Restriction*" OR "Drawback*" |

| | |
|---|---|
| Search string 4 : | "Mobile application*" OR "mobile app" OR "mHealth" OR "mobile health" OR "telehealth" OR "mobile technology" AND "Facilitate*" OR "Motivate*" OR "Promote*" OR "Help" OR "Ease" OR "Aid" |

## Stage 3: Study selection

The third stage of the framework of Arksey and O'Malley's framework (10) aims to identify the studies that will be included in the scoping review. Inclusion criteria for the search will be studies ranging from January 2009 to April 2019. The review process will consist of two levels of screening: (1) a tittle and abstract review and (2) full-text review. Studies will be considered eligible if they address older adults' perspectives with regards to their willingness, barriers and facilitators towards the use of mobile application in managing health.

Eligibility criteria:

- Published in the English language
- Must contain older populations aged 60 and older
- Time frame of 10 years (January 2009 to April 2019)
- Peer-reviewed primary research (e.g. journal and conference publications)

Exclusion criteria are :

- Literature, scoping, systematic and other reviews.

For the first level of screening, one reviewer will screen tittles and abstracts of the articles to exclude those that do not meet the eligibility criteria identified in the second stage of the protocol. For those fulfilling the eligibility criteria, the full article will be retrieved.

In the second level of screening, the review team will then each independently assess the full-text articles to determine if they meet the inclusion/exclusion criteria.

A sample of the retrieved articles will be screened by another team member to ensure a consistent application of the eligibility criteria for inclusion in the review. Disagreements about study eligibility of the sampled articles will be discussed between the two reviewers until consensus is reached or by arbitration of a third reviewer, if required.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart (12) will be used in the study selection process and will be updated once the review is completed (online supplementary material 2).

### Stage 4: Charting the data

A data extraction framework will be developed to confirm study relevance and to extract study characteristics. Study characteristics to be extracted will include, but not be limited to: standard bibliographical information (ie, authors, title, journal and year of publication), type and objectives of the review will be reported. For each article, information on the interventions covered by the review, characteristics of the study population, settings, characteristics of the mobile application used or tested, type of outcome assessed (ie. older adults' perspectives; their willingness and readiness) as well as barriers and facilitators towards the use of mobile phones and/or mobile applications among older adults. A combination of EndNote X8 and Microsoft Excel 2017 will be used to organize and track relevant data. We will use these software to (1) remove duplicates; (2) document and manage the screening process; (3) categorize publications that meet the inclusion and exclusion criteria; (4) extract, organize, and search related data and information from the publication content and (5) manage of full texts version of included publications; including adding relevant notes that include key data extraction insights.

### Stage 5: Data Synthesis

Using the information collected from the data extraction form, the key characteristics of included studies will be summarised qualitatively and tabulated. All key findings will be described in narrative form. We will also be conducting a content analysis, identify emergent themes with regards to willingness, barriers and facilitators from older adults. We will collect and identify objectives and gaps in our understanding of the current state or research. The discussion will be structured based on the themes that emerge.

## ETHICS/DISSEMINATION

This scoping review protocol reports a comprehensive methodology. Since the data used are from publicly available sources, this study does not require ethical approval. Findings from this review will be disseminated through academic journals, seminars and conferences. We anticipate that our findings regarding older adults' perspectives towards mobile applications use could guide the direction of future research and aid technology developers as well as health professionals working in the area of ageing and rehabilitation.

## REFERENCES


1. COMMISSION MCAM. Hand Phone Users Survey 2017. Malaysia: Malaysian Communications and Multimedia Commission; 2017.
2. Commission MCaM. Hand Phone Users Survey 2014. In: Malaysia SKdM, editor. Selangor: Malaysian Communications and Multimedia Commission; 2014.
3. Barnard Y, Bradley MD, Hodgson F, Lloyd AD. Learning to use new technologies by older adults: Perceived difficulties, experimentation behaviour and usability. Computers in Human Behavior. 2013;29(4):1715-24.
4. Population and Demographics : Ageing [press release]. Department of Statistics Malaysia2017.
5. Karim HA. The elderly in Malaysia: demographic trends. The Medical journal of Malaysia. 1997;52(3):206-12.
6. Current Population Estimates, Malaysia, 2017-2018 [press release]. Malaysia2018.
7. Mafauzy M. The problems and challenges of the aging population of malaysia. Malays J Med Sci. 2000;7(1):1-3.
8. Gordon B Lindsay RMM, Riley J Hedin. The Contribution of Public Health and Improved Social Conditions to Increased Life Expectancy: An Analysis of Public Awareness. Journal of Community Medicine & Health Education. 2014.
9. Davies AM. Epidemiology and the challenge of ageing. International journal of epidemiology. 1985;14(1):9-21.
10. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. International Journal of Social Research Methodology. 2005;8(1):19-32.
11. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implementation science : IS. 2010;5:69.

12. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. International Journal of Surgery. 2010;8(5):336-41.



## AUTHOR'S CONTRIBUTIONS

AF was responsible for developing the conception of study, reading and approving this manuscript's final version; giving final approval for the version that will be published, ensuring the integrity in all aspects of the work as well as making sure all research

questions were addressed accordingly. SS was responsible for approving the design of the study; doing thorough review to ensure intellectual content; reading and approving the final manuscript; giving the approval for the version that will be published, and ensuring all research questions are analysed accordingly. SAMH contributed to the design of the study; acquired data about the research, read and approved the final manuscript and gave the final approval for the published version.

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## COMPETING INTERESTS STATEMENT

None declared.

## SUPPLEMENTARY FILES

Supplementary File 1: PRISMA-P 2015 Checklist

Supplementary File 2: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart

## SUPPLEMENTARY MATERIAL 1

PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist : recommended items to address in a systematic review protocol*

| Section and topic | Item No | Checklist Item |
|---|---|---|
| **ADMINISTRATIVE INFORMATION** | | |
| Title: | | |
| Identification | 1a | Identify the report as a protocol of a systematic review |
| Update | 1b | If the protocol is for an update of a previous systematic review, identify as such |
| Registration | 2 | If registered, provide the name of the registry (such as PROSPERO) and registration number |
| Authors: | | |
| Contact | 3a | Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author |
| Contributions | 3b | Describe contributions of protocol authors and identify the guarantor of the review |
| Amendments | 4 | If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments |
| Support: | | |
| Sources | 5a | Indicate sources of financial or other support for the review |
| Sponsor | 5b | Provide name for the review funder and/or sponsor |
| Role of sponsor or funder | 5c | Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol |
| **INTRODUCTION** | | |
| Rationale | 6 | Describe the rationale for the review in the context of what is already known |
| Objectives | 7 | Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO) |
| **METHODS** | | |
| Eligibility criteria | 8 | Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review |
| Information sources | 9 | Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage |
| Search strategy | 10 | Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated |
| Study records: | | |
| Data management | 11a | Describe the mechanism(s) that will be used to manage records and data throughout the review |

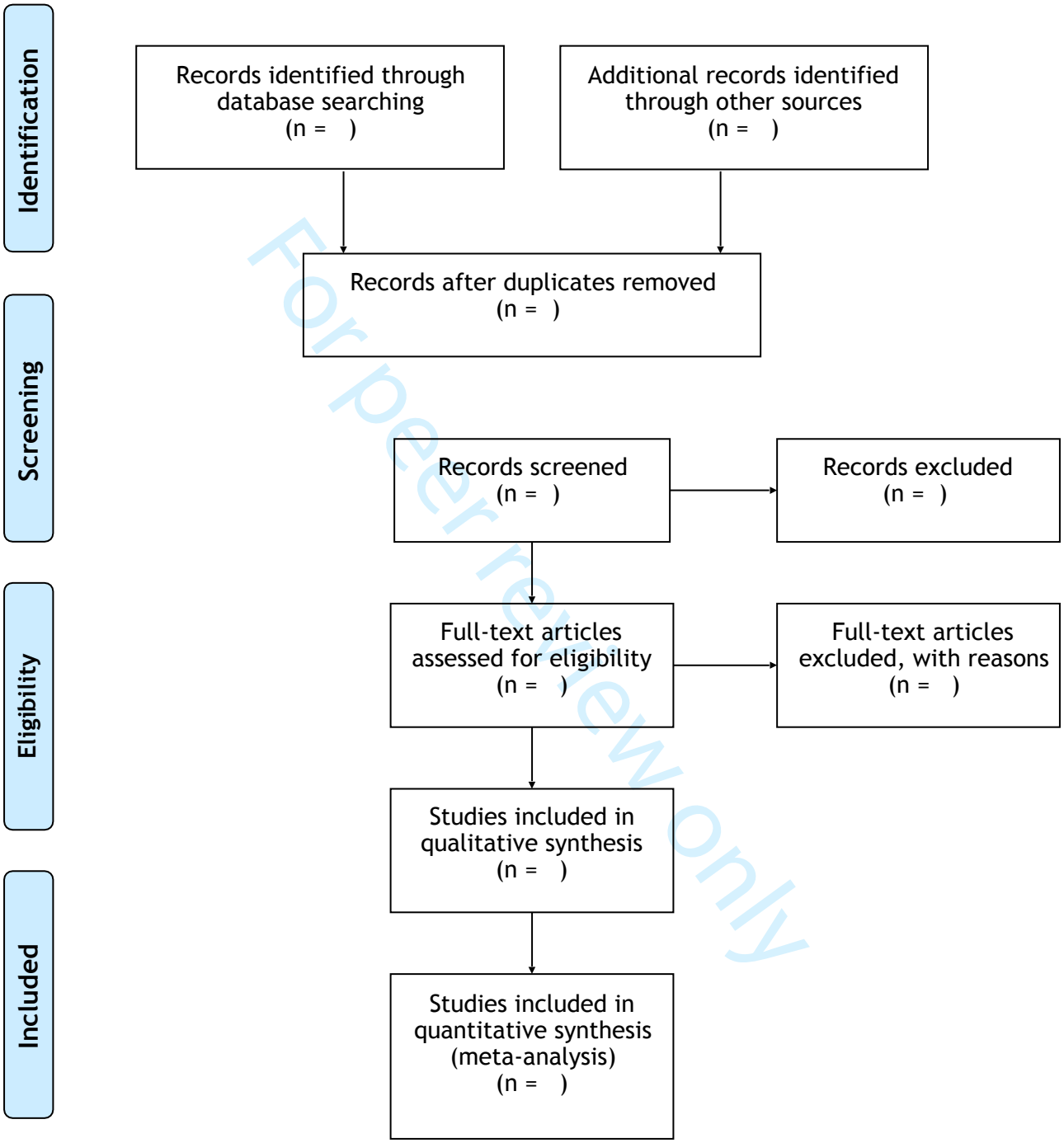
| | | |
|---|---|---|
| Selection process | 11b | State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis) |
| Data collection process | 11c | Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators |
| Data items | 12 | List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications |
| Outcomes and prioritization | 13 | List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale |
| Risk of bias in individual studies | 14 | Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis |
| Data synthesis | 15a | Describe criteria under which study data will be quantitatively synthesised |
| | 15b | If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as $I^2$, Kendall's $\tau$) |
| | 15c | Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression) |
| | 15d | If quantitative synthesis is not appropriate, describe the type of summary planned |
| Meta-bias(es) | 16 | Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies) |
| Confidence in cumulative evidence | 17 | Describe how the strength of the body of evidence will be assessed (such as GRADE) |

*** It is strongly recommended that this checklist be read in conjunction with the PRISMA-P Explanation and Elaboration (cite when available) for important clarification on the items. Amendments to a review protocol should be tracked and dated. The copyright for PRISMA-P (including checklist) is held by the PRISMA-P Group and is distributed under a Creative Commons Attribution Licence 4.0.**

*From: Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart L, PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ. 2015 Jan 2;349(jan02 1):g7647.*

**SUPPLEMENTARY MATERIAL 2**

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart



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| Secondary Subject Heading: | Research methods, Global health, Public health |
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## ABSTRACT

**Introduction:** The world's older population continues to grow at an unprecedented rate. An ageing population poses new and great challenge to our healthcare system that requires new tool to tackle the complexity of health services as well as the increasing expenses. Mobile health applications (mHealth app) is seen to have the potential to address these challenges, alleviating burdens on the healthcare system and enhance the quality of life for older adults. Despite the numerous benefits of mHealth apps, relatively little is known about whether older adults perceive that these apps confer such benefits. Their perspectives towards the use of mobile applications for health-related purposes have also been little studied. Therefore, in this paper, we outline our scoping review protocol to systematically review literature specific to older adults' willingness, perceived barriers and motivators towards the use of mobile applications to monitor and manage their health. .

**Methods and analysis:** Arksey and O'Malley's scoping review methodology framework will guide the conduct of this scoping review. The search strategy will include numerous electronic databases, grey literature sources and hand-searching of reference lists to identify studies appropriate for inclusion. Two reviewers will independently screen all abstracts and full-text studies for inclusion. All bibliographic data, study characteristics and indicators will be collected and analyzed using a tool developed through an iterative process by the research team. The extracted data will undergo a descriptive analysis of the contextual data and simple quantitative analysis will be conducted using descriptive statistics. Finally, engagement with relevant stakeholders will be carried out to gain more insights into our data from different perspectives.

**Ethics and dissemination:** Since the data used are from publicly available sources, this study does not require ethical approval. Results will be disseminated through academic journals, conferences and seminars. We anticipate that our findings regarding older adults' perspectives towards mobile

applications to monitor and manage their health will aid technology developers and health professionals working in the area of ageing and rehabilitation.

**Keywords:** Scoping review, mobile application, mHealth, older adult, ageing, perception, barrier, motivator

## STRENGTHS AND LIMITATIONS

- This scoping review will capture current issues and opportunities related to technology-enabled mobile applications among older adults.
- Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Review tool will be used in order to ensure a systematic approach to searching, screening, charting, collating, reporting and stakeholders consultation.
- The search strategy is comprehensive and includes both peer-reviewed literature (electronic bibliographic databases) and grey literature.
- Despite the strength, this scoping review only considers studies written in English where large number of studies in other languages will be missed out.
- As this is a scoping review, critical appraisal of the study quality and the risk of bias will not be undertaken.

## INTRODUCTION

The world's older population continues to grow at a rapid pace. Today, there are 703 million people aged 65 years or over in the world (1). This number is projected to double to 1.5 billion in 2050 with the proportion of one in six people in the world will be aged 65 years or over (1). In the case of Malaysia's population, this subpopulation has increased gradually since the 1970s and expected to be tripled from 2.0 million today to more than 6.0 million by 2040 (2, 3). This phenomenon represents one of the remarkable achievement of mankind history with respect to health, social and economic improvements over time (1). The improvements in health care system such as infections control, immunizations and better access in health care are among the huge contributors to the sustained increases in life expectancy across the globe (4-6).

However, this success history of human life expectancy did not come with a proportionate increase in quality of life for older adults. As heavily discussed in the literature, increased life expectancy has increased the risk in developing chronic diseases, disability and dementia prior to death (7, 8). This explains a higher use of health services and greater demand for specialized services among the elderly (9-11). Consequently, this puts increasing pressure on the economy and social systems in most countries due to the complexity of health services required along with increased health expenditure (12-14).

Technological innovations have enabled us to carry out tasks effectively and efficiently. The field of technology-supported health care is remarkably growing and provide new ways of self-management and support. Although older adults may be seen as technological laggards, the internet usage among this subpopulation has been reported to increase from year to year (15). For instance, in the UK, the internet usage among older adults aged 65 to 74 group has increased gradually over the last eight years, with 52% in 2011 to 83% in 2019 (16). To add, the trend of smartphone ownership reported to grow rapidly across the globe (17).

This rapid growth of technology, particularly in smartphones and internet use, has led to a surge of interest in using mobile applications as a tool to seek health information as well as to monitor and manage health (commonly known as mobile health or mHealth) (18-20). mHealh is defined as "medical and public health practice supported by mobile devices, personal digital assistants and other wireless devices" (21). There are more than 325,000 identified mHealth applications covering diverse of health, fitness and medical topics (22, 23). There is clear evidence that mHealth applications is effective in improving self-care, self-management, self-efficacy, medication adherence as well as in improving health behaviours such as quality of sleep, diet, physical activity and mental health (24). In particular to older adults population, there are a number of studies demonstrating the benefits of mHealth towards older adults. This includes, it can help to address existing barriers to treatment such as long waiting time at hospital, poor access to transportation and increased cost of healthcare services (25-29)

The steady growth of older adult population combined with rising trend in technology uptake within this subpopulation suggest mHealth applications may represent a novel way to improve the health of older adults as well as to reduce healthcare cost. Despite the numerous benefits of mHealth applications (30-33), relatively little is known about whether older adults perceive that these apps confer such benefits. Their perspectives towards the use of mobile applications for health-related purposes have also been little studied. Therefore, this review aims to identify older adults' willingness, perceived barriers and motivators towards the use of mobile applications to monitor and manage their health.

## METHODS AND ANALYSIS

### Protocol Development

This study will adopt Arksey and O'Malley's (34) scoping review methodology enhanced by Levac et al (35) as well as the updated framework by The Joanna Briggs Institute (36). According to this framework, there are six different stages which includes; (1) identifying the research question, (2) identifying relevant studies, (3) selecting studies, (4) charting the data, (5) collating, summarizing and reporting results, and (6) consulting with stakeholders. The scoping review will also adhere to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) (37). The PRISMA-ScR checklist is attached as Supplementary File 1. PROSPERO registration is not required as it is a scoping review.

### Stage 1: Identifying the research question.

Arksey and O'Malley (34) describe the definition of a relevant research question as a crucial initial step that define and refines the chosen research strategy. We have identified one overarching research question to guide our systematic search strategy and reporting of results: 'What is known about the perspectives in adopting mobile applications for health-related interventions among older adults?'. We aim to provide answers for the following sub-questions:

1. What is the level of willingness among older adults in using mobile applications to monitor and manage their health conditions?
2. What are the existing barriers among older adults in using mobile applications to monitor and manage their health conditions?
3. What motivates older adults to use mobile applications to monitor and manage their health conditions?

**Stage 2: Identifying relevant studies**

The search strategy was collaboratively developed by our research team. In order to determine the relevance of the citations and to resolve any potential disagreements, the research team will meet to refine the study inclusion and exclusion criteria prior to assessing the articles independently. Our literature search is open, including both peer-reviewed literature as well as grey literature ie. evidence not published in peer-reviewed publications and from the first ten pages in the Google search engine.

The identification of relevant literature will consist of three-stage approach. The first stage is searching the electronic databases using standardized search terms adapted to the requirements of each respective database. The following electronic databases have been selected: (1) PubMed; (2) Excerpta Medica Database (EMBASE); (3) Cumulative Index to Nursing and Allied Health Literature (CINAHL); (4) COCHRANE Library; (5) Google Scholar; and (6) ScienceDirect. In order to achieve the level of comprehensiveness required for scoping review, we will also hand search key electronic journals, including the Journal of the American Medical Informatics Association (JAMIA), the Journal of Medical Internet Research (JMIR), the International Journal of Digital Healthcare, Digital Health (SAGE) and the Journal of mHealth. The second stage involves searching the reference lists of literature that meet all inclusion criteria. The third and final stage involves hand searching specific key publications such as identified white papers or conference presentations for any references we may have missed. We will search relevant grey literature databases (eg, Grey Literature Report, OpenGrey, Web of Science Conference Proceedings, Government Document, academic thesis/dissertation) to identify studies, reports and conference abstracts of relevance to this review.

Search terms from key words, subject heading and synonyms such as mobile application*, mobile app*, mhealth, mobile health, mobile health, telehealth, mobile technolog*, older adult*, elder*, ageing population, older population, aging, geriatric, perspective, view, attitude, mindset, willingness, readiness, acceptability, barrier, limitation, difficulty, restriction, drawback, facilitate*,

motivate*, promote*, help, ease, aid will be generated by the research team members in order to capture any potential resources from the databases. Table 1 outlines the initial keywords and search terms generated. Boolean operators (AND, OR, NOT) will be used to combine search terms within related keywords. An additional search will be carried out using updated search terms if there are any search terms were missing. Table 2 shows the search strings generated.

**Table 1** List of keywords and synonyms generated as search terms

| Mobile application | Older adults | Perspective | Barrier | Facilitates |
|---|---|---|---|---|
| Mobile app* | Elderly | View | Limitation | Motivate* |
| mHealth | Ageing population | Attitude | Difficulty | Promote* |
| Mobile health | Older population | Mindset | Restriction | Help |
| Telehealth | Aging | Willingness | Drawback | Ease |
| Mobile technolog* | Geriatric | Readiness | | Aid |
| | | Acceptability | | |

**Table 2** List of search strings

| | |
|---|---|
| **Search string 1:** | "Mobile application*" OR "mobile app" OR "mHealth" OR "mobile health" OR "telehealth" OR "mobile technology" AND "Older adults" OR "Elderly" OR "Ageing population" OR "Older population" OR "Aging" OR "Aging" OR "Geriatric" |
| **Search string 2:** | "Mobile application*" OR "mobile app" OR "mHealth" OR "mobile health" OR "telehealth" OR "mobile technology" AND "Perspective*" OR "View" OR "Attitude" OR "Mindset" OR "Willingness" OR "Readiness" OR "Acceptability" |
| **Search string 3:** | "Mobile application*" OR "mobile app" OR "mHealth" OR "mobile health" OR "telehealth" OR "mobile technology" AND "Barrier*" OR "Limitation*" OR "Difficulty" OR "Restriction*" OR "Drawback*" |
| **Search string 4:** | "Mobile application*" OR "mobile app" OR "mHealth" OR "mobile health" OR "telehealth" OR "mobile technology" AND "Facilitate*" OR "Motivate*" OR "Promote*" OR "Help" OR "Ease" OR "Aid" |

**Stage 3: Study selection**

The third stage of Arksey and O'Malley's framework (34) aims to identify the studies that will be included in the scoping review. The screening process will consist of two stages: (1) a title and abstract/summary and (2) full-text screening.

In the first stage, two reviewers will independently screen the titles and abstract of the articles where during this stage, the following decisions will be undertaken: (1) for any article that both reviewers agree to include, the article will proceed onto the second stage of screening process where the article will be read in full by each reviewer; (2) for any article that both reviewers agree to exclude, the article will not be read in full and excluded from the study; (3) for any article that did not achieved agreement between both reviewer ie. whether to include or exclude, the article will proceed onto the second stage of screening process to be read in full by each reviewer before final decision is made. In the second stage, both reviewers will independently perform a full-text review of the included articles. Disagreements regarding eligibility of sampled articles will be discussed between the two reviewers until consensus is reached or by arbitration of a third reviewer, if required.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart (12) will be used in the study selection process and will be updated once the review is completed (Supplementary File 2).

*Eligibility criteria*

An article will be included when it:

- describes or reports older adults' perspectives either their willingness or barriers or motivators towards the use of mobile applications in monitoring and managing their health condition;
- is published in the English language;
- contains only older population aged 60 and older as its study population;

- is available in full text;
- is a peer-reviewed literature or grey literature;
- is dated 1 January 2009 to April 2019 (time frame of 10 years).

Studies that have been published from January 2009 to April 2019 were selected to be included in this study due to an immense growth reported in the number of mobile health applications download in the past 10 years with growth rate of more than 7% each year (38).

An article will be excluded when it:

- provide summaries and do not introduce any new knowledge (e.g. literature review, scoping review, systematic review, topical review, commentaries, opinion papers).

**Stage 4: Charting the data**

A data extraction framework will be developed to confirm study relevance and to extract study characteristics. Study characteristics to be extracted will include, but not be limited to: standard bibliographical information (ie, authors, title, journal and year of publication), type and objectives of the review will be reported. For each article, we are going to extract the following data: (1) characteristics of the study population, (2) settings, (3) characteristics of the mobile application used or tested, and (4) type of outcome assessed (ie. older adults' perspectives; their willingness, barriers and motivators towards the use of mobile applications to monitor and manage their health). A combination of EndNote X9 and Covidence software will be used to organize and track relevant data. We will use these software to (1) remove duplicates; (2) document and manage the screening process; (3) categorize publications that meet the inclusion and exclusion criteria; (4) extract, organize, and search related data and information from the publication content and (5) manage of full texts version of included publications; including adding relevant notes that include key data extraction insights.

**Stage 5: Collating, summarizing and reporting the results**

Using the information collected from the data extraction form, the key characteristics of included studies will be summarised qualitatively and tabulated. All key findings will be described in narrative form. We will also be conducting a content analysis, identify emergent themes with regards to willingness, barriers and motivators from older adults. We will collect and identify objectives and gaps in our understanding of the current state or research. The discussion will be structured based on the themes that emerge.

**Stage 6: Consultation with stakeholders**

This sixth stage of Arksey and O'Malley's framework (34) is an optional component in conducting scoping reviews. We aim to engage with relevant stakeholders to gain more insights into our data from different perspectives. A detailed design of consultation process will be created after stage five of the methodology (collating, summarizing and reporting the results) has completed.

**Patient and public involvement**

As the review will use secondary data, patient and public will not be involved throughout the study. Our study is meant to inform experts and stakeholders of the current state or issues concerning our topic. Following successful publishing of this protocol, we intend to submit a systematic scoping review to identify gaps within the research of older adults' perspectives towards the use of mobile application to monitor and manage health and identify what recommendations can be made to improve such gaps.

**ETHICS/DISSEMINATION**

This scoping review protocol reports a comprehensive methodology. Since the data used are from publicly available sources, this study does not require ethical approval. Findings from this review will be disseminated through academic journals, seminars and conferences. We anticipate that our

findings regarding older adults' perspectives towards the use of mobile applications to monitor and manage health conditions. This could guide the direction of future research and aid technology developers as well as health professionals working in the area of ageing and rehabilitation.

## REFERENCES


1. Nations U. World Population Ageing 2019: Highlights. New York, Department of Economic and Social Affairs PD; 2019.
2. Population and Demographics : Ageing [press release]. Department of Statistics Malaysia2017.
3. Karim HA. The elderly in Malaysia: demographic trends. The Medical journal of Malaysia. 1997;52(3):206-12.
4. Wilmoth JR. Demography of longevity: past, present, and future trends. Experimental Gerontology. 2000;35(9):1111-29.
5. Gordon B Lindsay RMM, Riley J Hedin. The Contribution of Public Health and Improved Social Conditions to Increased Life Expectancy: An Analysis of Public Awareness. Journal of Community Medicine & Health Education. 2014.
6. Davies AM. Epidemiology and the challenge of ageing. International journal of epidemiology. 1985;14(1):9-21.
7. Brayne C. The elephant in the room - healthy brains in later life, epidemiology and public health. Nature reviews Neuroscience. 2007;8(3):233-9.
8. Brown G. The living end: the future of death, aging and immortality. 2008. Macmillan, London.
9. Americans. IoMUCotFHCWfO, inventorRetooling for an Aging America: Building the Health Care Workforce. United States2008.
10. Acharya S, Ghimire S, Jeffers EM, Shrestha N. Health Care Utilization and Health Care Expenditure of Nepali Older Adults. 2019;7(24).
11. Xiaolong Z, Qiong C, Jin W, Yun LJIjoph. Determinants of medical and health care expenditure growth for urban residents in China: A systematic review article. 2014;43(12):1597.
12. Wolff JL, Starfield B, Anderson G. Prevalence, expenditures, and complications of multiple chronic conditions in the elderly. Archives of internal medicine. 2002;162(20):2269-76.
13. Hoffman C, Rice D, Sung HY. Persons with chronic conditions. Their prevalence and costs. Jama. 1996;276(18):1473-9.
14. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. Lancet (London, England). 2012;380(9836):37-43.
15. Hunsaker A, Hargittai E. A review of Internet use among older adults. 2018;20(10):3937-54.
16. Statistics OfN. Internet users, UK: 2019. UK: Office for National Statistics; 2019 24 May 2019.
17. Center PR. Smartphone Ownership Is Growing Rapidly Around the World, but Not Always Equally. United States: Pew Research Center; 2019.
18. Kontos E, Blake KD, Chou WY, Prestin A. Predictors of eHealth usage: insights on the digital divide from the Health Information National Trends Survey 2012. Journal of medical Internet research. 2014;16(7):e172.
19. Estacio EV, Whittle R, Protheroe J. The digital divide: Examining socio-demographic factors associated with health literacy, access and use of internet to seek health information. Journal of health psychology. 2019;24(12):1668-75.
20. Flynn KE, Smith MA, Freese J. When do older adults turn to the internet for health information? Findings from the Wisconsin Longitudinal Study. J Gen Intern Med. 2006;21(12):1295-301.
21. Ryu S. Book Review: mHealth: New Horizons for Health through Mobile Technologies: Based on the Findings of the Second Global Survey on eHealth (Global Observatory for eHealth Series, Volume 3). Healthc Inform Res. 2012;18(3):231-3.

22. West JH, Hall PC, Hanson CL, Barnes MD, Giraud-Carrier C, Barrett J. There's an App for That: Content Analysis of Paid Health and Fitness Apps. Journal of medical Internet research. 2012;14(3):e72.
23. Heart T, Kalderon E. Older adults: are they ready to adopt health-related ICT? International journal of medical informatics. 2013;82(11):e209-31.
24. Changizi M, Kaveh MH. Effectiveness of the mHealth technology in improvement of healthy behaviors in an elderly population-a systematic review. Mhealth. 2017;3:51-.
25. Syed ST, Gerber BS, Sharp LK. Traveling towards disease: transportation barriers to health care access. J Community Health. 2013;38(5):976-93.
26. Agyemang-Duah W, Peprah C, Peprah P. Barriers to formal healthcare utilisation among poor older people under the livelihood empowerment against poverty programme in the Atwima Nwabiagya District of Ghana. BMC Public Health. 2019;19(1):1185.
27. Fitzpatrick AL, Powe NR, Cooper LS, Ives DG, Robbins JA. Barriers to health care access among the elderly and who perceives them. Am J Public Health. 2004;94(10):1788-94.
28. Doetsch J, Pilot E, Santana P, Krafft T. Potential barriers in healthcare access of the elderly population influenced by the economic crisis and the troika agreement: a qualitative case study in Lisbon, Portugal. Int J Equity Health. 2017;16(1):184-.
29. Chang AY, Skirbekk VF, Tyrovolas S, Kassebaum NJ, Dieleman JL. Measuring population ageing: an analysis of the Global Burden of Disease Study 2017. Lancet Public Health. 2019;4(3):e159-e67.
30. Anderson K, Burford O, Emmerton L. Mobile Health Apps to Facilitate Self-Care: A Qualitative Study of User Experiences. PloS one. 2016;11(5):e0156164.
31. Free C, Phillips G, Galli L, Watson L, Felix L, Edwards P, et al. The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. PLoS medicine. 2013;10(1):e1001362.
32. Muessig KE, Pike EC, Legrand S, Hightow-Weidman LB. Mobile phone applications for the care and prevention of HIV and other sexually transmitted diseases: a review. Journal of medical Internet research. 2013;15(1):e1.
33. Zhao J, Freeman B, Li M. Can Mobile Phone Apps Influence People's Health Behavior Change? An Evidence Review. Journal of medical Internet research. 2016;18(11):e287.
34. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. International Journal of Social Research Methodology. 2005;8(1):19-32.
35. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implementation science : IS. 2010;5:69.
36. Aromataris E, Munn Z. Joanna Briggs Institute Reviewer's Manual. The Joanna Briggs Institute. 2017.
37. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. 2018;169(7):467-73.
38. Research2Guidance. mHealth App Economics 2017/2018: Current Status and Future Trends in Mobile Health. 2017.

## AUTHOR'S CONTRIBUTIONS

NAA and AF were responsible for developing the conception of the study. NAA wrote the manuscript with support from AF and SS. AF was responsible for reading and approving this manuscript's final version; giving final approval for the version that will be published, ensuring the integrity in all aspects of the work as well as making sure all research questions were addressed accordingly. SS was responsible for approving the design of the study; doing a thorough review to ensure intellectual content; reading and approving the final manuscript; giving the approval for the version that will be published, and ensuring all research questions are analysed accordingly. SAMH and NMT contributed to the design of the study; acquired data about the research, read and approved the final manuscript and gave the final approval for the published version.

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## COMPETING INTERESTS STATEMENT

None declared.

## SUPPLEMENTARY FILES

Supplementary File 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR)

Supplementary File 2: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart

**SUPPLEMENTARY FILE 1**

**Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist**

| SECTION | ITEM | PRISMA-ScR CHECKLIST ITEM | REPORTED ON PAGE # |
|---|---|---|---|
| **TITLE** | | | |
| Title | 1 | Identify the report as a scoping review. | 1 |
| **ABSTRACT** | | | |
| Structured summary | 2 | Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives. | 2 |
| **INTRODUCTION** | | | |
| Rationale | 3 | Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach. | 4-5 |
| Objectives | 4 | Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives. | 5 |
| **METHODS** | | | |
| Protocol and registration | 5 | Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number. | N/A for protocol |
| Eligibility criteria | 6 | Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale. | 9-10 |
| Information sources* | 7 | Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed. | 7 |
| Search | 8 | Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated. | 7-8 |
| Selection of sources of evidence† | 9 | State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review. | 9 |
| Data charting process‡ | 10 | Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators. | 10-11 |
| Data items | 11 | List and define all variables for which data were sought and any assumptions and simplifications made. | 11 |
| Critical appraisal of individual sources of evidence§ | 12 | If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate). | N/A |
| Synthesis of results | 13 | Describe the methods of handling and summarizing the data that were charted. | 11 |

| SECTION | ITEM | PRISMA-ScR CHECKLIST ITEM | REPORTED ON PAGE # |
|---|---|---|---|
| **RESULTS** | | | |
| Selection of sources of evidence | 14 | Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram. | N/A |
| Characteristics of sources of evidence | 15 | For each source of evidence, present characteristics for which data were charted and provide the citations. | N/A for protocol |
| Critical appraisal within sources of evidence | 16 | If done, present data on critical appraisal of included sources of evidence (see item 12). | N/A |
| Results of individual sources of evidence | 17 | For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives. | N/A for protocol |
| Synthesis of results | 18 | Summarize and/or present the charting results as they relate to the review questions and objectives. | N/A |
| **DISCUSSION** | | | |
| Summary of evidence | 19 | Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups. | N/A for protocol |
| Limitations | 20 | Discuss the limitations of the scoping review process. | N/A for protocol |
| Conclusions | 21 | Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps. | N/A for protocol |
| **FUNDING** | | | |
| Funding | 22 | Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review. | 14 |

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

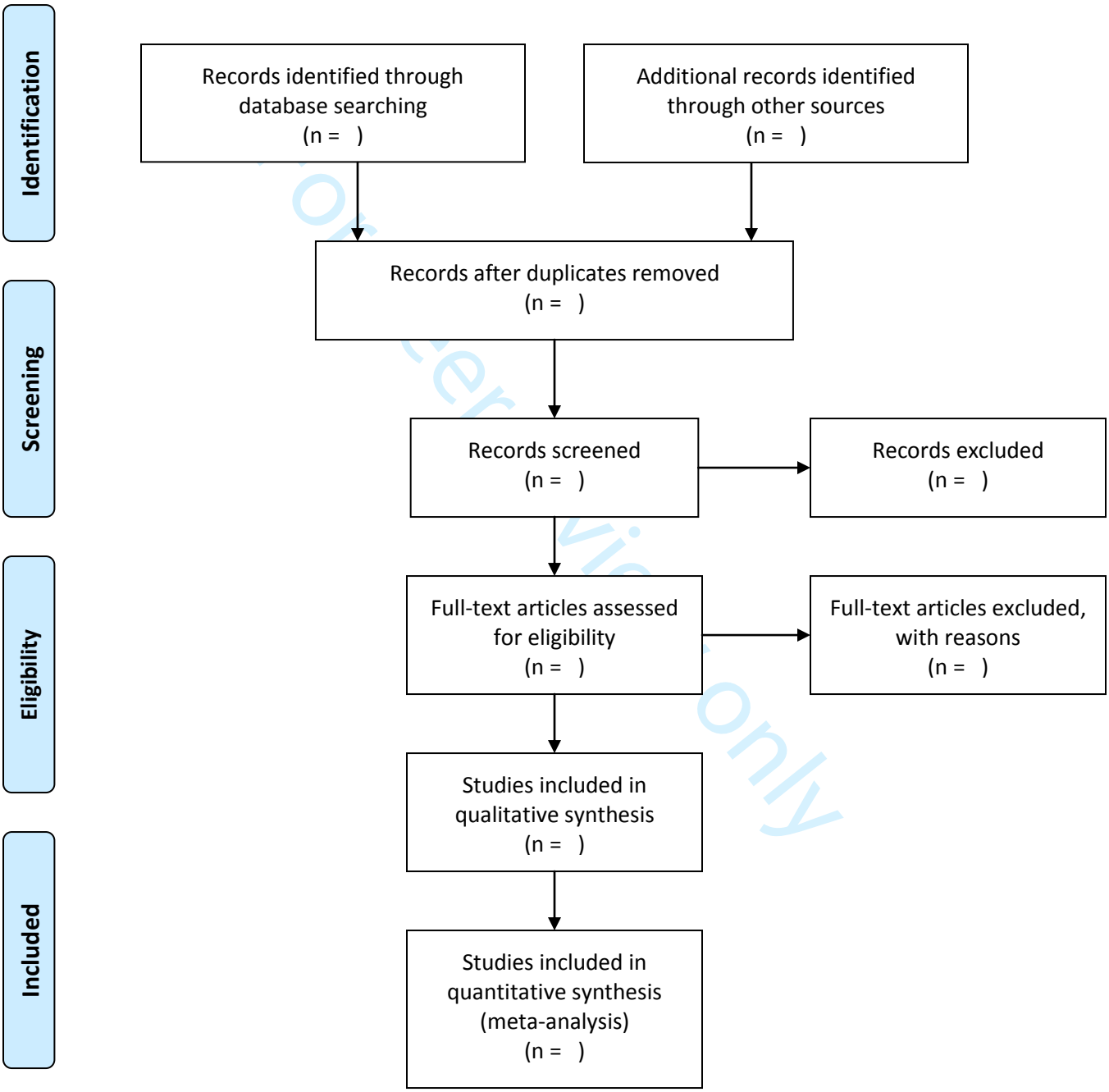
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

*From:* Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. ;169:467–473. doi: 10.7326/M18-0850

# SUPPLEMENTARY FILE 2

## PRISMA 2009 Flow Diagram




*From:* Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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BMJ Open

# Willingness, Perceived Barriers and Motivators in Adopting Mobile Applications for Health-Related Interventions among Older Adults: A Scoping Review Protocol



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| Secondary Subject Heading: | Research methods, Global health, Public health |
| Keywords: | ageing, scoping review, mobile application, older adult, barrier, PUBLIC HEALTH |
| | |

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# Willingness, Perceived Barriers and Motivators in Adopting Mobile Applications for Health-Related Interventions among Older Adults: A Scoping Review Protocol

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**Word Count:** 2810 words

## ABSTRACT

**Introduction:** The world's older population continues to grow at an unprecedented rate. An ageing population poses a great challenge to our healthcare system that requires new tool to tackle the complexity of health services as well as the increasing expenses. Mobile health applications (mHealth app) is seen to have the potential to address these challenges, alleviating burdens on the healthcare system and enhance the quality of life for older adults. Despite the numerous benefits of mHealth apps, relatively little is known about whether older adults perceive that these apps confer such benefits. Their perspectives towards the use of mobile applications for health-related purposes have also been little studied. Therefore, in this paper, we outline our scoping review protocol to systematically review literature specific to older adults' willingness, perceived barriers and motivators towards the use of mobile applications to monitor and manage their health.

**Methods and analysis:** Arksey and O'Malley's scoping review methodology framework will guide the conduct of this scoping review. The search strategy will involve electronic databases including PubMed, EMBASE, CINAHL, COCHRANE Library, Google Scholar, and ScienceDirect, in addition to grey literature sources and hand-searching of reference lists. Two reviewers will independently screen all abstracts and full-text studies for inclusion. Data will be charted and sorted through an iterative process by the research team. The extracted data will undergo a descriptive analysis and simple quantitative analysis will be conducted using descriptive statistics. Engagement with relevant stakeholders will be carried out to gain more insights into our data from different perspectives.

**Ethics and dissemination:** Since the data used are from publicly available sources, this study does not require ethical approval. Results will be disseminated through academic journals, conferences and seminars. We anticipate that our findings will aid technology developers and health professionals working in the area of ageing and rehabilitation.

**Keywords:** Scoping review, mobile application, mHealth, older adult, ageing, perception, barrier, motivator

## STRENGTHS AND LIMITATIONS

- This scoping review will capture current issues and opportunities related to technology-enabled mobile applications among older adults.
- Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Review tool will be used in order to ensure a systematic approach to searching, screening, charting, collating, reporting and stakeholders consultation.
- The search strategy is comprehensive and includes both peer-reviewed literature (electronic bibliographic databases) and grey literature.
- Despite the strength, this scoping review only considers studies written in English where large number of studies in other languages will be missed out.
- As this is a scoping review, critical appraisal of the study quality and the risk of bias will not be undertaken.

## INTRODUCTION

The world's older population continues to grow at a rapid pace. Today, there are 703 million people aged 65 years or over in the world (1). This number is projected to double to 1.5 billion in 2050 with the proportion of one in six people in the world will be aged 65 years or over (1). In the case of Malaysia's population, this subpopulation has increased gradually since the 1970s and expected to be tripled from 2.0 million today to more than 6.0 million by 2040 (2, 3). This phenomenon represents one of the remarkable achievement of mankind history with respect to health, social and economic improvements over time (1). The improvements in health care system such as infections control, immunizations and better access in health care are among the huge contributors to the sustained increases in life expectancy across the globe (4-6).

However, this success history of human life expectancy did not come with a proportionate increase in quality of life for older adults. As heavily discussed in the literature, increased life expectancy has increased the risk in developing chronic diseases, disability and dementia prior to death (7, 8). This explains a higher use of health services and greater demand for specialized services among the elderly (9-11). Consequently, this puts increasing pressure on the economy and social systems in most countries due to the complexity of health services required along with increased health expenditure (12-14).

Technological innovations have enabled us to carry out tasks effectively and efficiently. The field of technology-supported health care is remarkably growing and provide new ways of self-management and support. Although older adults may be seen as technological laggards, the internet usage among this subpopulation has been reported to increase from year to year (15). For instance, in the UK, the internet usage among older adults aged 65 to 74 group has increased gradually over the last eight years, with 52% in 2011 to 83% in 2019 (16). To add, the trend of smartphone ownership reported to grow rapidly across the globe (17).

This rapid growth of technology, particularly in smartphones and internet use, has led to a surge of interest in using mobile applications as a tool to seek health information as well as to monitor and

manage health (commonly known as mobile health or mHealth) (18-20). mHealh is defined as "medical and public health practice supported by mobile devices, personal digital assistants and other wireless devices" (21). There are more than 325,000 identified mHealth applications covering diverse of health, fitness and medical topics (22, 23). There is clear evidence that mHealth applications is effective in improving self-care, self-management, self-efficacy, medication adherence as well as in improving health behaviours such as quality of sleep, diet, physical activity and mental health (24). In particular to older adults population, there are a number of studies demonstrating the benefits of mHealth towards older adults (25-29). This includes, it can help to address existing barriers to treatment such as long waiting time at hospital, poor access to transportation and increased cost of healthcare services (25-29).

The steady growth of older adult population combined with rising trend in technology uptake within this subpopulation suggest mHealth applications may represent a novel way to improve the health of older adults as well as to reduce healthcare cost. Despite the numerous benefits of mHealth applications (30-33), relatively little is known about whether older adults perceive that these apps confer such benefits. Their perspectives towards the use of mobile applications for health-related purposes have also been little studied. Therefore, this review aims to identify what is known about the perspectives in adopting mobile applications for health-related interventions among older adults. The specific research questions are:

1. What is the level of willingness among older adults in using mobile applications to monitor and manage their health conditions?
2. What are the existing barriers among older adults in using mobile applications to monitor and manage their health conditions?
3. What motivates older adults to use mobile applications to monitor and manage their health conditions?

## METHODS AND ANALYSIS

### Protocol Development

This study will adopt Arksey and O'Malley's (34) framework for scoping reviews as the foundation and more recent advancements to the methodology (35-37) as well as the updated framework by The Joanna Briggs Institute (38). According to this framework, there are six different stages which includes; (1) identifying the research question, (2) identifying relevant studies, (3) selecting studies, (4) charting the data, (5) collating, summarizing and reporting results, and (6) consulting with stakeholders. The scoping review will also adhere to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) (39). The PRISMA-ScR checklist is attached as Supplementary File 1. PROSPERO registration is not required as it is a scoping review.

### Stage 1: Identifying the research question.

Arksey and O'Malley (34) describe the definition of a relevant research question as a crucial initial step that define and refines the chosen research strategy. We have identified one overarching research question to guide our systematic search strategy and reporting of results: 'What is known about the perspectives in adopting mobile applications for health-related interventions among older adults?'. We aim to provide answers for the following sub-questions:

1. What is the level of willingness among older adults in using mobile applications to monitor and manage their health conditions?
2. What are the existing barriers among older adults in using mobile applications to monitor and manage their health conditions?
3. What motivates older adults to use mobile applications to monitor and manage their health conditions?

**Stage 2: Identifying relevant studies**

The search strategy was collaboratively developed by our research team. In order to determine the relevance of the citations and to resolve any potential disagreements, the research team will meet to refine the study inclusion and exclusion criteria prior to assessing the articles independently. Our literature search is open, including both peer-reviewed literature as well as grey literature ie. evidence not published in peer-reviewed publications and from the first ten pages in the Google search engine.

The identification of relevant literature will consist of three-stage approach. The first stage is searching the electronic databases using standardized search terms adapted to the requirements of each respective database. The following electronic databases have been selected: (1) PubMed; (2) Excerpta Medica Database (EMBASE); (3) Cumulative Index to Nursing and Allied Health Literature (CINAHL); (4) COCHRANE Library; (5) Google Scholar; and (6) ScienceDirect. In order to achieve the level of comprehensiveness required for scoping review, we will also hand search key electronic journals, including the Journal of the American Medical Informatics Association (JAMIA), the Journal of Medical Internet Research (JMIR), the International Journal of Digital Healthcare, Digital Health (SAGE) and the Journal of mHealth. The second stage involves searching the reference lists of literature that meet all inclusion criteria. The third and final stage involves hand searching specific key publications such as identified white papers or conference presentations for any references we may have missed. We will search relevant grey literature databases (eg, Grey Literature Report, OpenGrey, Web of Science Conference Proceedings, Government Document, academic thesis/dissertation) to identify studies, reports and conference abstracts of relevance to this review.

Search terms from key words, subject heading and synonyms such as mobile application*, mobile app*, mhealth, mobile health, telehealth, mobile technolog*, older adult*, elder*, ageing population, older population, aging, geriatric, perspective, view, attitude, mindset, willingness, readiness, acceptability, barrier, limitation, difficulty, restriction, drawback, facilitate*, motivate*,

promote*, help, ease, aid will be generated by the research team members in order to capture any potential resources from the databases. Table 1 outlines the initial keywords and search terms generated. Boolean operators (AND, OR, NOT) will be used to combine search terms within related keywords. An additional search will be carried out using updated search terms if there are any search terms were missing. Table 2 shows the search strings generated.

**Table 1** List of keywords and synonyms generated as search terms

| Mobile application | Older adults | Perspective | Barrier | Facilitates |
|---|---|---|---|---|
| Mobile app* | Elderly | View | Limitation | Motivate* |
| mHealth | Ageing population | Attitude | Difficulty | Promote* |
| Mobile health | Older population | Mindset | Restriction | Help |
| Telehealth | Aging | Willingness | Drawback | Ease |
| Mobile technolog* | Geriatric | Readiness | | Aid |
| | | Acceptability | | |

**Table 2** List of search strings

| | |
|---|---|
| **Search string 1:** | "Mobile application*" OR "mobile app" OR "mHealth" OR "mobile health" OR "telehealth" OR "mobile technology" AND "Older adults" OR "Elderly" OR "Ageing population" OR "Older population" OR "Aging" OR "Geriatric" |
| **Search string 2:** | "Mobile application*" OR "mobile app" OR "mHealth" OR "mobile health" OR "telehealth" OR "mobile technology" AND "Perspective*" OR "View" OR "Attitude" OR "Mindset" OR "Willingness" OR "Readiness" OR "Acceptability" |
| **Search string 3:** | "Mobile application*" OR "mobile app" OR "mHealth" OR "mobile health" OR "telehealth" OR "mobile technology" AND "Barrier*" OR "Limitation*" OR "Difficulty" OR "Restriction*" OR "Drawback*" |
| **Search string 4:** | "Mobile application*" OR "mobile app" OR "mHealth" OR "mobile health" OR "telehealth" OR "mobile technology" AND "Facilitate*" OR "Motivate*" OR "Promote*" OR "Help" OR "Ease" OR "Aid" |

**Stage 3: Study selection**

The third stage of Arksey and O'Malley's framework (34) aims to identify the studies that will be included in the scoping review. The screening process will consist of two stages: (1) a title and abstract/summary and (2) full-text screening.

In the first stage, two reviewers will independently screen the titles and abstract of the articles where during this stage, the following decisions will be undertaken: (1) for any article that both reviewers agree to include, the article will proceed onto the second stage of screening process where the article will be read in full by each reviewer; (2) for any article that both reviewers agree to exclude, the article will not be read in full and excluded from the study; (3) for any article that did not achieved agreement between both reviewers ie. whether to include or exclude, the article will proceed onto the second stage of screening process to be read in full by each reviewer before final decision is made. In the second stage, both reviewers will independently perform a full-text review of the included articles. Disagreements regarding eligibility of sampled articles will be discussed between the two reviewers until consensus is reached or by arbitration of a third reviewer, if required.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart (12) will be used in the study selection process and will be updated once the review is completed (Supplementary File 2).

*Eligibility criteria*

An article will be included when it:

- describes or reports older adults' perspectives either their willingness or barriers or motivators towards the use of mobile applications in monitoring and managing their health condition;
- is published in the English language;
- contains only older population aged 60 and older as its study population;

- is a peer-reviewed literature or grey literature;
- is dated 1 January 2009 to April 2019 (time frame of 10 years).

Studies that have been published from January 2009 to April 2019 were selected to be included in this study due to an immense growth reported in the number of mobile health applications download in the past 10 years with growth rate of more than 7% each year (40).

An article will be excluded when it:

- provide summaries and do not introduce any new knowledge (e.g. literature review, scoping review, systematic review, topical review, commentaries, opinion papers).

**Stage 4: Charting the data**

A data extraction framework will be developed to confirm study relevance and to extract study characteristics. Study characteristics to be extracted will include, but not be limited to: standard bibliographical information (ie, authors, title, journal and year of publication), type and objectives of the review will be reported. For each article, we are going to extract the following data: (1) characteristics of the study population, (2) settings, (3) characteristics of the mobile application used or tested, and (4) type of outcome assessed (ie. older adults' perspectives; their willingness, barriers and motivators towards the use of mobile applications to monitor and manage their health). A combination of EndNote X9 and Covidence software will be used to organize and track relevant data. We will use these software to (1) remove duplicates; (2) document and manage the screening process; (3) categorize publications that meet the inclusion and exclusion criteria; (4) extract, organize, and search related data and information from the publication content and (5) manage of full texts version of included publications; including adding relevant notes that include key data extraction insights.

**Stage 5: Collating, summarizing and reporting the results**

Using the information collected from the data extraction form, the key characteristics of included studies will be summarised qualitatively and tabulated. All key findings will be described in narrative form. We will also be conducting a content analysis, identify emergent themes with regards to willingness, barriers and motivators from older adults. We will collect and identify objectives and gaps in our understanding of the current state or research. The discussion will be structured based on the themes that emerge.

**Stage 6: Consultation with stakeholders**

This sixth stage of Arksey and O'Malley's framework (34) is an optional component in conducting scoping reviews. We aim to engage with relevant stakeholders such as geriatricians, family medicine doctors, mobile applications developers, dietitians, psychologists and/or clinical psychologists to gain more insights into our data from different perspectives. A detailed design of consultation process will be created after stage five of the methodology (collating, summarizing and reporting the results) has completed.

**Patient and public involvement**

As the review will use secondary data, patient and public will not be involved throughout the study. Our study is meant to inform experts and stakeholders of the current state or issues concerning our topic. Following successful publishing of this protocol, we intend to submit a systematic scoping review to identify gaps within the research of older adults' perspectives towards the use of mobile application to monitor and manage health and identify what recommendations can be made to improve such gaps.

## ETHICS/DISSEMINATION

This scoping review protocol reports a comprehensive methodology. Since the data used are from publicly available sources, this study does not require ethical approval. Findings from this review will be disseminated through academic journals, seminars and conferences. We anticipate that our findings regarding older adults' perspectives towards the use of mobile applications to monitor and manage health conditions. This could guide the direction of future research and aid technology developers as well as health professionals working in the area of ageing and rehabilitation.

## REFERENCES


1. Nations U. World Population Ageing 2019: Highlights. New York, Department of Economic and Social Affairs PD; 2019.
2. Population and Demographics : Ageing [press release]. Department of Statistics Malaysia2017.
3. Karim HA. The elderly in Malaysia: demographic trends. The Medical journal of Malaysia. 1997;52(3):206-12.
4. Wilmoth JR. Demography of longevity: past, present, and future trends. Experimental Gerontology. 2000;35(9):1111-29.
5. Gordon B Lindsay RMM, Riley J Hedin. The Contribution of Public Health and Improved Social Conditions to Increased Life Expectancy: An Analysis of Public Awareness. Journal of Community Medicine & Health Education. 2014.
6. Davies AM. Epidemiology and the challenge of ageing. International journal of epidemiology. 1985;14(1):9-21.
7. Brayne C. The elephant in the room - healthy brains in later life, epidemiology and public health. Nature reviews Neuroscience. 2007;8(3):233-9.
8. Brown G. The living end: the future of death, aging and immortality. 2008. Macmillan, London.
9. Americans. IoMUCotFHCWfO, inventorRetooling for an Aging America: Building the Health Care Workforce. United States2008.
10. Acharya S, Ghimire S, Jeffers EM, Shrestha N. Health Care Utilization and Health Care Expenditure of Nepali Older Adults. 2019;7(24).
11. Xiaolong Z, Qiong C, Jin W, Yun LIjoph. Determinants of medical and health care expenditure growth for urban residents in China: A systematic review article. 2014;43(12):1597.
12. Wolff JL, Starfield B, Anderson G. Prevalence, expenditures, and complications of multiple chronic conditions in the elderly. Archives of internal medicine. 2002;162(20):2269-76.
13. Hoffman C, Rice D, Sung HY. Persons with chronic conditions. Their prevalence and costs. Jama. 1996;276(18):1473-9.
14. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. Lancet (London, England). 2012;380(9836):37-43.
15. Hunsaker A, Hargittai E. A review of Internet use among older adults. 2018;20(10):3937-54.
16. Statistics OfN. Internet users, UK: 2019. UK: Office for National Statistics; 2019 24 May 2019.
17. Center PR. Smartphone Ownership Is Growing Rapidly Around the World, but Not Always Equally. United States: Pew Research Center; 2019.
18. Kontos E, Blake KD, Chou WY, Prestin A. Predictors of eHealth usage: insights on the digital divide from the Health Information National Trends Survey 2012. Journal of medical Internet research. 2014;16(7):e172.
19. Estacio EV, Whittle R, Protheroe J. The digital divide: Examining socio-demographic factors associated with health literacy, access and use of internet to seek health information. Journal of health psychology. 2019;24(12):1668-75.
20. Flynn KE, Smith MA, Freese J. When do older adults turn to the internet for health information? Findings from the Wisconsin Longitudinal Study. J Gen Intern Med. 2006;21(12):1295-301.
21. Ryu S. Book Review: mHealth: New Horizons for Health through Mobile Technologies: Based on the Findings of the Second Global Survey on eHealth (Global Observatory for eHealth Series, Volume 3). Healthc Inform Res. 2012;18(3):231-3.
22. West JH, Hall PC, Hanson CL, Barnes MD, Giraud-Carrier C, Barrett J. There's an App for That: Content Analysis of Paid Health and Fitness Apps. Journal of medical Internet research. 2012;14(3):e72.
23. Heart T, Kalderon E. Older adults: are they ready to adopt health-related ICT? International journal of medical informatics. 2013;82(11):e209-31.
24. Changizi M, Kaveh MH. Effectiveness of the mHealth technology in improvement of healthy behaviors in an elderly population-a systematic review. Mhealth. 2017;3:51-.
25. Syed ST, Gerber BS, Sharp LK. Traveling towards disease: transportation barriers to health care access. J Community Health. 2013;38(5):976-93.

26. Agyemang-Duah W, Peprah C, Peprah P. Barriers to formal healthcare utilisation among poor older people under the livelihood empowerment against poverty programme in the Atwima Nwabiagya District of Ghana. BMC Public Health. 2019;19(1):1185.
27. Fitzpatrick AL, Powe NR, Cooper LS, Ives DG, Robbins JA. Barriers to health care access among the elderly and who perceives them. Am J Public Health. 2004;94(10):1788-94.
28. Doetsch J, Pilot E, Santana P, Krafft T. Potential barriers in healthcare access of the elderly population influenced by the economic crisis and the troika agreement: a qualitative case study in Lisbon, Portugal. Int J Equity Health. 2017;16(1):184-.
29. Chang AY, Skirbekk VF, Tyrovolas S, Kassebaum NJ, Dieleman JL. Measuring population ageing: an analysis of the Global Burden of Disease Study 2017. Lancet Public Health. 2019;4(3):e159-e67.
30. Anderson K, Burford O, Emmerton L. Mobile Health Apps to Facilitate Self-Care: A Qualitative Study of User Experiences. PloS one. 2016;11(5):e0156164.
31. Free C, Phillips G, Galli L, Watson L, Felix L, Edwards P, et al. The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. PLoS medicine. 2013;10(1):e1001362.
32. Muessig KE, Pike EC, Legrand S, Hightow-Weidman LB. Mobile phone applications for the care and prevention of HIV and other sexually transmitted diseases: a review. Journal of medical Internet research. 2013;15(1):e1.
33. Zhao J, Freeman B, Li M. Can Mobile Phone Apps Influence People's Health Behavior Change? An Evidence Review. Journal of medical Internet research. 2016;18(11):e287.
34. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. International Journal of Social Research Methodology. 2005;8(1):19-32.
35. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implementation science : IS. 2010;5:69.
36. Daudt HML, van Mossel C, Scott SJ. Enhancing the scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework. BMC Medical Research Methodology. 2013;13(1):48.
37. Colquhoun HL, Levac D, O'Brien KK, Straus S, Tricco AC, Perrier L, et al. Scoping reviews: time for clarity in definition, methods, and reporting. Journal of Clinical Epidemiology. 2014;67(12):1291-4.
38. Aromataris E, Munn Z. Joanna Briggs Institute Reviewer's Manual. The Joanna Briggs Institute. 2017.
39. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. 2018;169(7):467-73.
40. Research2Guidance. mHealth App Economics 2017/2018: Current Status and Future Trends in Mobile Health. 2017.

## AUTHOR'S CONTRIBUTIONS

NAA and AF were responsible for developing the conception of the study. NAA wrote the manuscript with support from AF and SS. AF was responsible for reading and approving this manuscript's final version; giving final approval for the version that will be published, ensuring the integrity in all aspects of the work as well as making sure all research questions were addressed accordingly. SS was responsible for approving the design of the study; doing a thorough review to ensure intellectual content; reading and approving the final manuscript; giving the approval for the version that will be published, and ensuring all research questions are analysed accordingly. SAMN and NMT contributed to the design of the study; acquired data about the research, read and approved the final manuscript and gave the final approval for the published version.

## FUNDING STATEMENT

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## COMPETING INTERESTS STATEMENT

None declared.

## SUPPLEMENTARY FILES

Supplementary File 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR)

Supplementary File 2: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart

**SUPPLEMENTARY FILE 1**

**Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist**

| SECTION | ITEM | PRISMA-ScR CHECKLIST ITEM | REPORTED ON PAGE # |
|---|---|---|---|
| **TITLE** | | | |
| Title | 1 | Identify the report as a scoping review. | 1 |
| **ABSTRACT** | | | |
| Structured summary | 2 | Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives. | 2 |
| **INTRODUCTION** | | | |
| Rationale | 3 | Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach. | 4-5 |
| Objectives | 4 | Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives. | 5 |
| **METHODS** | | | |
| Protocol and registration | 5 | Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number. | N/A for protocol |
| Eligibility criteria | 6 | Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale. | 9-10 |
| Information sources* | 7 | Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed. | 7 |
| Search | 8 | Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated. | 7-8 |
| Selection of sources of evidence† | 9 | State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review. | 9 |
| Data charting process‡ | 10 | Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators. | 10-11 |
| Data items | 11 | List and define all variables for which data were sought and any assumptions and simplifications made. | 11 |
| Critical appraisal of individual sources of evidence§ | 12 | If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate). | N/A |
| Synthesis of results | 13 | Describe the methods of handling and summarizing the data that were charted. | 11 |

| SECTION | ITEM | PRISMA-ScR CHECKLIST ITEM | REPORTED ON PAGE # |
|---|---|---|---|
| **RESULTS** | | | |
| Selection of sources of evidence | 14 | Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram. | N/A |
| Characteristics of sources of evidence | 15 | For each source of evidence, present characteristics for which data were charted and provide the citations. | N/A for protocol |
| Critical appraisal within sources of evidence | 16 | If done, present data on critical appraisal of included sources of evidence (see item 12). | N/A |
| Results of individual sources of evidence | 17 | For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives. | N/A for protocol |
| Synthesis of results | 18 | Summarize and/or present the charting results as they relate to the review questions and objectives. | N/A |
| **DISCUSSION** | | | |
| Summary of evidence | 19 | Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups. | N/A for protocol |
| Limitations | 20 | Discuss the limitations of the scoping review process. | N/A for protocol |
| Conclusions | 21 | Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps. | N/A for protocol |
| **FUNDING** | | | |
| Funding | 22 | Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review. | 14 |

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

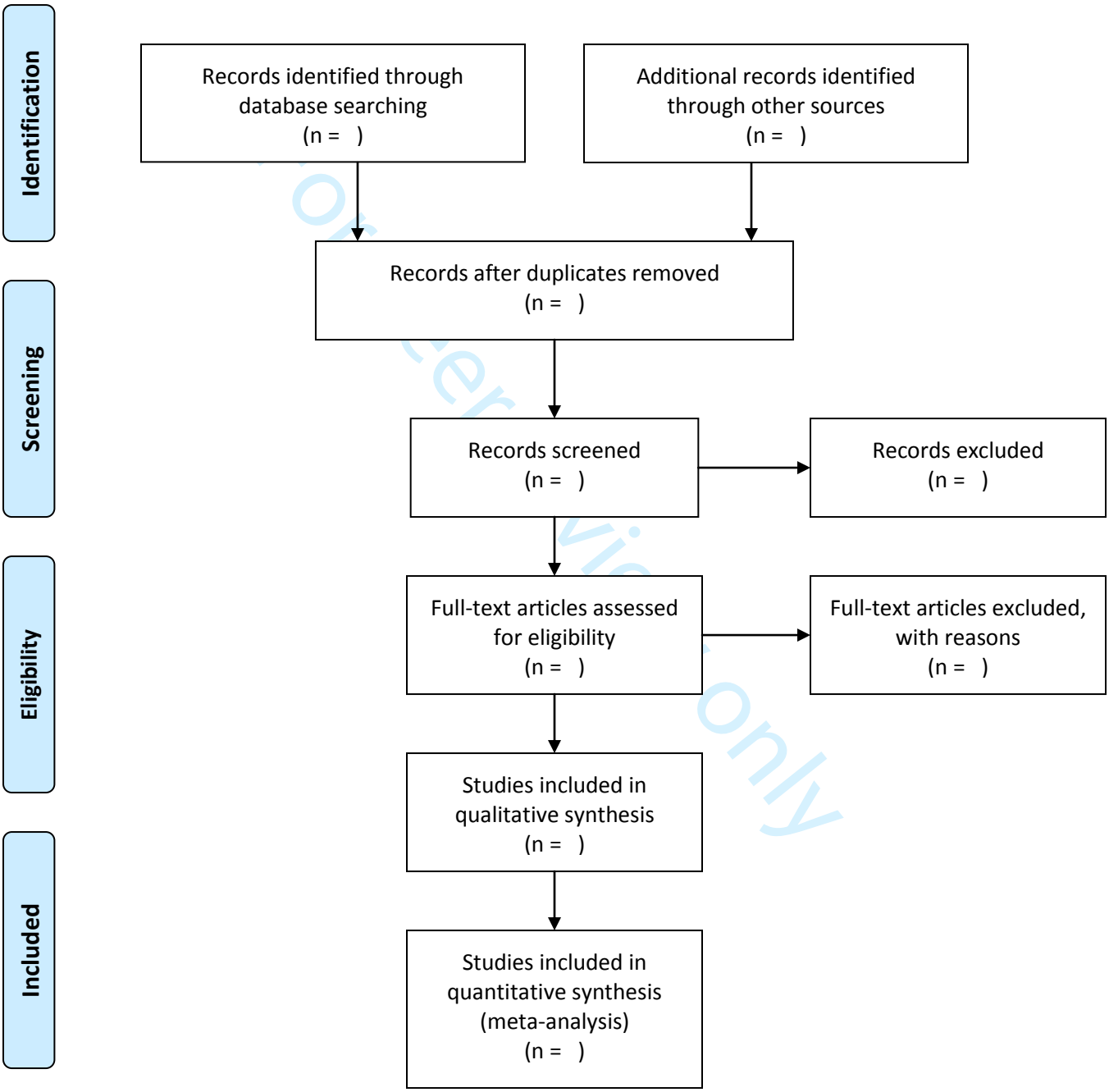
‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

*From:* Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. ;169:467–473. doi: 10.7326/M18-0850

# SUPPLEMENTARY FILE 2

## PRISMA 2009 Flow Diagram




*From:* Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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