The Cost Effectiveness of M-health Interventions for Older Adults: Protocol for a Systematic Review

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Abstract

Background: Many studies reported effectiveness of mhealth interventions targeting middle aged and older adults to improve healthcare delivery process, efficacy and management of chronic diseases. However, the knowledge about their cost-effectiveness is important to implement mhealth interventions at large scale for proper allocation of scarce resources. This systematic review will summarize the results from identified studies for the cost effectiveness of mhealth interventions aimed for middle aged and older adults.

Method: mhealth interventions aimed to improve healthcare delivery process, efficacy and delivering training will be included in this systematic review. A comprehensive electronic search strategy will be used to identify health economic evaluations, published since 2007, and indexed in Pubmed, Scopus and CINAHL. The search strategy will include terms (and synonyms) for the following mhealth devices: mobile phone, smartphone, mhealth. Middle aged and older adults will be used to identify all mhealth interventions introduced to middle aged and older adults. Terms such as economic evaluation, cost effectiveness, cost utility etc will be used to identify economic evaluations of all mhealth interventions.

Discussion: This systematic review will report evidence on cost effectiveness of mhealth interventions targeting middle aged and older adults.

Key words: Critical appraisal; cost benefit; elderly; mobile application; cell phone.

Introduction

The advancement in science and technology over the years has improved quality of life (QoL) and results in longer lives (1). However, living longer could also increase the risk of developing chronic diseases such as dementia disorders, cardiovascular disease, diabetes, neurological disorders etc. The probability of getting more than one chronic condition increases with ageing which would results in high healthcare costs. Therefore, the projection of 45% increase in European elderly population in coming 20 years is likely to require a substantial increase in healthcare budget (2).

The use of Mobile Health (mhealth) has been increased in healthcare with an aim to improve the healthcare delivery process and efficacy of healthcare providers as well as to reduce healthcare expenditures (3, 4). Although a consensus on definition of mhealth is yet to make, World Health Organization (WHO) defines it as a means to support healthcare delivery process and disseminate information with the help of mobile (mobile phones, smart phones, patient monitoring devices, personal digital assistants) and other wireless devices (5).

Prior systematic reviews highlighted that mhealth improves health outcomes such as SMS appointment reminders and smartphone health applications (apps) found effective in reducing missing appointments and improving QoL of older adults (3, 4). However, health technology assessment such as economic evaluation covers both costs and consequences (benefits) of these interventions to establish their cost effectiveness compared to other alternatives. Thus, the knowledge about cost effectiveness of mhealth interventions is important for informed decision making to implement these interventions as well as for changing policy or priorities in allocation of scarce healthcare resources (6, 7).

Also, the choice of model and its underlying assumptions can have impact on cost-effectiveness results (7, 8). Therefore, analysis of methods employed in different types of full economic evaluation (cost utility, cost effectiveness and cost benefit) is important to identify the differences in results between studies.

Previous systematic reviews of economic evaluation of mhealth have not reported quality assessment of found studies (9-11) except a recent systematic review (12). These reviews were focused on telemedicine, mhealth interventions in general or on a specific disease such as diabetes. However, to authors' best knowledge, there has been no explicit systematic review conducted to gather and critically appraise evidence on cost effectiveness of mhealth interventions for patients aged 55 or above.

This study has two-fold aim. First is to find out cost effectiveness of mhealth interventions based on the results of identified studies. Second is an in-depth review of long-term modelling assumptions and methods used for economic evaluation of mhealth technology interventions.

The main aims of this study can be decomposed in following questions:

Q1: What are the results of economic evaluations of mhealth interventions?

Q2: What are the general characteristics of economic evaluations of mhealth interventions?

Q3: What models have been applied to carry out economic evaluations?

Q4: What assumptions have been considered to see long-term effectiveness of interventions beyond the intervention period?

Methods

Eligibility Criteria

PICO approach is used to design search strategy to be used in this systematic review (13). PICO is an abbreviation for population, intervention, comparison, outcome and study design which helps to divide research questions into small parts to clearly understand and formulate a search strategy. The PICOS approach used for the searches is described as under.

Population or patient's characteristics

Study population will be limited to middle aged and elderly (55+) patients, however, we will not limit study participants in terms of gender, ethnicity, morbidities. Studies on primary, secondary and tertiary healthcare as well as community setting will be included.

Types of technology and intervention

For the present study, we define mhealth as encompassing any delivery of healthcare and/or dissemination of healthcare information using portable devices having internet connection and/or software applications. Portable devices may include mobile phones, smart phones, tablets and wireless devices. Any mhealth intervention aims to improve healthcare delivery process (reminders, appointment attendance, disease management, tele-homecare), efficacy (screening, diagnosis, monitoring etc), and to deliver disease management programmes, and trainings will be included in this study if targeted at middle aged or older patients (14, 15).

Types of outcome measure

Incremental Cost-Effectiveness Ratio (ICER) will be included because results of economic evaluations are often reported in terms of ICER. We will also include other types of outcome measures used in economic evaluations of mhealth interventions. For example, Quality Adjusted life years (QALY), number of years saved, life years gained etc. Also, economic evaluations targeting any outcomes related to clinical decision support systems diagnoses, disease monitoring, appointment reminders, chronic disease management, medication adherence, health promotion programmes/campaigns will also be included.

Comparator or Control Treatment

There is no limit on type of comparator or control treatment. Therefore, we will include all types of comparators as used in the identified economic evaluations.

Study Design

There are three types of full economic evaluations and we aim to include all these into our systematic review. These are named as Cost Benefit Analysis (CBA), Cost Utility Analysis (CUA) and Cost Effectiveness Analysis (CEA). We will include Cost Minimization Analysis (CMA) because it is a special case of CEA in which alternative options equates in terms of consequences (benefits) and an alternative with minimum cost is considered. We will also include both model based and trial based full economic evaluations.

Exclusion Criteria

- Studies on partial economic evaluations such as cost of illness, effectiveness evaluation etc; OR
- Systematic literature reviews, commentaries (letter to the editors, editorials), congress abstracts etc; OR
- Studies related to telephonic interview or survey or questionnaire or recruitment of trial participants on telephone.
- Interventions related to telephone counseling or follow-up calls using basic mobile phone.

Information Sources and Search Strategy

We will include studies that have been published since 2007. The literature search will be restricted to the English language. A comprehensive search strategy will be developed using medical subject headings (Mesh) and text words related to economic evaluation, elderly and mhealth.

We will search *Pubmed, Scopus and CINAHL* databases. A complementary search will be done in *Google Scholar* and first 50 articles will be assessed. We will also scan the reference list of selected studies and citations made on selected studies to ensure that all relevant studies are captured. Likewise, the reference lists of previously published relevant systematic reviews will also be searched. A draft of search strategies in Pubmed, scopus and CINAHL is included in Appendix 1.

Study Records

Data Management

Database search results will be imported into Endnote X7. After removing duplicates in Endnote X7, the remaining records will be exported to Excel worksheet. Title and abstract of all records will be screened. After this, full text reading of selected articles will be done and cause of exclusion of studies at this stage will be recorded. Data extraction and quality assessment of selected studies will also be done in Excel/word. Any disagreement will be resolved by consensus. At each screening stage full records will be screened by two authors independently.

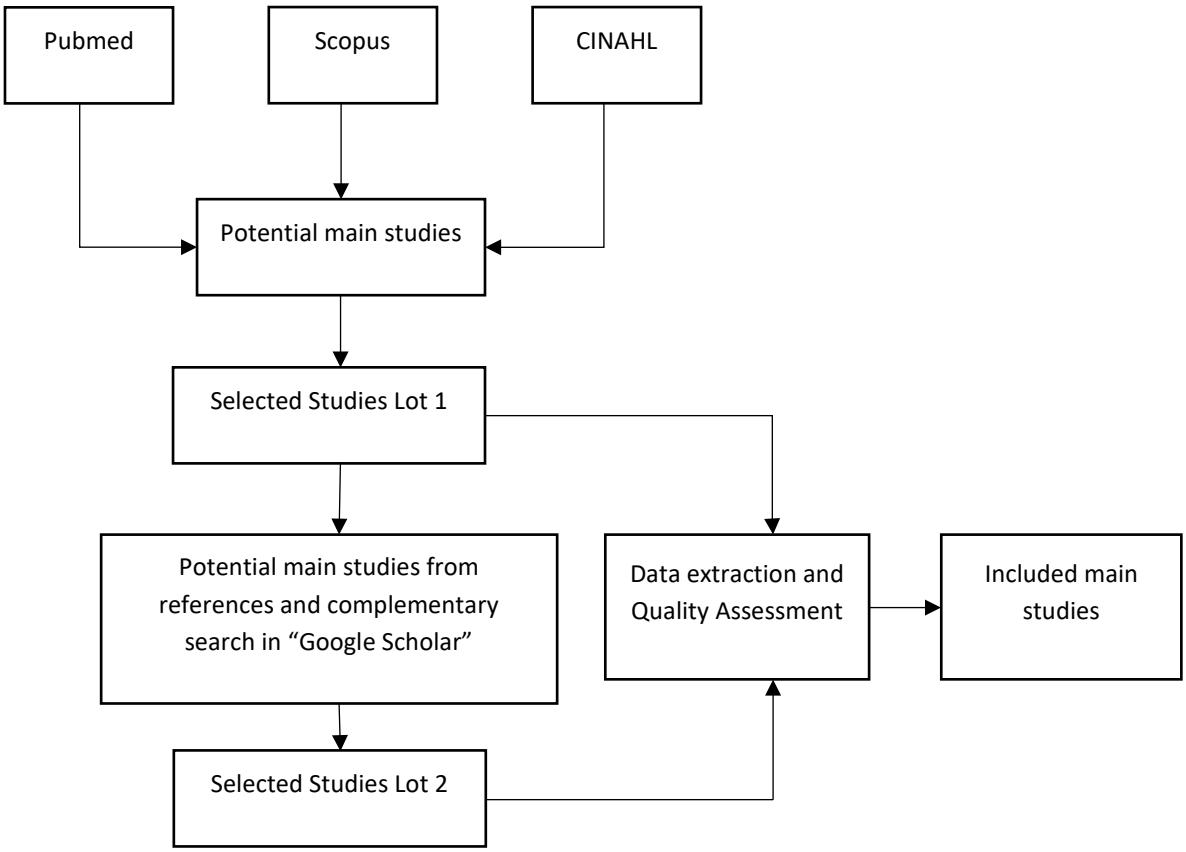
Selection Process

The Potential main studies are retrieved by ZGH from three databases (Pubmed, Scopus and CINAHL). After removal of duplicates, two review team members will independently screen title and abstract of all records based on inclusion criteria. The figure 1 elaborates different phases of the systematic review according to the PRISMA Statement (16).

“Selected studies lot 1” will represent results of assessment of potential main studies. The reference lists of “selected studies in lot 1” will be evaluated to get additional relevant studies by two review team members independently. Also, two review team members will evaluate citations made on “selected studies in lot 1”. In this phase, a complementary search will also be done in Google Scholar. The title and abstract of potential main studies found from references and google scholar (first 50 studies) will independently be assessed by two review authors based

on inclusion criteria. This will result in “Selected studies lot 2”. Any conflict appears during this process will be resolved through discussion and a third reviewer will be involved in case a conflict remains unresolved.

Figure 1. Flowchart for the Systematic Literature Review



Two review authors will independently do the full text reading for all studies in Lot 1 and Lot 2. All the articles fulfill the established criteria will be included in final set of main studies to be included in this systematic review.

Data extraction and quality appraisal for included studies will be done by ZGH on a standardized form and verified by PAN, JSB, JJA and MAN to reduce bias and error. Disagreements will be resolved through discussion. Authors of selected studies will also be contacted to seek missing information through email (maximum of three email attempts).

Data Extraction

Data extraction form will be designed using items for data extraction mentioned in (17). We decomposed the list of items into Table 1-4 to answer the research questions posed in introduction.

Assessing Risk of Bias

CHEERS statement will be used to appraise for the quality of reporting of studies (18). The checklist is presented in Table 5. CHEERS list has 24 items covering information about title and abstract, introduction, methods, results, discussion and other. A score of one will be assigned if an item has been reported according to reporting requirement and zero otherwise. Therefore, an article will receive a maximum score of 24 if it has reported required information.

A check-list from Drummond et al. will be used to critically appraise both trial-based and model based economic evaluations (7). Information on conflict of interest will also be reported to assess the quality of included studies.

Data Synthesis and Reporting

The characteristics, methodology and findings of identified studies will be presented in tables along with narrative summaries. We will provide additional analysis where possible around type of interventions, geographical distribution of studies, funding source and type of diseases etc. We will also discuss the results of selected studies in terms of cost effectiveness acceptability curve, cost effectiveness threshold etc. Though any specific approach will not be used to discuss the strength of the body of evidence, the overall strength of cost effectiveness results of selected studies will be assessed with respect to overall methodological approach and expected bias.

Results

To date, search strategy has been completed. we obtained 1853 records in total after searching three databases (Pubmed, Scopus and CINAHL). We are currently in the process of removing duplicates. The expected date of submission of final results for publication is going to be in the spring of 2019.

Conclusion

This systematic review will summarize evidence on cost effectiveness of mhealth interventions targeting middle aged and older adults to improve their health and also healthcare delivery process.

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Table 1. Results of Economic Evaluation (Question 1)

First author, year	Total benefits	Total costs	Results	Conclusion	ICER	Probability of cost effectiveness
Significance level						

Table 2. Summary of General Characteristics (Question 2)

Study No.	Extracted by	Source of funding	Competing interest	Publication type	setting	First author, year	Patient characteristic (inclusion &exclusion criteria)	Analytic approach	Type of Intervention
Comparator	Age, risk factor	Country, type of EE	Intervention period	Perspective	Effectiveness measure	Effectiveness source	Price year, discount rate	Discount rate for cost	Discount rate for effects
Reference year	Type and category of costs	Data source of resource use	Methods for identifying resource use	Assumptions for the measurement of resources cost (in reported currency or in converted currency)	Methods used to calculated unit costs				

Table 3. Summary of Model Characteristics (Question 3)

First author, year	model	Health states in model	population	Time horizon	Risk factor
Effectiveness data	**Effectiveness measure**	**Metods/ instruments**	**Data source of effects**	**Methods of valuation of effects**	

Table 4. Summary of Long-term Effectiveness (Question 4)

First author, year	Base case Assumption	Intervention period	Sensitivity analysis	Sensitivity analysis assumption	Base Case result	Change in result due to sensitivity analysis

Table 5. CHEERS List for Quality of Reporting

Title and abstract		
Title	Identify the study as an economic evaluation or use more specific terms such as "cost-effectiveness analysis", and describe the interventions compared	Yes=1; No=0
Abstract	Provide a structured summary of objectives, perspective, setting, methods (including study design and inputs), results (including base case and uncertainty analyses), and conclusions.	Yes=1; No=0
Introduction		
Background and objectives	Provide an explicit statement of the broader context for the study. Present the study question and its relevance for health policy or practice decisions.	Yes=1; No=0
Methods		
Target population and subgroups	Describe characteristics of the base case population and subgroups analysed, including why they were chosen.	Yes=1; No=0
Setting and location	State relevant aspects of the system(s) in which the decision(s) need(s) to be made.	Yes=1; No=0
Study perspective	Describe the perspective of the study and relate this to the costs being evaluated.	Yes=1; No=0
Comparators	Describe the interventions or strategies being compared and state why they were chosen.	Yes=1; No=0
Time horizon	State the time horizon(s) over which costs and consequences are being evaluated and say why appropriate.	Yes=1; No=0
Discount rate	Report the choice of discount rate(s) used for costs and outcomes and say why appropriate.	Yes=1; No=0
Choice of health outcomes	Describe what outcomes were used as the measure(s) of benefit in the evaluation and their relevance for the type of analysis performed.	Yes=1; No=0
Measurement of effectiveness	Single study-based estimates: Describe fully the design features of the single effectiveness study and why the single study was a sufficient source of clinical effectiveness data.	Yes=1; No=0
	Synthesis-based estimates: Describe fully the methods used for identification of included studies and synthesis of clinical effectiveness data.	Yes=1; No=0
Measurement and valuation of preference	If applicable, describe the population and methods used to elicit preferences for outcomes.	Yes=1; No=0

based outcomes		
Estimating resources and costs	Single study-based economic evaluation: Describe approaches used to estimate resource use associated with the alternative interventions. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	Yes=1; No=0
	Model-based economic evaluation: Describe approaches and data sources used to estimate resource use associated with model health states. Describe primary or secondary research methods for valuing each resource item in terms of its unit cost. Describe any adjustments made to approximate to opportunity costs.	Yes=1; No=0
Currency, price date, and conversion	Report the dates of the estimated resource quantities and unit costs. Describe methods for adjusting estimated unit costs to the year of reported costs if necessary. Describe methods for converting costs into a common currency base and the exchange rate.	Yes=1; No=0
Choice of model	Describe and give reasons for the specific type of decisionanalytical model used. Providing a figure to show model structure is strongly recommended	Yes=1; No=0
Assumptions	Describe all structural or other assumptions underpinning the decision-analytical model.	Yes=1; No=0
Analytical methods	Describe all analytical methods supporting the evaluation. This could include methods for dealing with skewed, missing, or censored data; extrapolation methods; methods for pooling data; approaches to validate or make adjustments (such as half cycle corrections) to a model; and methods for handling population heterogeneity and uncertainty.	Yes=1; No=0
Results		
Study parameters	Report the values, ranges, references, and, if used, probability distributions for all parameters. Report reasons or sources for distributions used to represent uncertainty where appropriate. Providing a table to show the input values is strongly recommended.	Yes=1; No=0
Incremental costs and outcomes	For each intervention, report mean values for the main categories of estimated costs and outcomes of interest, as well as mean differences between the comparator groups. If applicable, report incremental cost-effectiveness ratios.	Yes=1; No=0
Characterising uncertainty	Single study-based economic evaluation: Describe the effects of sampling uncertainty for the estimated incremental cost and incremental effectiveness parameters, together with the impact of methodological assumptions (such as discount rate, study perspective).	Yes=1; No=0

	Model-based economic evaluation: Describe the effects on the results of uncertainty for all input parameters, and uncertainty related to the structure of the model and assumptions.	Yes=1; No=0
Characterising heterogeneity	If applicable, report differences in costs, outcomes, or costeffectiveness that can be explained by variations between subgroups of patients with different baseline characteristics or other observed variability in effects that are not reducible by more information.	Yes=1; No=0
Discussion		
Study findings, limitations, generalisability, and current knowledge	Summarise key study findings and describe how they support the conclusions reached. Discuss limitations and the generalisability of the findings and how the findings fit with current knowledge.	Yes=1; No=0
Other		
Source of funding	Describe how the study was funded and the role of the funder in the identification, design, conduct, and reporting of the analysis. Describe other non-monetary sources of support.	Yes=1; No=0
Conflicts of interest	Describe any potential for conflict of interest of study contributors in accordance with journal policy. In the absence of a journal policy, we recommend authors comply with International Committee of Medical Journal Editors recommendations.	Yes=1; No=0

Schedule

The table 6 includes the planned schedule for the systematic review.

Table 6. Schedule of the Activities

Activity	Due Date	Participants
Protocol development	20/06/2018	ZGH, JSB, PAN, MAN, JJA
Perform searches	01/01/2018-22/04/2018	ZGH
Organization of search results into Excel sheet and selection by title and abstract	01/07/2018-01/08/2018	ZGH,
Validation of "Selected Studies Lot 1"	01/07/2018-15/08/2018	JSB, PAN, MAN, JJA
Follow up from references and google scholar citation	16/08/2018-16/09/2018	ZGH
Validation of the additional set	16/08/2018-30/09/2018	JSB, PAN, MAN, JJA
Full text reading of selected studies	01/10/2018-31/12/2018	ZGH, JSB, PAN, MAN, JJA
Data extraction and quality assessment	01/10/2018-31/12/2018	ZGH
Validation of Data extraction and quality assessment	01/10/2018-31/12/2018	JSB, PAN, MAN, JJA
First draft of full study	31/01/2019	ZGH, JSB, PAN, MAN, JJA
Submission	30/04/2019	ZGH, JSB, PAN, MAN, JJA

Table 7. Participant's Acronyms

Participant	Acronym
Zartashia Ghani	ZGH
Johan Jarl	JJA
Johan Berglund	JSB
Peter Anderberg	PAN
Martin Andersson	MAN

Authors' Contributions

ZGH designed the search strategy with support of a health librarian, PAN, JSB, JJA and MAN. ZGH also prepared the first draft. PAN, JSB, JJA and MAN reviewed and revised the first draft. All authors read and approved the final manuscript.

Conflicts of Interest

None declared.