

BMJ Open Artificial intelligence (AI) for home support interventions in dementia: a scoping review protocol

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To cite: Qi J, Wu C, Yang L, *et al.* Artificial intelligence (AI) for home support interventions in dementia: a scoping review protocol. *BMJ Open* 2022;**12**:e062604. doi:10.1136/bmjopen-2022-062604

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2022-062604>).

Received 27 March 2022
Accepted 26 August 2022

ABSTRACT

Introduction Dementia has become one of the significant causes of disability and dependency among older people globally. The proportion of people with dementia who are cared for at home has soared. The rapid growth of technology and data has stimulated artificial intelligence (AI) in patients with dementia at home. However, there are still tremendous opportunities and challenges in applying AI to patients with dementia at home, and there is no systematic overview.

Methods and analysis The review will adopt the Unified Theory of Acceptance and Use of Technology. This scoping review will follow the Joanna Briggs Institute scoping review methodology. The structure and content of this protocol follow the Preferred Reporting Items for Systematic reviews and Meta-analyses extension for Scoping Reviews checklist. The proposed study will consider applying AI technology for dementia patients living at home and their families. Authors will conduct systematic searches: China National Knowledge Infrastructure, Wanfang Database, China Science and Technology Journal Database, China Biology Medicine disc, PubMed, CINAHL, Web of Science Cochrane database, EBSCO, Ovid, PsycINFO, Embase. The extracted data will be processed qualitatively and described through tables. The findings are integrated by a narrative synthesis. This review aims to evaluate the nature and extent of the application of AI technology in patients with dementia at home through a systematic search of the literature.

Ethics and dissemination Scoping review is an analysis of existing data and therefore does not require ethical approval. We will publish our findings in a peer-reviewed journal.

Scoping review protocol registration . DOI:10.17605/OSF.IO/3NU9C.

INTRODUCTION

Dementia is currently one of the leading causes of disability and dependency among older people worldwide.¹ Dementia describes a cognitive impairment syndrome that affects memory, cognitive ability and behaviour. It severely interferes with a person's ability to perform daily activities. Alzheimer's is the most common dementia, accounting for approximately 60%–70% of cases.¹ With the development of population ageing, the number of patients with dementia is

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This review will be the first to review the scope of artificial intelligence (AI) in home nursing for patients with dementia. This agreement follows the Joanna Briggs Institute manual and is analysed and reported following Preferred Reporting Items for Systematic reviews and Meta-analyses extension for Scoping Reviews.
- ⇒ To ensure the comprehensiveness of retrieval, researchers in the field of AI discussed our retrieval strategy.
- ⇒ Although our broad search strategy covers a shared database of relevant health studies, we acknowledge that some information related to the issues under our review may not be captured.
- ⇒ As the primary researchers in this study are scholars in the field of medicine and nursing, all possible AI explanations are not in-depth enough and require further research and discussion.

increasing rapidly. About 50 million people worldwide have dementia, and it is estimated that by 2050, it will reach 152 million.² Nearly 9.9 million people have dementia each year; most of them (63%) live in low-income and middle-income countries.¹ It is the second leading cause of disability and the seventh leading cause of death for people aged 70 years and over.² In such a large number of patients with dementia, the proportion of people with dementia who are cared for at home has soared.³ Three-quarters of patients with dementia in China are cared for at home by their spouses or other family members.⁴ It is estimated that the number of patients with dementia in China will exceed 30 million by 2050,⁵ and it is estimated that there are 15.07 million elderly people with dementia now.⁶

Due to the lack of public medical resources and economic burdens, many people in low-income and middle-income countries and most patients with dementia in China choose home treatment after their disease has stabilised.⁷ Since patients with dementia are primarily in the state of home nursing, the



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level of home nursing largely determines patients' quality of life. Symptoms of cognitive impairment, behavioural changes and increased risk of vagal loss in patients with dementia make home nursing challenging.⁸ The elderly with dementia are prone to have more comorbidities, and the elderly with dementia are more likely to have mental health conditions, neurological conditions, cognitive disorders, cerebrovascular disease, diabetes with acute complications and injuries.⁹ Due to the complexity of dementia, patients have higher requirements for family environment and nursing level. Previous nursing studies have also shown that most family members who care for dementia lack knowledge about dementia and daily nursing knowledge and cannot provide corresponding care promptly and effectively.¹⁰ Their caregivers and family members need a new family supported response to meet the needs of patients with dementia, their caregivers, and families to improve their quality of life.

Artificial intelligence (AI) has rapidly become a hot spot in contemporary society under the rapid development of science and technology. The system is based on an artificial neural network and uses mathematical models to extract various complex non-linear relationships from big massive data as a branch of computer science.¹¹ AI is a field of science and engineering concerned with the computational understanding of what is commonly called intelligent behaviour and creating artefacts that exhibit such behaviour.¹² AI was officially born in 1956 and was described as the science and engineering of making intelligent machines.¹³ AI, first used in medical services, is an expert system program. It is a system that integrates various decision-making behaviours of clinicians into a database in advance and then extracts corresponding knowledge from the database through a computer algorithm when there are clinical needs.¹⁴ The technology is suitable for a wide range of medical fields, such as detection, assistive robots, therapeutic robots, and so on.¹³ AI is widely used in society, population, environment and other aspects and promotes the progress and innovation of the medical model in medicine.¹⁵ AI has also shown great potential in the field of home nursing for senile dementia.

AI provides a series of functions to help patients with dementia and their caregivers improve their daily productivity, quality of life, and daily care and reduce caregivers' burden. The procedures provide cognitive stimulation and training, medication and task management, recreational activities, vital sign measurement, and remote consultations with healthcare professionals.^{16,17} At present, many countries have applied telepresence robots to the home intervention of patients with dementia, which has shown promising benefits in the intervention experiment. The American social assistance robot socially assistive robots (SAR_s) can enhance or support the needs of patients with dementia through non-contact interaction. The robot provides users with step-by-step tips, encouraging task execution, reminding events, safety monitoring and seeking emergency assistance, active social

participation and entertainment. The research results show that this robot has reduced the anxiety and depression of patients with dementia and improved patients with dementia.¹⁸ Japan has developed AIBO, an entertainment robot made of metal that can recognise and respond to up to 75 voice commands. AIBO can communicate with patients with dementia using four senses: touch, vision, hearing and balance. The study results showed that the entertainment robot increased the activities of patients.¹⁹ Telepresence robots are controlled by an independent and mobile video conferencing system, including cameras, Liquid Crystal Display (LCD), and microphones. Australian researchers validated the effects of this sort of robot to enhance socialisation by asking participating families to use remote intelligent robots (Giraff in Sweden and VGO in the USA). Family members can remotely call the robot and drive the robot to watch and communicate with patients with dementia through the robot. Telepresence robots encourage residents and family caregivers to take long-distance walks together and participate in social interaction. In the future, telepresence robots can connect family caregivers, nursing staff in elderly care institutions and doctors in hospitals to share patient health information remotely.²⁰

Because of the wide variety and different functions of AI in home nursing for dementia, it is necessary to determine the AI tools systematically, their effects that can be used for home support and intervention of patients with dementia and whether patients with dementia can benefit from them.²¹ At present, efforts are being made to confirm the relevant information of AI technology applied to home support intervention for elderly patients with dementia. Still, the research in this field has not been reviewed and integrated. This study aims to review the content elements, outcome types and effects of AI for home support intervention for elderly patients with dementia, point out the existing problems in this field and clarify the future research direction.

What does this paper contribute to the broader global clinical community?

1. It can promote the better integration of AI and nursing.
2. Obstacles and opportunities faced by the application of AI in the field of home care for dementia can be clearly understood to improve the level of care for patients with dementia.

METHODS AND ANALYSIS

Registration and protocol

The protocol has been registered in the open science framework (OSF) registry and is accessible to the public <https://osf.io/5nqzd>; DOI:10.17605/OSF.IO/3NU9C. If necessary, we will update the protocol in the OSF registration.

Theoretical framework

We will adopt the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh *et al* to guide this

scoping review.²² UTAUT integrates and improves eight other competing model elements, including the theory of reasoned action, technology acceptance model, motivational model, theory of planned behaviour, combined technology acceptance model and theory of planned behaviour, model of PC utilisation, innovation diffusion theory, and social cognitive theory. This model mainly includes four dimensions, Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI) and Facilitation Conditions (FC). PE refers to the degree to which the individual feels that using the system will help the job. EE is ‘the amount of effort required by an individual to use a system’. SI refers to ‘the degree to which individuals feel influenced by the surrounding groups’, mainly including Subjective Norm, social factors and public Image (displayed externally).

FCs are ‘Facilitating an individual’s perception of the organisation’s support for the use of the system in terms of relevant technology or equipment’. At the same time, the above four core factors are also affected by four moderating variables, such as gender, age, experience and voluntariness of use. The framework of the UTAUT model is often supplemented by other factors, such as adding relevant external factors based on actual use cases. Adding contextual factors to UTAUT is an effort to better understand the connection between new technologies and their users. This study adopted the UTAUT framework modified by Pal *et al*, which added four factors: Technology Anxiety (TA), Perceived Trust (PT), Perceived Cost (PC) and Expert Advice (EA).²³ TA is the fear, anxiety and hopes that arise when considering or using it. PT is the mental state in which an older person feels that their data will be safe, carefully protected and anonymous. PC is the price that older users consider appropriate monetary sacrifice in exchange for the services they receive from using the smart home. With EA, from a healthcare perspective, these users tend to rely on the authority of the experts to make their decisions. The UTAUT model

is also closely related to the structure of perceived usefulness and perceived ease of use of the technology acceptance model. The UTAUT model discusses a range of technologies (including the internet, websites, hospital information systems, tax payment systems and mobile technologies, among others) with different control factors (such as age, gender, experience, voluntariness to use, income and education), focusing on a variety of user groups (ie, students, professionals and general users).²⁴ The revised UTAUT theory not only helps to explore the specific organisational issues of the adoption and implementation of AI in the home environment of patients with dementia but also explains the general views of patients with dementia and caregivers on using AI for home support interventions (figure 1). Therefore, we take UTAUT as the basic conceptual framework for this study.

Protocol design

The primary purpose of this study is to present the current research status and possible future trends of AI to readers as comprehensively as possible and draw a map of related concepts through a broad search of ‘AI for home support interventions in dementia’. There will be no systematic review of data from studies examining the effect of AI on home-support interventions for patients with dementia to allow definitive findings (benefit, harm or lack of effectiveness). A scoping review will have a broader ‘scope’ with less restrictive inclusion criteria.²⁵ A typical systematic review aims to answer a specific question or series of questions based on a strict set of relevant or defining factors detailed in the protocol. A scoping review will take a broader approach to map the literature and address a more comprehensive range of research questions.²⁶ Therefore, the methodological principles of a scoping review will be used as a guide in this study. The Joanna Briggs Institute (JBI) methodology will guide the scoping review of AI used in home-based patients with

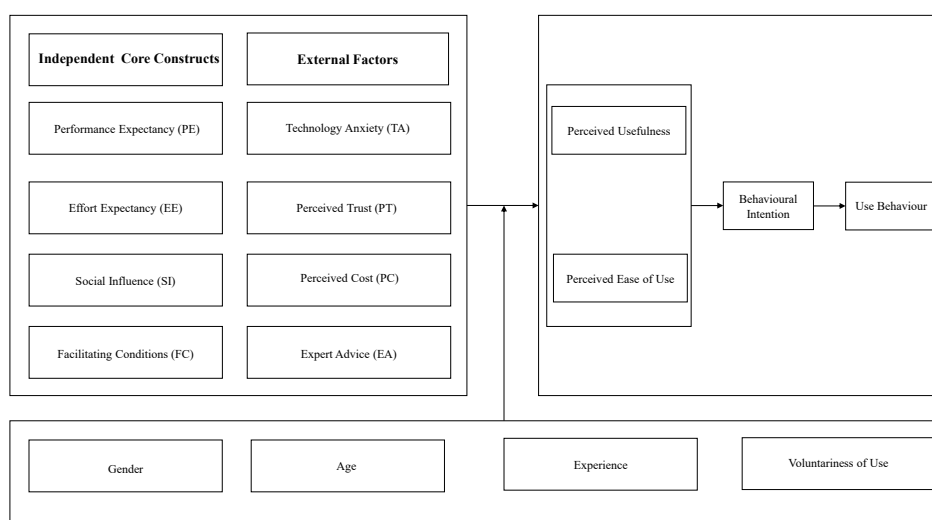


Figure 1 Integrated theoretical framework.

dementia.²⁷ The structure and content of this protocol following the Preferred Reporting Items for Systematic reviews and Meta-analyses extension for Scoping Reviews (PRISMA-ScR) checklist.²⁸ The study is planned to begin in June 2022 and is scheduled to end by December 2022.

Stage 1: Identifying the research questions

This scoping review aims to outline the application of available AI in home support interventions for patients with dementia. According to the objectives of the scoping review, we raised the following research questions:

1. What aspects of AI are applied to home support interventions for patients with dementia?
2. What AI technologies would patients with dementia prefer to use in home support interventions?
3. What are the main characteristics of applying AI in home support interventions for patients with dementia?
4. What are the obstacles and challenges faced by the application of AI in dementia family support interventions?

Stage 2: Identifying relevant studies

The following electronic bibliographic databases will be searched: China National Knowledge Infrastructure, Wan Fang database, China Science and Technology Journal Database, China Biology Medicine disc, PubMed, CINAHL, Web of Science, Cochrane database, EBSCO, Ovid, PsycINFO, Embase. Grey literature will be searched for through Google Scholar.

The retrieval process is as follows: the first step is to build a search strategy through (1) PubMed, (2) China National Knowledge Infrastructure and (3) China Biology Medicine disc. The search terms of AI are agreed on by the researchers in the field of AI, and the search terms are adjusted according to the researchers' suggestions. The search strategy will be piloted to check the appropriateness of keywords and databases. Thus, a complete search strategy is issued and displayed in online supplemental tables S1–S2. The publication date will be limited to database establishment and 31 July 2022. In the second step, a second search will be conducted in all databases according to the formulated retrieval strategy, and the citations will be downloaded. Finally, the third step will include screening the reference list of all studies to find more sources. All references identified will be imported into the reference manager software EndNote X9. References from different electronic databases will be merged, and any duplicate records will be deleted, and then our researchers will carry out back-to-back screening. In case of differences, we will make decisions through group discussion.

Stage 3: Study selection

The screening process of this study is divided into two steps. In the first step, researchers use the document management software EndNote X9 to screen the documents by reading the title and abstract. In the second

Table 1 Inclusion criteria study selection

Category	Inclusion criteria
Publication date	From database establishment to 31 July 2022
Language	English or Chinese
Population	Adults with a diagnosis of dementia The living environment at home or in the community
Context	In a home-based or community-based setting (excluding hospital setting, long-term care setting, nursing home, nursing centre)
Concept	AI primarily refers to information science that expands human intelligence based on theoretical methods and application systems that model human cognitive function using computer science. ^{32 33} The current AI includes machine learning, deep learning, supervised machine learning, unsupervised machine learning and other directions. This study adopts a broad definition of AI; whether AI is virtual or physical, it is eligible for inclusion.

AI, artificial intelligence.

step, the researchers further screen by reading the full text. In the screening process, if two researchers (JQ and CW) encounter differences, the third researcher (LY) will choose. The number of excluded studies will be described in the flow sheet, and the reasons for exclusion will be explained. This process follows PRISMA-ScR.²⁸ The inclusion criteria are shown in [table 1](#).

Stage 4: Pilot searching, screening and extraction of data

Before the formal search and screening studies, the research team members conducted pilot searches to familiarise the group with the process, harmonise standards and agree on chart forms. This study will conduct a pilot search in two databases (PubMed and China National Knowledge Infrastructure) in both Chinese and English to select the first 50 articles that can be included. Two researchers will conduct simultaneous screening and consult our expert (LY) for consultation in case of disagreement. The five studies that meet the inclusion criteria will be reviewed and relevant information extracted. Through this step, researchers can be familiar with and predict the research process in advance to better control the quality of research results. This step should be taken prior to stage 2 and stage 3 (the screening and data charting of the complete set of retrieved abstracts and selected papers for full review) to ensure the quality of the formally conducted research.

Stage 5: Charting the data

Two independent reviewers (JQ and CW) will extract data from all studies in this scoping review. Any disagreements that arise between reviewers during the data extraction stage will be resolved through discussion or with another reviewer until a consensus is reached. The

Table 2 Data charting form

Study characteristics	Extracted data
Essential information	Author
	Publication year
	Country of origin
	Research purpose
	Participants
	Concept
	Background
	Research design
	Technology and intervention details
AI	Type of AI used
	AI mode
	Equipment used main functions
Methods	Frequency of use
	Evaluation deviation and quality information
	Evaluation methods
Outcome measurement	AI—usefulness/user-friendliness/feasibility/benefits and disadvantages, patients with dementia—autonomy/quality of life/cognitive function and neuropsychiatric symptoms/economics, the caregiver—carer burden/stress/anxiety

AI, artificial intelligence.

structured data record form developed by the reviewer will be used, and the information will be recorded in Microsoft Excel. The extracted data will include details about the author, publication year, country of origin, research purpose, participants, concept, research design, technology and intervention details, type of AI used, AI mode, equipment used, main functions, frequency of use, evaluation deviation and quality information, evaluation methods, and outcome measurement (AI—usefulness/user-friendliness/feasibility/benefits and disadvantages, patients with dementia—autonomy/quality of life/cognitive function and neuropsychiatric symptoms/economics, and the caregiver—carer burden/stress/anxiety). A draft data extraction tool is included in [table 2](#).

Critical appraisal of sources of evidence

We will critically assess the sources of evidence using an appropriate critical appraisal tool. Randomized Controlled Trials (RCT) will be evaluated using the Risk of Bias V.2 tool.²⁹ Non-RCT and case studies will be evaluated using the JBI critical appraisal tools.³⁰

Stage 6: Synthesising and reporting of results

In order to summarise and report the research results, the data extracted from the included papers will be displayed

Table 3 The table represents the classification and screening of AI technology in the process of data extraction and analysis

Domain	Description
Types of AI	Monitoring technology
	Auxiliary robot
	Therapeutic robot
	Other applications
The role of AI	Daily life care
	Brain function training
	Psychological intervention
	Communication and other functions

AI, artificial intelligence.

in the form of charts. We will follow the PRISMA flow chart to describe the search and screening results of the literature. We will summarise the results and relevant information according to the PRISMA-ScR checklist analysis and report. The data extracted from the included literature will be qualitatively analysed alongside a narrative synthesis, and the results will be expressed in tables. Narrative synthesis is the adoption of a textual approach to analyse the relationships within and between studies and an overall assessment of the robustness of the evidence.³⁰ Narrative synthesis will follow the framework of guidance of Centre for Reviews and Dissemination (CRD). Above all, reviewers will extract data from the included study following the data extraction form, which will be presented as a table. The analysis steps are listed as follows: developing a theory of how the intervention works, why and for whom; developing a preliminary synthesis of findings of included studies; exploring relationships within and between studies; assessing the robustness of the synthesis. A researcher will likely move iteratively among the activities that comprise these four elements.³¹ To match the objectives of this study, we will provide the participants with the target, the content of AI and the role of AI ([table 3](#)). The research team will modify and improve the result table concerning the JBI manual and the included literature in the synthesis process.

Patient and public involvement

We invited researchers in the field of AI to participate in the formulation of our research strategy and the collation and analysis of data in the later stage. Patients and the public were not involved in design, conduct or reporting plans of this research.

Ethics and dissemination

Ethical approval is not required for this scoping review because it will only summarise the existing published data. We will disseminate the results of AI research on home support interventions for patients with dementia in peer-reviewed journals and meetings. We hope that the research results will be helpful to the stakeholders of dementia care: family caregivers, health practitioners and decision makers,

and provide valuable insights for technology developers. We also expect the research results to win more attention and help families caring for patients with dementia. In addition, these data will provide valuable information for researchers to study AI in the future.

DISCUSSION

This study will explore the application of AI in the family intervention of patients with dementia and further analyse the current situation and effect of AI application, which is conducive to providing better long-term care services for the home intervention of patients with dementia. The results of this study can analyse and show the impact of AI on the nursing of patients with dementia at home and provide an essential basis for the application of AI in the nursing of patients with dementia in the future.

Acknowledgements The authors would like to thank the postgraduate student under the direction of Ai Dezheng Yang, from the University of Liverpool, UK, and Zeyuan Hong, from the Harbin Institute of Technology, China, for assistance in developing the search strategy for AI.

Contributors JQ and YL proposed the idea and designed the entire study. JQ and CW constructed the retrieval strategy and carried out the retrieval. LY and CN reviewed the methodology section. JQ wrote the first draft of the protocol, and LY, LY and CN reviewed and revised the first draft.

Funding This study was supported by the Department of Science & Technology of Liaoning province (2019JH8/10300013). The views expressed in this study are those of the authors and are not affected by funding agencies.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available.

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