Journal of Information and Learning
Volume 37, Issue 1, January - April, 2026 ■ e283811
E-ISSN 2730-2202 ■ https://so04.tci-thaijo.org/index.php/jil

Research Article

Digital Learning Assistant Using Artificial Intelligence for Elderly Health Literacy: A Systematic Review

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Received October 17, 2025 ■ Revised February 19, 2025 ■ Accepted March 11, 2025 ■ Published April 8, 2026

Abstract

This review focuses on the use of digital learning assistants (DLAs) powered by Artificial Intelligence (AI) in supporting health literacy of older adults. The objectives of this review are to examine the characteristics of existing studies, identify the types of AI-based DLAs and design approaches employed, and synthesize reported outcomes related to health literacy and self-care among older adults. Following the PRISMA 2020 guidelines, 17 studies published between 2011 and 2025 were retrieved from six databases and reviewed. The interventions studied included chatbots, virtual coaches, conversational agents, voice assistants, and integrated systems. Overall, the tools enhanced functional health literacy, self-care, health provider communication, and psychosocial outcomes such as loneliness and stress relief. The most successful initiatives applied geragogy principles, culturally and linguistically tailored approaches, and co-design strategies to strengthen trust and enhance usability. Remaining challenges include low digital literacy levels in older adults, brief program length, scalability, and persistent ethical issues of privacy and misinformation. DLAs powered by AI can meaningfully contribute to diminishing health literacy gaps in the aging population. Integrating these tools with primary health care, community health centers, and educational programs for older adults is a practical suggestion. Future studies should focus on randomized controlled trials, longitudinal studies, cross-cultural research, and meaningful engagement of older adults in participatory design. The evidence presented showcases the potential of designed DLAs to promote equitable and informed aging.

Keywords: artificial intelligence, digital learning assistants, elderly, health literacy, systematic review

Introduction

The world is going through a major demographic change. People are living longer, and older adults now make up a larger part of the population everywhere. According to the United Nations (2019), the global population aged 60 and above passed one billion in 2019 and is expected to reach more than two billion by 2050. Asia is experiencing this shift more quickly than many other regions. Thailand is a clear example: about 19% of its population, or 12 million people, are over 60. In just over a decade, this number will rise to nearly 28%, making Thailand a "super-aged society." This change brings serious challenges for a country that must combine traditional family care with modern health systems.

Health literacy is widely recognized as a critical factor in addressing health challenges in ageing societies. It refers to individuals' ability to access, understand, appraise, and apply health information to make informed health-related decisions (Sørensen et al., 2012). Nutbeam (2000) conceptualized health literacy into three levels, functional, interactive, and critical, which remain influential in contemporary research. More recent studies have expanded the concept to include digital health literacy and emphasized its role as a key social determinant of health outcomes (Nutbeam & Lloyd, 2021). Higher levels of health literacy are associated with improved self-care, more effective communication with healthcare providers, and appropriate use of health services, whereas limited health literacy is linked to medication errors, poor treatment adherence, increased hospitalization, and higher healthcare costs (Leung et al., 2013; Stormacq et al., 2020).

Despite its importance, many older adults experience lower health literacy due to age-related cognitive changes, multiple chronic conditions, and difficulties in accessing and interpreting health information. In Thailand, these challenges are further intensified by the digital divide: although digital health technologies are increasingly available, many older adults lack adequate access, digital skills, or confidence to use them effectively (Tangcharoensathien et al., 2018).

In response to these challenges, artificial intelligence (AI) has emerged as a promising tool for health education and support in later life. In this study, AI refers to computational systems capable of functions such as natural language understanding, adaptive feedback, personalization, and decision support. Within health learning contexts, AI has been operationalized through several categories of AI-based digital learning assistants (DLAs), including conversational agents or chatbots, voice-based intelligent assistants, virtual coaches or tutors, and hybrid or embodied systems such as socially assistive robots (Vaidyam et al., 2019; Bickmore et al., 2018). Unlike conventional digital health tools, these systems enable interactive, dialogic,

and personalized learning experiences. Recent studies suggest that AI-based DLAs can enhance engagement, comprehension, and motivation among older adults, particularly when content is adapted to users' pace, language, and learning preferences (Zhou et al., 2020; Peng et al., 2024; Quinn et al., 2024).

Despite growing interest, research on AI-based DLAs for older adults remains fragmented. Many studies categorize these tools broadly as digital health or mobile health interventions, obscuring the specific contribution of AI and limiting understanding of how older adults engage with intelligent systems (Vaidyam et al., 2019; Brownson-Smith et al., 2025). Existing evidence is further constrained by short intervention periods, small sample sizes, heterogeneous outcome measures, and limited attention to cultural, linguistic, and geragogical factors (Stormacq et al., 2020; Wegener et al., 2024). Consequently, policymakers and practitioners lack consolidated guidance for designing AI-based learning tools suitable for ageing populations.

Existing studies on AI-based DLAs for older adults' health literacy remain fragmented and methodologically diverse. Given these gaps, a systematic synthesis of existing evidence is warranted. Accordingly, this study adopts a systematic review approach guided by the PRISMA 2020 framework, which supports transparent identification, appraisal, and synthesis of research across health, education, and human–computer interaction (Page et al., 2021). By applying explicit inclusion and exclusion criteria and structured quality appraisal, this review aims to provide a comprehensive and critical overview of current research on AI-based DLAs for older adults' health literacy.

This review fills these gaps through four questions:

1. What are the characteristics of studies involving AI-based DLAs for enhancement of health literacy for the older population?

2. What design approaches and AI modalities (e.g. chatbots, virtual tutors, recommender systems) have been used and how?

3. What have been the reported outcomes in relation to their effectiveness?

4. What gaps and future research opportunities can be recognized?

Objectives

1. To examine the characteristics of existing studies on AI-based Digital Learning Assistants for older adults' health literacy.

2. To identify the types of AI technologies and design approaches employed.

3. To synthesize reported outcomes related to health literacy, self-care, and related psychosocial factors.

Methodology

Research Design

This study undertakes a systematic review within the principles of the PRISMA 2020 framework (Page et al., 2021). This decision was intentional. There is a 'siloing' of evidence regarding the AI-based digital learning assistants (DLAs) for older adults, and a narrative summary would almost certainly create gaps. In contrast, a systematic review makes the researcher justify how studies were located, what criteria were used for inclusion/exclusion, and how the evidence was evaluated. Such clarity is important in this case, especially when the enthusiasm for AI far exceeds the rigorous evaluation of evidence. Consistent with PRISMA 2020, the review followed four core stages: (1) identification of relevant records through systematic database searches, (2) screening of titles and abstracts against predefined inclusion and exclusion criteria, (3) eligibility assessment through full-text review, and (4) inclusion of studies for qualitative synthesis. Each stage was documented using a PRISMA flow diagram to ensure transparency in study selection and exclusion decisions.

Drafting the protocol is done before the review and is influenced by the criteria usually used in the evaluation of health technologies and in educational research (Moher et al., 2015; Page et al., 2021). This review was not registered with PROSPERO, a limitation that should be acknowledged, but the procedures nonetheless follow international expectations for evidence synthesis. In effect, this means the review is reproducible, although this is a rare case of international evidence synthesis without registration.

Search Strategy

The search aimed to be comprehensive while maintaining methodological rigor. The database selection was prioritized to reflect both international standards and contextual relevance. Scopus and Web of Science were used as the primary databases for identifying internationally recognized, interdisciplinary research. ERIC was included to capture studies grounded in educational theory and practice, while PubMed/MEDLINE complemented the search with its specific focus on biomedical and health-related research.

The Thai Journal Citation Index (TCI) was incorporated as an essential national database to identify high-quality, peer-reviewed studies situated within the Thai and Southeast Asian context, thereby reducing geographical bias and capturing culturally specific interventions. Google Scholar was used as a supplementary source to retrieve relevant grey literature or articles not indexed in the aforementioned databases. All records retrieved from Google Scholar were manually screened to ensure quality, methodological clarity, explicit use of AI-based

digital learning assistants, and relevance to health literacy outcomes in older adults.

The search timeframe spanned January 2010 to March 2025, covering the period of the growing application of artificial intelligence in health and educational contexts.

The following keywords were adapted for each database:

("Artificial Intelligence" OR "AI-generated content" OR "Digital Learning Assistant") AND ("Elderly" OR "Older Adults") AND ("Health Literacy")

Inclusion and Exclusion Criteria

To ensure relevance and rigor, inclusion and exclusion criteria were applied in Table 1.

Table 1

Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Population	Elderly participants aged ≥60 years	Non-elderly participants (children, adolescents, younger adults)
Intervention	AI-based Digital Learning Assistants (chatbots, recommender systems, virtual tutors, social robots)	Non-AI technologies (e.g., static websites, traditional e-learning)
Outcomes	Health literacy, self-care, health communication, comprehension, recall	No outcomes related to health literacy
Publication year	2010–2025	
Language	English or Thai	

A total of 1,543 records were retrieved from the searches of the databases. After deleting 267 duplicates, 1,276 unique records remained and were screened by title and abstract. Two independent reviewers conducted the title and abstract screening independently. As a result of this stage of screening, approximately 1,096 records were excluded, as they did not target older adult populations or did not incorporate AI-based interventions. The remaining 180 articles were read in full. Out of these, 163 were eliminated. The main reasons for exclusion were the absence of an AI component in general mobile health interventions and the inclusion of caregiver populations instead of older adults. After applying these criteria, 17 studies met the eligibility requirements and were included in the final synthesis.

Quality Appraisal

To ensure the methodological quality of the review, two tools were used.

Qualitative and mixed-methods studies were assessed using the CASP checklists, which evaluate clarity of aims, appropriateness of methodology, validity of findings, and reflexivity.

The study made use of AMSTAR 2 (A MeaSurement Tool to Assess Systematic Reviews) with respect to review-type studies, which were few, reflecting the limited number of systematic-type studies in the sample. The aim was to assess the transparency of search strategy, risk of bias, and comprehensiveness.

Each study was independently assessed by two reviewers and rated as High, Moderate, or Low quality. Inter-rater reliability was calculated using Cohen's Kappa, yielding a value of K = 0.82, indicating strong agreement. Any disagreements were resolved through discussion. Of the 17 included studies, 9 were rated High quality, 5 Moderate, and 3 Low (included for contextual interpretation).

Results

PRISMA: Flow of Study Selection

The systematic search identified a total of 1,543 records across the six databases. After removing 267 duplicates (17.3% of all records), 1,276 unique titles and abstracts were screened. During this stage, 1,096 records (85.9% of the screened records) were excluded because they:

- Focused on mobile health (mHealth) or e-learning applications without AI,
- Targeted caregivers or healthcare workers rather than elderly populations, or
- Lacked outcomes related to health literacy.

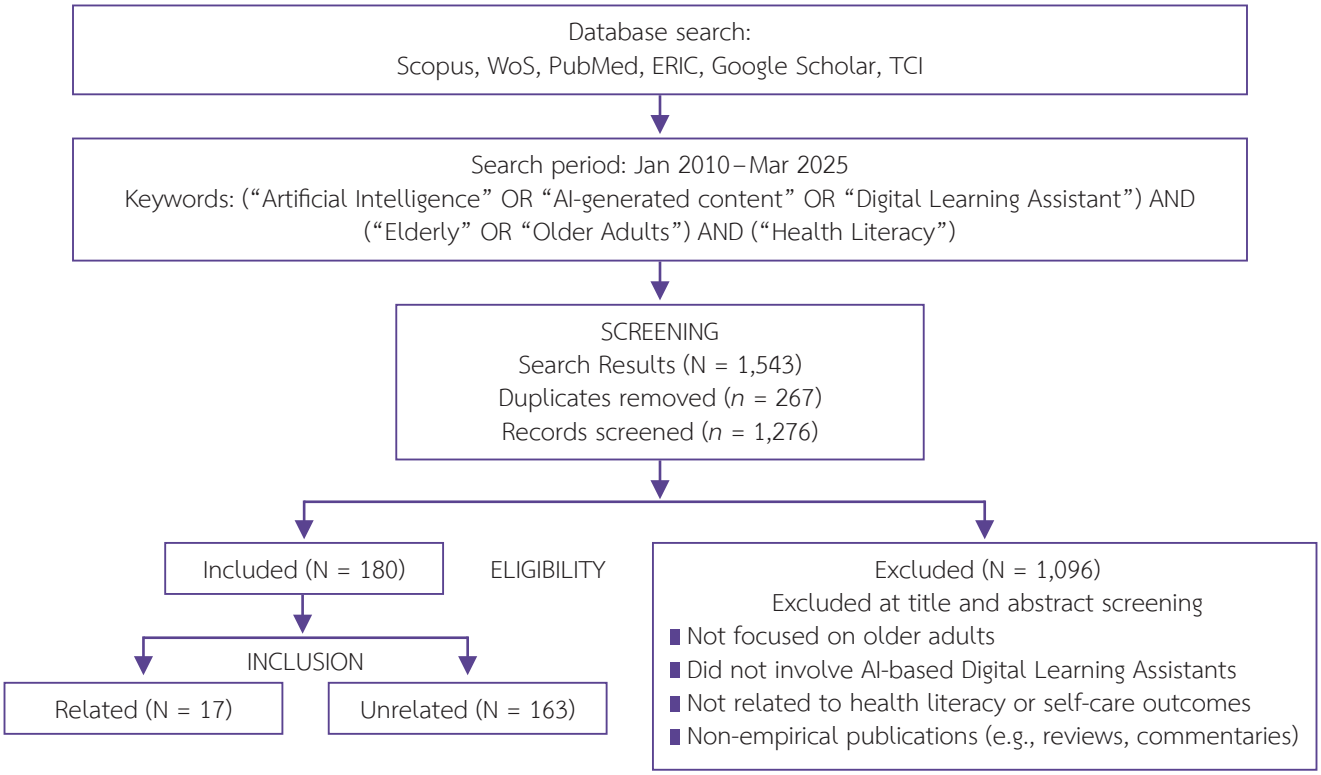
Of the 180 articles read in full, the majority—163 in total—were excluded. Some made only passing reference to AI, others described pilot projects that involved different populations, and a number were concerned with digital literacy rather than health literacy. That left just 17 studies for inclusion.

The 17 included studies were heterogeneous in both context and design. They were conducted across the United States, Europe, several Asian countries, and Thailand, and ranged methodologically from randomized controlled trials to small exploratory studies. The AI-based

DLAs examined were also diverse, including chatbots, voice assistants, virtual coaches, and hybrid systems. This variation reflects the early and evolving nature of the field. The study selection process is summarized in Figure 1 (PRISMA diagram).

Figure 1

PRISMA Flow Diagram of Study Selection



Characteristics of Included Studies

More than half (nine) of the 17 studies were based in the United States, while three were from Thailand. Other countries that had two studies completed were Taiwan, while there was one study from China, Australia, and the United Kingdom. The scale of these projects varied considerably. Some of these were exploratory studies, which had fewer than thirty participants. Others involved large community samples of five hundred or more older adults.

The quality of the included studies was rated using standard assessment tools. CASP was used to review qualitative and mixed-methods work. AMSTAR 2 was used for review-type designs. The results were mixed. Out of the total studies conducted, nine were of high quality, five were of moderate quality, and three were of low quality. It is this irregular pattern characteristic that is important: because it provides some encouraging evidence of rigor in certain cases, and it identifies gaps that cause cross-study comparisons to be less straightforward. Table 3 gives a summary of characteristics and quality ratings.

Table 2

Summary of Selected Studies on AI-based DLAs for Elderly Health Literacy

Author (Year)	Country	Sample Characteristics	Sample Size (*n*)	Study Design	AI Type / System	Research Instruments	Key Outcomes/ Findings
Chattaraman et al. (2019)	USA	Older adults (61–89 yrs) with varying digital competency	121	Laboratory experiment	Conversational Digital Assistant	Trust scale, perceived interactivity, ease of use, self-efficacy	Social-style agents enhanced trust for high-competency users; task-style agents improved ease of use for low-competency users

Table 2
(continued)

Author (Year)	Country	Sample Characteristics	Sample Size (*n*)	Study Design	AI Type / System	Research Instruments	Key Outcomes/ Findings
McDonald et al. (2011)	USA	Older adults with chronic pain	24	Pilot intervention	Virtual Pain Coach	Pain communication assessment, interviews	Improved pain communication with healthcare providers
McDonald et al. (2012)	USA (Hispanic)	Spanish-speaking Hispanic older adults with osteoarthritis	18	Randomized controlled pilot	Spanish Virtual Pain Coach	Brief Pain Inventory–SF, BDI-II	Reduced depressive symptoms; improved pain communication
Bickmore et al. (2013)	USA	Sedentary older adults (mean age 71.3; 61% female; 63% African American)	263	Single-blind block-randomized controlled trial	Relational Agent (embodied CA)	Engagement metrics, adherence logs	Increased long-term engagement and adherence
Azevedo et al. (2018)	USA	Older adults receiving medication instructions	360	Experimental study	Conversational Agent	Medication recall tests, affective scales	Improved medication understanding and recall
Wei et al. (2021)	Taiwan	Adults ≥50 years	60	Quasi-experimental	Robot-Assisted Learning System	HLS-EU-Q16, motivation and flow scales	Improved health knowledge, literacy, motivation, and flow
Jabjone (2020)	Thailand	Thai older adults with chronic disease	100	Quasi-experimental	Chatbot + E-learning	Health literacy questionnaire	Improved chronic disease health literacy
Sumruamjit et al. (2023)	Thailand	Thai older adults	100	Intervention study	Mental Health Chatbot	Depression scale, satisfaction survey	Reduced depressive symptoms
Wongworasun et al. (2023)	Thailand	Community-dwelling older adults	57	Quasi-experimental (pre–post)	Oral Health Chatbot	Oral health knowledge interview	Improved oral health literacy
Ali et al. (2021)	USA	Community-dwelling older adults	30	Pilot intervention study	Conversational Skills Coach	UCLA Loneliness Scale, usability questionnaire	Reduced loneliness and improved social communication skills
Bosco et al. (2024)	USA	African American older adults (>55 yrs)	15	Wizard-of-Oz usability study	Voice Assistant + Chatbot	Task-based usability testing, interviews	Enhanced trust and information-seeking behavior
Quinn et al. (2024)	USA	Older adults ≥65 years	18	Mixed-methods feasibility study	Smart Speaker Voice Assistant	Technology acceptance scale, interviews, device logs	High acceptability and usability; technical support required
Chou et al. (2024)	Taiwan	Older adults with anxiety/ depression	35	Usability and intervention study	Mental Health Chatbot (LINE-based)	UCLA Loneliness Scale, anxiety/ depression scales	Reduced loneliness among adults ≥65 years
Peng et al. (2024)	USA	Older adults (≥50 yrs)	17	Participatory design study	Chatbot (misinformation management)	Design workshops, qualitative analysis	Improved strategies for managing health misinformation

Table 2
(continued)

Author (Year)	Country	Sample Characteristics	Sample Size (*n*)	Study Design	AI Type / System	Research Instruments	Key Outcomes/ Findings
Wegener et al. (2024)	Denmark /Norway	Older adults with COPD	33	Qualitative co-design study	Conversational Agent	Interviews, thematic analysis	Enhanced disease-related health literacy and self-management
Liang et al. (2025)	China (Hong Kong)	Inactive community-dwelling older adults	278 (planned RCT)	Randomized controlled trial (protocol)	NLP-based Chatbot	IPAQ-SF, accelerometers	Increased physical activity (expected)
Brownson-Smith et al. (2025)	UK	Older adults in social care contexts	NA (review)	Scoping review protocol	Conversational Systems (chatbots, voice assistants)	PRISMA-ScR framework	Identified design gaps and ethical considerations

Table 3
Results of Study Quality Appraisal

Author/Year	Tools	Quality Rating
McDonald et al., 2011	CASP	High
McDonald et al., 2012	CASP	High
Bickmore et al. (2013)	CASP	High
Azevedo et al., 2018	CASP	High
Chattaraman et al., 2019	CASP	High
Jabjone et al. 2020	CASP	Moderate
Wei et al., 2021	CASP	High
Ali et al., 2021	CASP	Moderate
Sumruamjit et al. (2023)	CASP	Moderate
Wongworasun et al. (2023)	CASP	Moderate
Bosco et al., 2024	CASP	High
Wegener et al., 2024	CASP	Moderate
Quinn et al., 2024	CASP	Low
Chou et al., 2024	CASP	Low
Peng et al., 2024	CASP	Low
Liang et al., 2025	CASP	High
Brownson-Smith et al., 2025	AMSTAR 2	High

Thematic Synthesis of Findings

The 17 studies were thematically analyzed, identifying 4 main themes on the use of AI-based Digital Learning Assistants for elderly health literacy.

1. Effectiveness in Enhancing Health Literacy and Self-care.

Results from multiple studies show that AI tools can help older adults understand, remember, and use health information better. For instance, virtual pain coaches were said to enhance conversations between patients and doctors (McDonald et al., 2011; 2012). Projects that used conversational agents to support

exercise or medication routines reported some benefits in adherence. (Bickmore et al., 2013; Azevedo et al., 2018). Chatbots used in China, Taiwan, and Thailand explored quite different subjects: chronic disease, oral health, and mental well-being. All three studies reported improvements in specific outcomes, including disease-related knowledge and self-management skills, oral health literacy, and psychological well-being (e.g., reduced stress or depressive symptoms), reflecting the versatility of the approach. A robot-assisted learning system (Wei et al., 2021) has been shown to outperform video lessons not just at enhancing knowledge, but also at keeping participants motivated and engaged. The educational outcomes suggest that embodied AI platforms can contribute a more interactive and sometimes persuasive presence compared to static learning media.

2. Geragogy-fit Design and Usability.

Many studies highlighted the importance of creating systems that older adults would be able to use easily. Simplified interfaces, voice interaction, and cultural adaptations—say, a Thai-language chatbot in a community clinic or a Spanish-language version for migrant seniors—made voice assistants and chatbots feel more accessible and reduced the cognitive effort required (McDonald et al., 2012; Peng et al., 2024). When systems were co-designed with older adults themselves (Wegener et al., 2024), usability and trust improved noticeably, largely because the tools reflected participants' preferred ways of learning and communicating.

Interestingly, not all users responded in the same way. Chattaraman et al. (2019) showed that interaction style mattered: socially oriented designs worked better for tech-savvy older adults, who valued the sense of dialogue and connection, while task-oriented approaches gave less confident users what they needed most—clarity, structure, and a boost in self-efficacy. The lesson here is fairly clear, though not always acted upon: systems have to adapt. A single design is unlikely to meet the needs of such a heterogeneous group.

3. Engagement, Motivation, and Social Interaction.

Some of the included studies suggest that AI systems did more than pass along health information—they also offered a measure of companionship and, at times, motivation. One project using conversational skills coaches reported reductions in loneliness and better social interaction among older adults (Ali et al., 2021). Another, carried out during the COVID-19 lockdowns, used chatbots to help ease psychological strain when in-person contact was limited (Chou et al., 2024).

Engagement was also shaped by design. Gamified features, quick feedback, and reinforcement loops encouraged people to keep up with daily tasks like exercise or taking medication. Perhaps the most striking example came from a robot-assisted system (Wei et al., 2021). Because interaction was embodied—participants could respond to a physical presence rather than a screen—it created a sense of immersion that static resources simply could not. These findings indicate that motivation in health education often depends less on what is being taught than on how the learning environment is experienced.

4. Limitations and Challenges.

Not all of the findings were encouraging. Many older adults struggled with digital basics, and some systems had trouble interpreting natural language in ways users found natural. Most studies were short-lived, so we still know very little about whether the benefits would persist over months or years.

Concerns about trust and privacy also came up—sometimes coupled with worries about misinformation—especially in studies that looked at chatbots or voice assistants (Peng et al., 2024; Brownson-Smith et al., 2025). Hybrid models that combined chatbots with mobile apps or e-learning platforms seemed promising, but the evidence on whether such systems can be scaled, or delivered at a reasonable cost, is thin at best. One study by Chattaraman et al. (2019) raised a more subtle issue: when the design of the AI didn't match the user's level of digital skill, the tool simply failed to deliver what it promised. That misalignment points to an obvious but often overlooked lesson—systems need to adapt to users, not the other way around.

To provide a clear overview of how the evidence from the included studies supports the four identified themes, a matrix table is presented below. Table 4 maps each of the 17 included studies against the thematic categories derived from the synthesis. This visual representation enables readers to quickly identify patterns across studies and understand how different types of AI-based Digital Learning Assistants contribute to health literacy, design considerations, engagement, and reported challenges.

Table 4

Matrix Mapping of Included Studies and Identified Themes

Author (Year)	Effectiveness in Health Literacy & Self-care	Geragogy-fit Design & Usability	Engagement, Motivation & Social Interaction	Limitations & Challenges
McDonald et al. (2011)	Improved pain communication with providers	Simple dialogue-based virtual coach	Supported patient–provider interaction	Short-term pilot; small sample
McDonald et al. (2012)	Enhanced culturally adapted pain expression	Spanish-language adaptation for Hispanic elders	Increased comfort in communication	Limited follow-up duration
Bickmore et al. (2013)	Improved adherence to exercise routines	Relational agent with simplified interaction	Sustained engagement over time	Resource-intensive intervention
Azevedo et al. (2018)	Improved medication understanding and recall	Conversational instruction reduced cognitive load	Maintained attention during learning tasks	Laboratory-based setting
Chattaraman et al. (2019)	Improved self-efficacy and perceived usefulness	Interaction style tailored to digital skill level	Social presence valued by confident users	Misalignment reduced effectiveness for some users
Wei et al. (2021)	Increased health knowledge and self-management	Embodied robot-assisted learning	High motivation and flow experience	Possible novelty effects
Jabjone (2020)	Improved chronic disease health literacy	Thai-language chatbot in community context	Encouraged regular self-care behaviors	Limited methodological reporting
Sumruamjit et al. (2023)	Reduced depressive symptoms	Simple chatbot interface	Emotional support during use	Short intervention period
Wongworasun et al. (2023)	Improved oral health literacy	Local language and familiar platform	High user satisfaction	Limited generalizability
Ali et al. (2021)	Indirect benefits for communication skills	Conversational skills coaching	Reduced loneliness and improved social interaction	Psychosocial outcomes only
Bosco et al. (2024)	Supported information seeking	Voice-based access reduced literacy barriers	Increased trust and engagement	Small qualitative sample
Quinn et al. (2024)	Supported physical activity routines	Voice assistant bypassed reading demands	Continued engagement at home	Technical and connectivity issues
Chou et al. (2024)	Reduced stress and improved well-being	User-friendly chatbot design	Psychological support during COVID-19	Context-specific (pandemic)
Peng et al. (2024)	Improved misinformation awareness	Co-design enhanced relevance and trust	Empowered reflective engagement	Did not test long-term outcomes
Wegener et al. (2024)	Supported COPD-related health literacy	Co-created, age-appropriate design	Engagement through daily-life relevance	Qualitative design limits causality
Liang et al. (2025)	Increased physical activity behaviors	Stage-of-change tailored chatbot	Sustained motivation via personalization	Protocol-stage evidence
Brownson-Smith et al. (2025)	Identified gaps in health and social care support	Highlighted accessibility and usability issues	Addressed social inclusion potential	Lack of outcome evaluation

Summary of Key Findings

The review of 17 studies suggests that AI-based Digital Learning Assistants have real promise for improving health literacy, self-care, and communication in older populations. Chatbots and conversational agents were the most common tools, and they generally helped participants better understand, remember, and act on health information. Voice assistants and virtual coaches had varying effects, including improved exercise adherence, enhanced pain communication with healthcare providers, and increased confidence in seeking and understanding health information. Most participants reported these tools to be particularly useful in supporting physical activity routines, pain management, and everyday health

information seeking. One study found that robot-assisted learning was superior to video-based learning through stronger motivation and a greater sense of flow (Wei et al., 2021).

Design mattered. Interventions that draw on principles of geragogy—for instance, simplified interfaces, voice interaction, or culturally adapted versions in Thai or Spanish—tended to be more usable and more accepted. Chattaraman et al. (2019) added another valuable nuance: matching the interaction style to the user's digital competence. People who are confident were attracted towards the socially oriented designs. This was because the additional structure and clarity given by the task-oriented designs had limited users. Some of the systems not only supported cognitive outcomes, such as improved comprehension of health information, recall of instructions, and self-management skills, but also enhanced emotional well-being by reducing loneliness and stress.

The picture, however, was not without its shortcomings. Most interventions were short, which leaves open the question of long-term sustainability. Many participants struggled with basic digital literacy, and concerns about trust, privacy, and scalability surfaced repeatedly. In sum, the evidence to date indicates that AI-based systems can indeed support older adults in meaningful ways—but durable impact will require adaptive design, stronger empirical grounding, and frameworks that take ethical and equity issues seriously.

Discussion

This review examined 17 studies published between 2011 and 2025 that explored the use of AI-based Digital Learning Assistants (DLAs) to support older adults' health literacy. In line with the study objectives, the discussion is organized around 1) the characteristics of existing studies, 2) the types of AI technologies and design approaches employed, and 3) the reported outcomes related to health literacy, self-care, and psychosocial factors.

Characteristics of Existing Studies

Addressing the first objective, the reviewed studies show considerable diversity in geographic context, methodology, and intervention focus. Research was conducted across the United States, Europe, East Asia, and Southeast Asia, including Thailand, reflecting growing global interest in AI-supported health education for ageing populations. Most studies relied on small-scale designs, pilot studies, feasibility studies, quasi-experiments, or qualitative approaches, while only a limited number employed randomized controlled trials. Intervention durations were often short, typically lasting a few weeks to a few months, which limits conclusions about long-term effectiveness.

Despite these limitations, the studies collectively provide a snapshot of how DLAs are currently being applied in real-world contexts. Many focused on community-dwelling older adults, often with chronic conditions, and emphasized practical health topics such as pain management, medication use, physical activity, mental health, and disease self-management. Together, these characteristics suggest that the field is still in an exploratory phase, prioritizing feasibility and acceptability over long-term outcome evaluation.

Types of AI Technologies and Design Approaches

Responding to the second objective, a wide range of AI technologies were identified. Chatbots and conversational agents were the most common, likely due to their flexibility and relatively low development cost. Other approaches included virtual pain coaches, conversational skills coaches, voice assistants embedded in smart speakers, and robot-assisted learning systems. Hybrid systems combining multiple modalities, text, voice, and embodied interaction, also appeared in several studies.

Across these technologies, design considerations emerged as more influential than the specific AI form itself. Interventions were more effective when they were culturally and linguistically tailored, when older adults were involved in the design or co-design process, and when systems adapted their interaction style to users' digital competence. McDonald et al.'s (2012) Spanish-language pain coach for Hispanic older adults and Wegener et al.'s (2024) co-designed COPD chatbot illustrate how aligning language, culture, and daily routines increased relevance and trust. Chattaraman et al. (2019) further showed that socially oriented conversational styles benefited digitally confident users, whereas task-focused designs supported users with lower digital skills by reducing cognitive load and enhancing self-efficacy.

These findings align closely with principles of geragogy, which emphasize age-appropriate learning that accounts for slower information processing, memory changes, and attentional shifts in later life. Simplified interfaces, clear voice interaction, repetition, and flexible pacing were repeatedly highlighted as essential design features.

Outcomes Related to Health Literacy, Self-Care, and Psychosocial Factors

The third objective concerned synthesizing reported outcomes. Across the studies, AI-based DLAs consistently supported core components of health literacy: understanding health information, remembering instructions, communicating with health professionals, and applying knowledge in daily self-care. Improvements were reported in medication literacy, symptom reporting, physical activity adherence, oral health knowledge, and chronic disease self-management.

Beyond functional outcomes, several studies documented psychosocial benefits. Reduced loneliness, stress, or depressive symptoms were reported in interventions that emphasized conversational interaction

and social presence, such as Ali et al.'s (2021) conversational skills coach and Chou et al.'s (2024) mental health chatbot used during the COVID-19 pandemic. These findings suggest that DLAs can function not only as informational tools but also as sources of companionship and emotional support.

Some studies also hinted at higher-level health literacy skills. Peng et al. (2024), for example, described chatbot designs that helped older adults reflect on and challenge health misinformation, moving beyond basic comprehension toward more critical engagement. However, such outcomes were less common, indicating that most current interventions focus on functional rather than interactive or critical health literacy.

Implications

Educational Practice

The evidence points to a simple but often overlooked lesson: AI-based DLAs need to be grounded in educational approaches that make sense for older learners. Techniques long used by health educators—Ask Me 3 or the Teach-back method—translate well into digital dialogues, where a virtual coach or chatbot can prompt an older adult to restate instructions or explain what they have understood. This is more than a gimmick. It follows the strategies used by skilled clinicians and helps people understand in ways that a static handout could never achieve.

Wei et al.'s (2021) study gives an important insight. Their robot-assisted system kept older adults engaged more often than video lessons. This shows that embodied interaction can create a sense of closeness that screen-based tools often lack. One clear lesson is that repetition and using many forms of input are important. Text, audio, visual signals—and in some cases, a physical presence—can work together to hold attention. When these elements are combined with content that matches culture and language, such as a Thai-language pain coach or a Spanish version for Hispanic elders, the result is not only better engagement but also deeper learning that feels more personal.

Healthcare Systems

For clinicians and community health workers, AI-based DLAs are more than new technology. They offer a low-cost way to continue patient education beyond the short time spent in the clinic. Tools such as medication reminder chatbots, virtual pain coaches, or voice-based health tutors can support patients between visits, encourage them to follow treatment plans, and lower the chance of avoidable readmissions.

The setting is also important. In Thailand, community health centers and "elderly schools" already serve as places for group education. These programs could easily include hybrid or robot-assisted systems, which would support group learning while also meeting individual needs. Design, however, remains the critical piece. As Chattaraman et al. (2019) showed, elderly users with high digital competence may prefer socially oriented systems, while those less confident benefit from task-oriented designs that feel structured and straightforward.

If implemented thoughtfully, such integration could do two things at once: ease the burden on healthcare staff and, more importantly, give older adults a greater sense of control over their own health. This change from being a passive recipient to becoming an active manager, may be the most important outcome of all.

Research Implications

Implications for Practice and Policy

1. Supporting Health Literacy and Self-Care

The reviewed studies consistently show that AI-based Digital Learning Assistants (DLAs) can support older adults in understanding, remembering, and applying health information. Tools such as chatbots, virtual coaches, voice assistants, and conversational agents helped users recall medical instructions, adhere to treatment routines, and communicate more confidently with health professionals. These findings suggest that DLAs can complement traditional health education, especially where static materials such as pamphlets or videos fail to meet older adults' learning needs.

2. Design Principles for Effective Implementation

Across studies, outcomes depended less on the specific AI technology and more on how it was designed. Interventions were more effective when they reduced cognitive load, used simple and clear language, allowed repetition, and adapted interaction styles to users' digital skills. Cultural and linguistic tailoring also increased trust and engagement, as seen in adapted pain coaches and locally designed chatbots. These findings highlight that geragogy-informed design should be treated as a practical requirement rather than an optional feature.

3. Placement in Real-World Settings

The findings suggest that DLAs may be most useful when integrated into familiar environments such as community health centers, senior clubs, or elderly schools. In these settings, AI tools can support learning beyond clinical encounters and work alongside health staff and caregivers rather than replacing them. Such integration may improve accessibility and sustained use, particularly for older adults with limited digital confidence.

4. Ethical and Trust Considerations

Trust emerged as a central condition for adoption. Older adults expressed concerns about data privacy, transparency, and the reliability of AI-generated advice. Without clear safeguards and accountability, these tools

risk excluding the very groups they are meant to support. Transparent system design, clear communication about data use, and alignment with trusted institutions are therefore essential for responsible implementation.

Implications for Future Research

1. Strengthening Methodological Rigor

Most studies reviewed were short-term pilots with small samples. Future research should prioritize larger-scale and longer-duration studies to examine whether improvements in health literacy, self-care behaviors, and psychosocial outcomes are sustained over time. Beyond test scores or knowledge gains, research should focus on meaningful outcomes such as improved health management, reduced complications, and quality of life.

2. Expanding Cultural and Contextual Coverage

Current evidence is concentrated in Western and East Asian contexts. More research is needed in low- and middle-income countries, where access to technology, cultural norms, and health communication practices differ substantially. Cross-cultural studies would clarify how local language, values, and social structures shape both the design and effectiveness of AI-based DLAs.

3. Participatory Design and User Diversity

Several studies demonstrated that involving older adults in co-design led to higher trust, usability, and relevance. Future research should continue to treat participatory design as a core methodological approach rather than a supplementary step. Differences in digital skill levels should also be addressed explicitly, as socially oriented systems may benefit confident users, while task-focused designs may better support those with limited experience.

4. Evaluating AI as Supportive, Not Substitutive, Care

Future work should clarify the role of DLAs as supportive tools rather than replacements for human care. Research conducted in community-based settings could assess how AI systems interact with health professionals, caregivers, and peer networks. Such studies would help determine whether DLAs can be scaled in ways that reduce health disparities instead of reinforcing existing inequalities.

Limitations of the Review

This review has several limitations that should be acknowledged.

1. The number of included studies was relatively small, and many were pilot or feasibility studies with short intervention periods. As a result, the evidence base primarily reflects short-term outcomes rather than long-term impacts on health literacy or self-care.

2. The methodological quality of the included studies varied. Few used randomized controlled designs, and outcome measures were heterogeneous, which limits direct comparison across studies. Third, although the studies covered multiple regions, most evidence came from high-income Western and East Asian countries, reducing the generalizability of findings to other contexts.

3. Publication bias cannot be ruled out, as studies reporting positive outcomes may be more likely to be published. These limitations suggest that the conclusions of this review should be interpreted with caution and highlight the need for more robust and diverse future research.

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