Impact of Digital Health on Dementia Caregivers' KAP: A systematic review

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Abstract
Informal caregivers of people living with dementia often lack formal training, leading to gaps in knowledge, attitudes, and caregiving practices (KAP). Digital health interventions may help address these gaps. This systematic review, conducted in accordance with PRISMA 2020, searched five major databases up to February 2025 for studies assessing at least one KAP outcome. Study quality was appraised using the EPHPP tool. Seven studies met the inclusion criteria. Digital interventions generally improved caregiver knowledge and attitudes, while effects on practice were less consistent. Overall study quality was moderate. Digital interventions are promising, but more rigorous research is needed.

Keywords: Dementia; caregivers; KAP; systematic review.

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1.0 Introduction

1.1 Research Background
     Dementia is a growing global public health challenge, affecting an estimated 55 million people worldwide, with numbers projected to nearly triple by 2050 due to population ageing (WHO, 2017). The progressive cognitive, functional, and behavioural decline associated with dementia leads to increasing dependence on others for daily activities, placing substantial physical, emotional, and financial burdens on informal caregivers, most often family members (Loh, 2024).
     Caregiving for people living with dementia (PLwD) requires not only practical skills but also sound knowledge and a positive, resilient attitude to manage behavioural and psychological symptoms, and maintain quality of life. Deficits in these domains, conceptualised as knowledge, attitude, and practice (KAP), are associated with increased caregiver burden, poorer care outcomes, and reduced well-being for both caregivers and care recipients. Interventions aimed at improving caregiver KAP can empower families, reduce stress, and enhance the quality of care provided (Guilin, 2019). The KAP model**,** first

introduced in the 1950s within the domain of population research, emphasizes the interrelated dimensions of what individuals know (knowledge), believe (attitude), and do (practice) in relation to a given context (Andrade, 2020).

In recent years, mobile health (mHealth) applications and internet-based interventions have emerged as promising tools to support caregivers of PLwD (Zou, 2024). These technologies offer accessible, flexible platforms for delivering education, skills training, and psychosocial support, overcoming many of the barriers to traditional face-to-face interventions, such as travel distance, time constraints, and limited service availability. Furthermore, mobile platforms can facilitate care coordination, centralise information sharing, and provide timely, tailored content that meets caregivers' evolving needs (Fernandez, 2024; Zhou, 2024).

Given the increasing prevalence of dementia, the central role of informal caregivers, and the expanding reach of digital health solutions, there is a critical need to synthesise existing evidence on how mHealth and internet-based interventions affect KAP outcomes among caregivers of PLwD. This systematic review aims to address this gap by comprehensively mapping and synthesising current evidence on the effectiveness of mobile health applications and internet-based interventions in improving KAP of family caregivers of the elderly with dementia.

The review will examine various types of interventions, including mobile e-learning programs, web-based information platforms, and mobile applications designed to support caregivers in their caregiving journey. By synthesizing these findings, this review will provide critical insights into the potential of technology to support family caregivers of elderly PLwD, offering significant implications for healthcare professionals, researchers, and policymakers in the development and implementation of interventions designed to improve caregiver KAP and enhance the quality of life for both caregivers and recipients.

2.0 Literature Review

A growing body of research has investigated the effectiveness of these technologies in improving dementia-related knowledge, promoting more positive attitudes, and enhancing caregiving practices among informal caregivers of PLwD (Zou, 2024). Digital and mobile health interventions, including internet-based psychoeducation, telehealth, and mobile applications, have been increasingly evaluated as supportive tools for informal caregivers of PLwD (Rodriguez, 2021; Zou, 2024). Evidence from systematic reviews and meta-analyses consistently shows that digital interventions can improve the psychological well-being of caregivers of PLwD. A meta-analysis of 13 Randomised Controlled Trials (RCTs) of internet-based psychoeducation reported small but significant reductions in depressive symptoms (SMD ≈ –0.19) and stress (SMD ≈ –0.29) (Yu, 2023). Broader digital supports demonstrated significant improvements in depression (SMD ≈ –0.21), perceived stress (SMD ≈ –0.40), anxiety (SMD ≈ –0.33), and self-efficacy (SMD ≈ +0.19) (Leng, 2020). A more recent narrative systematic review examining psychoeducational, psychotherapeutic, and multicomponent interventions found that internet-based and mobile apps were found to improve caregivers' emotional, social, and self-care well-being (de-Moraes-Ribeiro, 2024). A technology-focused systematic review further concluded that on-demand access, a combination of health education and skills training, and regular contact with professionals tend to produce better psychoemotional outcomes (Ferrero-Sereno, 2025). Educational tools, whether web-based or mobile, can improve self-efficacy, knowledge, although the strength and consistency of these effects vary with study quality (Lewis, 2010).

3.0 Materials and Methods

This systematic review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Schiavo, 2019) and is registered with PROSPERO (CRD420251120508).

3.1 Literature Search and Selection of Studies

A systematic review of studies identified in the electronic databases Scopus, PubMed, Cochrane Library, ScienceDirect, and ACM Digital Library was conducted for articles published up to and including 3 February 2025, limited to the English language. The Population, Intervention, Comparison, and Outcome (PICO) framework was used to formulate the research questions and guide the search and selection of relevant studies. The search strategy incorporated the following keywords: "dementia," "Alzheimer," "Alzheimer's disease," "caregiver," "carer," "informal care," "digital intervention," "mobile application," "internet-based," "web-based," "knowledge," "attitude," "awareness," "practice," "behaviour," and "competency." Boolean operators AND and OR were used to combine and refine search terms: AND retrieves results that meet all specified conditions, while OR retrieves results that meet at least one of the conditions. The detailed logical structure of the search strategy, including all keywords and Boolean connectors applied to each database, is presented in Table 1.

Table 1. Search Strategy for the Databases

Database	Search strategy	Filters
PubMed	(("dementia"[MeSH Terms] OR "Alzheimer Disease"[MeSH Terms] OR dementia[tiab] OR "Alzheimer*"[tiab])	English, Humans, Last 15 years, Open access
	AND ("Caregivers"[MeSH Terms] OR caregiver*[tiab] OR carer*[tiab] OR "informal care*"[tiab])	

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	AND ("Mobile Applications"[MeSH Terms] OR "Internet"[MeSH Terms] OR "Telemedicine"[MeSH Terms] OR "eHealth"[tiab] OR "mHealth"[tiab] OR "mobile app*"[tiab] OR "web-based"[tiab] OR "internet-based"[tiab] OR "digital intervention*"[tiab]) AND ("Knowledge"[MeSH Terms] OR "Attitude"[MeSH Terms] OR "Practice"[MeSH Terms] OR knowledge[tiab] OR attitude[tiab] OR practice[tiab] OR behavior[tiab] OR behaviour[tiab] OR awareness[tiab] OR competency[tiab] OR KAP[tiab]) AND ("Randomized Controlled Trial"[pt] OR "Intervention Study"[tiab] OR "Trial"[tiab] OR "pre-post"[tiab] OR "evaluation"[tiab]))	
Scopus	(TITLE-ABS-KEY(dementia OR "Alzheimer*") AND TITLE-ABS-KEY(caregiver* OR carer* OR "informal care*") AND TITLE-ABS-KEY("mobile health" OR mHealth OR "mobile app*" OR "internet-based" OR "web-based" OR eHealth OR "digital intervention*") AND TITLE-ABS-KEY(knowledge OR attitude OR practice OR behavior OR behaviour OR awareness OR competency OR KAP) AND (TITLE-ABS-KEY("randomized controlled trial" OR intervention OR trial OR "pre-post" OR evaluation)))	English, Humans, Last 15 years, Open access
Cochrane	("dementia":ti,ab,kw OR "Alzheimer*":ti,ab,kw) AND ("caregiver*":ti,ab,kw OR "carer*":ti,ab,kw OR "informal care*":ti,ab,kw) AND ("mobile app*":ti,ab,kw OR "internet-based":ti,ab,kw OR "web-based":ti,ab,kw OR "digital intervention*":ti,ab,kw OR mHealth:ti,ab,kw OR eHealth:ti,ab,kw OR telemedicine:ti,ab,kw) AND (knowledge:ti,ab,kw OR attitude:ti,ab,kw OR practice:ti,ab,kw OR behavior:ti,ab,kw OR behaviour:ti,ab,kw OR awareness:ti,ab,kw OR competency:ti,ab,kw OR KAP:ti,ab,kw OR competence:ti,ab,kw OR skills:ti,ab,kw) AND ("randomized controlled trial":ti,ab,kw OR intervention:ti,ab,kw OR trial:ti,ab,kw OR "pre-post":ti,ab,kw OR evaluation:ti,ab,kw OR qualitative:ti,ab,kw)	English, Humans, Last 15 years, Open access
Science Direct	(TITLE-ABSTR-KEY(dementia OR "Alzheimer*")) AND (TITLE-ABSTR-KEY(caregiver* OR carer* OR "informal care*")) AND (TITLE-ABSTR-KEY("mobile health" OR mHealth OR "mobile app*" OR "internet-based" OR "web-based" OR eHealth OR "digital intervention*" OR "telemedicine")) AND (TITLE-ABSTR-KEY("knowledge" OR "attitude" OR "practice" OR "behavior" OR "behaviour" OR "awareness" OR "KAP" OR "competency" OR "skills")) AND (TITLE-ABSTR-KEY("randomized controlled trial" OR "intervention" OR "trial" OR "pre-post" OR "evaluation" OR "qualitative"))	English, Humans, Last 15 years, Open access
ACM Digital Library	("dementia" OR "Alzheimer*") AND (caregiver* OR carer* OR "informal care*") AND ("mobile app*" OR "internet-based" OR "web-based" OR "digital intervention*" OR "mHealth" OR "eHealth" OR "telemedicine") AND ("knowledge" OR "attitude" OR "practice" OR "behavior" OR "behaviour" OR "awareness" OR "KAP" OR "competence" OR "skills") AND ("randomized controlled trial" OR "intervention" OR "trial" OR "pre-post" OR "evaluation" OR "qualitative")	English, Humans, Last 15 years, Open access

3.2 Eligibility Criteria

Studies were eligible for inclusion in this systematic review if they met the following criteria, structured according to the PICOS (Population, Interventions, Comparators, Outcomes, and Study type) framework: (1) Population: informal (unpaid) caregivers aged 18 years or older who provide care to individuals diagnosed with any type of dementia. This group was selected because they face distinct physical, emotional, and social challenges that can significantly affect their well-being, making them an important target for supportive interventions; (2) Interventions: any digital intervention delivered fully or partially via a mobile application, website, or other internet-based platform. Eligible interventions included, but were not limited to, educational modules, psycho-emotional support programs, discussion forums, reminders, decision aids, and other technology-enabled supports; (3) Comparators: usual care, no intervention, face-to-face or non-digital interventions, or pre–post comparisons within the same participants. The inclusion of a comparator group was essential to determine whether observed effects could be attributed to the digital intervention rather than other external factors; (4) Outcomes: at least one outcome related to the Knowledge, Attitude, or Practice (KAP) of dementia caregiving, assessed using validated tools, structured instruments, or well-described qualitative approaches. Outcomes could be reported quantitatively or qualitatively, provided that sufficient detail was available for extraction and synthesis; (5) Study types: randomized controlled trials (RCTs), quasi-experimental studies, pre-post studies, mixed-methods studies, and qualitative studies. Including qualitative and survey designs allows for a richer understanding of caregivers' experiences, perceptions, and contextual factors, complementing quantitative findings. (6) Exclusion criteria: protocols, reviews, editorials, and opinion pieces; Studies without any KAP-related outcome; Studies involving caregivers of individuals without dementia; Interventions not delivered via a digital or internet-based platform.

3.3 Study Selection

Two independent reviewers (NIM and DR) screened titles and abstracts for eligibility, with a third and fourth reviewer (NNA and KI) resolving any disagreements. Remaining full-text studies were then assessed against the inclusion criteria, a process detailed in the PRISMA flowchart (Figure 1).

Figure 1. PRISMA Flow Diagram for Study Selection Procedure
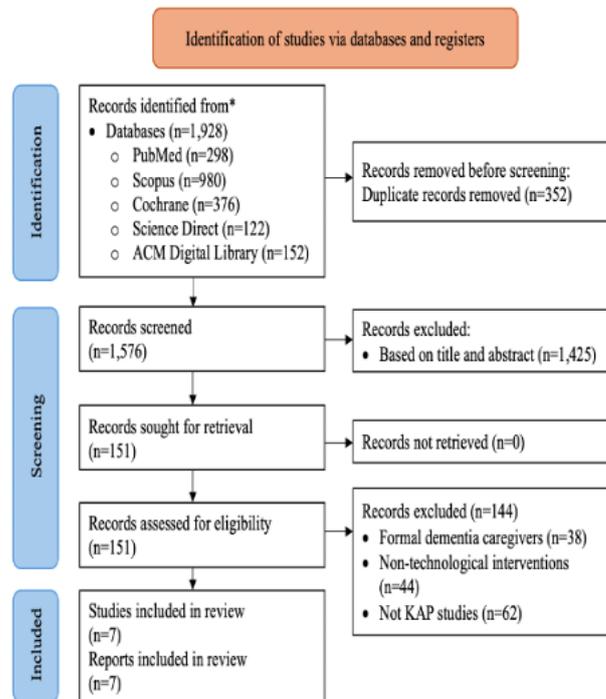
3.4 Data extraction

The data extraction process included the following key details: study information (author name, year of publication, and country), sample characteristics (sample size and participants), study design, intervention details (description and duration), control group, outcome measures (knowledge, attitude, and practice), and main findings.

3.5 Quality Assessment

Methodological rigor was evaluated using the Effective Public Health Practice Project (EPHPP) Quality Assessment Tool (Thomas, 1999). Four reviewers (NIM, NNA, DR, and KI) independently assessed each study across six critical domains: selection bias, study design, confounders, blinding, data collection methods, and withdrawals. Following EPHPP criteria, studies were assigned a global quality rating of Strong (no "weak" ratings), Moderate (one "weak" rating), or Weak (two or more "weak" ratings). Any discrepancies between reviewers were resolved through consensus to ensure inter-rater reliability.

4.0 Results

4.1 Search Strategy and Description of Studies

A total of 1,928 records were identified through database searches: PubMed (n = 298), Scopus (n = 980), Cochrane (n = 376), Science Direct (n = 122), and ACM Digital Library (n = 152). After removing 352 duplicate records, 1,576 records remained for screening. Following title and abstract screening, 1,425 records were excluded as irrelevant. The full texts of 151 records were sought and successfully retrieved. After eligibility assessment, 144 studies were excluded: 38 involved formal dementia caregivers, 44 applied non-technological interventions, and 62 were not KAP-related studies. Ultimately, 7 studies met the inclusion criteria and were included in this systematic review.

4.2 Quality Assessment of the Included Studies Using the EPHPP Tool

Based on the quality assessment of the included studies using the EPHPP tool, the methodological rigor of the seven reviewed studies varies (Thomas, 1999). While a significant proportion of the studies demonstrated strengths in data collection methods (100% rated strong) and low dropout rates (85.7% rated strong), major weaknesses were identified in other areas. A notable finding is that all seven studies (100%) received a weak rating for blinding, which suggests a high risk of performance or detection bias across the board. Furthermore, a large number of studies were rated as having weak study designs (42.9%) and weak control of confounders (42.9%). As a result of these pervasive weaknesses, particularly in blinding, no study achieved a "strong" global rating. The majority of the studies (57.1%) were categorized as having a "moderate" global

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rating, while a substantial number (42.9%) were deemed "weak" overall. The detailed quality assessment results are presented in Table 2.

Table 2. The EPHPP Quality Assessment

Component	A. Selection Bias	B. Study Design	C. Confounders	D. Blinding	E. Data Collection Methods	F. Withdrawals and Dropouts	Global Rating
Hattink B et al., 2015	Moderate	Strong	Strong	Weak	Strong	Moderate	Moderate
Salehinejad S et al., 2024	Moderate	Strong	Strong	Weak	Strong	Strong	Moderate
Turnbull N et al., 2024	Moderate	Moderate	Weak	Weak	Strong	Strong	Weak
Noel MA et al., 2022	Moderate	Moderate	Strong	Weak	Strong	Strong	Moderate
Ashida S et al., 2024	Weak	Weak	Weak	Weak	Strong	Strong	Weak
Kagwa AS et al., 2024	Moderate	Weak (quantitative EPHPP), Strong (qualitative rigour)	Not applicable	Weak	Strong	Strong	Weak
Lewis MA et al., 2010	Moderate	Weak	Weak	Weak	Strong	Strong	Moderate
Sum of weak (%)	1 (14.3%)	3 (42.9%)	3 (42.9%)	7 (100%)	0	0	3 (42.9%)
Sum of moderate (%)	6 (85.7%)	2 (28.6%)	0	0	0	1 (14.3%)	4 (57.1%)
Sum of strong (%)	0	2 (28.6%)	3 (42.9%)	0	7 (100%)	6 (85.7%)	0
Sum of not applicable (%)	0	0	1 (14.3%)	0	0	0	0

4.3 Characteristics of the Included Studies

Table 3 illustrates the Characteristics of the Included Studies. The seven studies reviewed employed a range of research designs and were conducted in various geographical locations with different sample sizes.

The included studies used a mix of quantitative, qualitative, and mixed-methods approaches. Two of the studies were randomized controlled trials (RCTs): the study by Hattink et al. (2015) was a traditional RCT, while the one by Salehinejad et al. (2024) was an unblinded RCT. Other quantitative designs included a quasi-experimental one-group pre-post-test design used by Turnbull et al. (2024), a pre-post comparison design by Noel et al. (2022), a pre-post survey by Ashida et al. (2024), and a formative evaluation with both quantitative and qualitative data by Lewis et al. (2010). In contrast, the study by Kagwa et al. (2024) used a qualitative descriptive design to explore participants' experiences.

The geographical settings of the studies were diverse, covering multiple continents. Studies were conducted in Europe, North America, and Asia. Specifically, the studies were located in the Netherlands and the United Kingdom, Iran, Thailand, the United States, and Sweden. The variety in locations, from a rural province in Thailand to two municipalities in Sweden and a specific region in the United States, reflects the global interest in and application of e-learning tools for dementia caregivers.

The sample sizes across the studies varied considerably. The largest sample size was in the Turnbull et al. (2024) study, which involved 402 caregivers. In contrast, the smallest sample was in the Ashida et al. (2024) pilot study, with only 31 participants. Other studies had sample sizes ranging from 30 participants in the qualitative study by Kagwa et al. (2024) to 142 participants in the Hattink et al. (2015) study. The Lewis et al. (2010) study had 47 participants who completed the program, while the Salehinejad et al. (2024) and Noel et al. (2022) studies had 50 and 134 participants, respectively.

Table 3. Characteristics of the Included Studies

First author, year	Study design, country	Participants	Intervention	Outcomes	Main findings
Hattink B et al., 2015	A randomized Controlled Trial (RCT) conducted in the Netherlands and the United Kingdom.	The study had a total of 142 participants, including informal caregivers, volunteers, and professional caregivers. Participants were randomly assigned to one of two groups: Intervention Group: This group had access to the STAR training portal for 2 to 4 months. Control Group: This group received free access to the STAR training portal after the study had ended.	The intervention is the STAR (Skills Training and Reskilling) e-learning course, was a web-based training portal designed to provide training to informal and professional caregivers of people with dementia. It consisted of 8 modules covering various topics related to dementia and dementia care.	Improved Attitudes: The training was effective in improving caregivers' attitudes toward dementia and their approach to providing person-centered care. Factual Knowledge: The training did not increase participants' factual knowledge about Alzheimer's disease.	While the program didn't boost caregivers' factual knowledge about dementia, it did improve their attitude by teaching them how to be more empathetic and focus on person-centered care.
Salehinejad S et al., 2024	An unblinded randomized controlled trial (RCT) conducted in Kerman, Iran.	50 family caregivers of patients with moderate to severe dementia. Participants were randomly allocated to one of groups: • Intervention Group: 25 caregivers who received access to a password-protected, web-based health information platform for two months. • Control Group: 25 caregivers who received "information as usual," which consisted of a neurologist's semi-annual follow-up appointment.	The intervention was a free, password-protected, web-based platform in the Persian language accessible via any device (smartphone, tablet, or desktop). It provides written guides on dementia and self-care, along with training videos for practical techniques and relaxation. Users can stay up-to-date with the latest news and events and connect with others in a private forum.	Knowledge: The intervention group showed a significant increase in their knowledge score after the intervention, while the control group's score remained unchanged. Attitudes: The intervention group showed an approximately 11-unit improvement in their attitudes towards dementia, while no significant change was observed in the control group.	The web-based intervention was effective in significantly improving the knowledge, and attitudes, of family caregivers of people with dementia. The findings suggest that web-based interventions are a potential platform for delivering support to caregivers due to their accessibility and ability to overcome geographic and time barriers.
Turnbull N et al., 2024	A quasi-experimental design with a one-group pre-post-test, conducted in the rural areas of Maha Sarakham province, Thailand.	There were no separate intervention and control groups in the traditional sense, as it was a one-group pre-post-test design. The study involved 402 caregivers: The main group of participants who participated in all five phases of the ADDIE model. Of these, 340 caregivers were part of the quasi-experimental pre-post-test for effectiveness.	The intervention was the "SmartCaregivers" 1.0 mobile application, developed to enhance caregiver support and resource management for long-term dependent individuals in rural areas. The app's purpose was to provide tools for managing care routines, accessing local resources, and improving communication with healthcare providers.	The application significantly improved caregivers' knowledge scores. The mean knowledge score increased from 10.49±2.53 to 12.18±2.76 after using the app (p<0.001).	The study concluded that the "SmartCaregivers" mobile application was effective in supporting caregivers in rural areas. The app demonstrated significant improvements in caregivers' knowledge.
Noel MA et al., 2022	A pre-post comparison design, conducted in the Western North Carolina region of the United States.	The study had a total of 134 participants among dementia family caregivers: • Intervention Group: 90 caregivers who enrolled in and completed a five-week, synchronous, virtual education program delivered via Zoom. • Control Group: 44 caregivers who had participated in a different caregiver education event and were surveyed at two time points, six weeks apart.	The intervention was a five-week, interactive Virtual Caregiver Education Program for family caregivers of people living with dementia (PLwD). The course covered key topics on dementia, including its nature, progression, treatment options, and risk reduction, alongside caregiver roles in safety, behavior management, communication, self-care, and accessing community support.	Participants' self-reported perceptions of the program's impact were highly positive, with nearly all reporting increased knowledge, and ability to manage dementia-related behaviors.	The findings suggest that the Virtual Education Program effectively enhanced perceived knowledge in managing dementia, with outcomes comparable to or surpassing those of the traditional in-person format.
Ashida S et al., 2024	A pre-post survey in the United States.	This was a one-group pre-post study, so there were no distinct intervention and control groups. The pilot test (Phase 2) involved a total of 31 participants: • Family caregivers (n=16) of people living with dementia (PLwD).	The intervention was a web-based mobile application Dental.Aging.Tips (https://dental.aging.tips), designed to provide on-demand, evidence-based guidance on oral healthcare for frail older adults, particularly those with dementia. The app can be	Attitudes: Both family and paid caregivers reported a significant increase in positive attitudes toward providing oral hygiene care (p=0.05 for family and p=0.02 for paid caregivers). Knowledge: Both family and paid caregivers reported a significant increase in	The study showed the app improved caregivers' knowledge, attitudes, and skills in oral care. It has potential to enhance oral health literacy and support caregivers by addressing gaps in educational resources.

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		• Paid care providers (n=15) of PLwD.	accessed on personal devices or desktop computers without installation.	knowledge about oral health and care (p=0.001 for family and p=0.02 for paid caregivers).	
Kagwa AS et al., 2024	A qualitative descriptive design to explore the experiences of participants. It was conducted in two municipalities in Sweden, Stockholm County and Västerbotten County.	This study involved 30 participants: • 19 family caregivers, consisting of 16 women and 3 men. • 11 social care professionals (all women) who worked in municipalities or senior day care centers.	The intervention was an 8-week program where social care professionals provided tailored support to family caregivers through a mobile app named STAV (STöd till AnhörigVårdare: Support to family caregivers). The features included mindfulness sessions, a digital diary, and a collection of web links with relevant information about dementia and caregiving.	Caregivers' experiences with the app fell into three themes: • Accessibility: It provided flexible, private, and convenient support, with chat lowering barriers compared to calls or groups. • Engagement: Features like the diary and mindfulness supported reflection and relaxation, while professionals reported improved efficiency and continuity.	The study highlighted the need for family caregivers to receive support that is tailored to their individual needs. The findings support the use of a mobile app as a complement to traditional support methods, which can facilitate caregivers' knowledge, awareness, and self-care management.
Lewis MA et al., 2010	A formative evaluation process with both quantitative and qualitative data collection, conducted in the United States.	A total of 47 dementia family caregivers completed the Internet-Based Savvy Caregiver (IBSC) program and a follow-up questionnaire, representing a 74% response rate.	The intervention was a prototype of the IBSC program, adapted from the face-to-face Savvy Caregiver Program. It consisted of four modules covering the effects of dementia on thinking, balancing control and independence, providing practical help, and managing daily care and challenging behaviors.	The program was designed to provide caregivers with the knowledge, skills, and outlook they need to succeed in their role. The theoretical framework for the program, the stress and coping model, postulates that positive and negative caregiving outcomes can be mediated by strengthening a caregiver's personal resources, including their knowledge and attitude.	The formative evaluation showed that participants felt more confident in their caregiving skills and communication with family members. Participants reported increased knowledge, and understanding, in dementia caregiving. Participants' qualitative responses also reflected an increase in knowledge, with some commenting on learning useful strategies and techniques for dealing with the behaviors associated with dementia.

4.4 E-Learning and Web-Based Platforms

The interventions by Hattink et al. (2015) and Salehinejad et al. (2024) used web-based platforms to deliver training. The STAR (Skills Training and Reskilling) e-learning course by Hattink et al. was a web-based training portal with eight modules covering various dementia topics. Similarly, Salehinejad et al. used a free, password-protected, web-based health information platform accessible via any device. These platforms provided written guides, training videos, and forums for users to connect. Lewis et al. (2010) also employed an internet-based program, a prototype of the Savvy Caregiver Program, which consisted of four modules. Noel et al. (2022) used a five-week, interactive virtual education program delivered via Zoom.

4.5 Mobile Applications

Several studies focused on mobile applications. Turnbull et al. (2024) developed the "SmartCaregivers" 1.0 mobile application to assist caregivers in rural areas with managing care routines and accessing resources. Ashida et al. (2024) tested a web-based mobile app, Dental.Aging.Tips, which was designed to provide on-demand guidance on oral healthcare for older adults with dementia. Kagwa et al. (2024) explored an 8-week program using a mobile app named STAV (STöd till AnhörigVårdare), which featured mindfulness sessions, a digital diary, and a collection of web links.

4.6 Outcomes of Knowledge, Attitude, and Practice (KAP)

The outcomes across the seven included studies demonstrate that mobile health applications and internet-based interventions can meaningfully influence caregivers' KAP, although the magnitude and consistency of these effects vary.

Most interventions significantly improved caregivers' dementia-related knowledge. Salehinejad et al. (2024) reported a marked increase in knowledge scores following a two-month web-based intervention, while Turnbull et al. (2024) demonstrated significant pre–post knowledge gains with the SmartCaregivers mobile application in rural Thailand. Similarly, Ashida et al. (2024) showed improvements in oral health knowledge among both family and paid caregivers after using a mobile app. Virtual education programs also yielded knowledge benefits, as reported by Noel et al. (2022). Lewis et al. (2010)

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further highlighted enhanced knowledge and understanding through the Internet-Based Savvy Caregiver program, with qualitative feedback underscoring practical applicability. Kagwa et al. (2024) echoed these findings, showing that tailored mobile app support complemented conventional services to expand caregivers' knowledge base. However, not all interventions were effective: Hattink et al. (2015) found that their STAR e-learning course improved empathy and understanding but did not significantly increase factual knowledge of Alzheimer's disease. This discrepancy suggests that intervention design and content delivery format critically influence knowledge outcomes.

Attitudinal shifts were consistently reported, particularly with interventions incorporating interactive or person-centered approaches. The STAR training portal improved caregivers' attitudes toward dementia care, despite limited effects on factual knowledge. Salehinejad et al. (2024) demonstrated an approximate 11-unit improvement in caregivers' attitudes toward dementia following the use of a web-based health information platform. Likewise, Ashida et al. (2024) showed that both family and paid caregivers exhibited significantly more positive attitudes toward oral health provision. These findings suggest that digital interventions may be particularly effective at fostering empathy, acceptance, and more person-centred approaches to caregiving, especially when combined with interactive or experiential learning features.

Evidence of practice-level improvements, though less extensively studied, was promising. Lewis et al. (2010) reported that participants gained confidence in their caregiving skills, particularly in communication and behavioural management. Ashida et al. (2024) observed that caregivers improved their ability to identify oral health problems after using the Dental.Aging.Tips application. These findings indicate that practice-related outcomes may be strengthened when interventions integrate skills-based modules and provide context-specific guidance. Nonetheless, the overall paucity of standardized, validated practice measures across studies represents a key limitation.

Taken together, the reviewed evidence suggests that digital interventions are effective in enhancing knowledge, improving attitudes, and promoting better caregiving practices. However, the heterogeneity in outcome measures, study design, and intervention content constrains comparability and generalisability.

5.0 Discussion

This systematic review demonstrates that mobile health and internet-based interventions are effective in enhancing caregivers' knowledge, attitudes, and caregiving practices. The findings extend the literature beyond psychosocial endpoints (e.g., stress, depression) from study by Leng et al. (2020) and Yu et al. (2023), highlighting digital health's role in shaping knowledge acquisition, attitudinal shifts, and caregiving practices.

In the context of Malaysia and other ASEAN countries, where the prevalence of dementia is increasing in parallel with population aging, these findings hold particular importance. The burden of dementia caregiving often falls on family members, many of whom have limited access to formal training or institutional support. Scalable, low-cost digital interventions may therefore represent a feasible strategy to strengthen community-based dementia care.

The consistent improvements in knowledge across multiple interventions align with prior reviews showing that e-health tools close knowledge gaps and enhance caregivers' understanding of dementia care tasks (Leng, 2020; Yu, 2023). However, divergent findings, such as those reported by Hattink et al. (2015), suggest that knowledge gains depend on both the quality of instructional design and the inclusion of interactive, applied learning components.

Positive attitudinal change emerged as one of the most consistent findings, with interventions enhancing empathy, confidence, and readiness to adopt person-centered care. The improvements observed in Iran (Salehinejad, 2024), the Netherlands (Hattink, 2015), and the United States (Ashida, 2024) indicate that attitudinal benefits transcend cultural boundaries. These shifts can be interpreted through the Technology Acceptance Model, where perceived usefulness and ease of access shape users' willingness to adopt new caregiving approaches (Fernandez, 2024; Wang, 2022). However, the reliance on self-reported attitudinal measures introduces risks of social desirability bias, underscoring the need for validated scales and triangulation with behavioural outcomes.

The term 'practice' is used interchangeably with other terms such as 'skill' and 'ability' (Ashida, 2024; Lewis, 2010). Although fewer in number, studies addressing practice outcomes highlight the potential of digital interventions to build caregiver competencies. The improvements in oral care skills and caregiving skills reflect a transition from knowledge acquisition to practical application, consistent with adult learning theory, which emphasizes experiential, context-driven learning (Ashida, 2024; Lewis, 2010). Nonetheless, the absence of long-term follow-up and validated behavioural outcome measures limits confidence in the sustainability of these practice changes.

Most interventions were conducted in high- or middle-income countries, raising questions about generalisability to low-resource contexts. Rural caregivers, as studied by Turnbull et al. (2024), particularly benefit from mobile platforms that bridge geographical barriers, yet many interventions remain inaccessible to caregivers with limited digital literacy. This digital divide represents a critical challenge for scaling inclusive solutions (Samari, 2024). Future research must adopt equity-driven approaches to ensure accessibility across diverse caregiver populations.

5.1 Limitations of the Study

The heterogeneity in KAP measurement instruments limits synthesis across studies. Furthermore, the lack of standardized outcome frameworks is a major barrier to advancing the field. A notable gap is the absence of systematic

integration of digital interventions into formal healthcare pathways. None of the included studies embedded digital tools into existing health or social care services, which restricts their scalability and long-term sustainability. Evidence from multicomponent approaches suggests that hybrid models, combining mHealth with professional coaching and peer support, may produce more durable benefits across KAP domains.

Another limitation lies in the geographical and cultural diversity of studies. Although a strength in demonstrating global relevance, it also introduces heterogeneity in intervention design, caregiver populations, and outcome measures. Moreover, sample sizes varied widely, from small pilot studies to large quasi-experiments, limiting comparability.

5.2 Implications for Practice and Policy, and Future Research

The findings of this review highlight that digital interventions should not be regarded as replacements for formal caregiving services but rather as scalable and cost-effective complements. These tools are particularly valuable in low-resource or rural settings, where access to conventional support is often limited. As such, healthcare systems and policymakers should consider embedding mHealth and internet-based programs within national dementia care strategies, ensuring that they are culturally adapted and equitably accessible.

Future research should prioritise several key areas to strengthen the evidence base and maximise the potential of digital interventions. First, there is a pressing need for robust study designs, including adequately powered randomized controlled trials with longer-term follow-up, to establish sustained effects beyond pilot phases. Second, the development and adoption of standardised KAP measures would allow for greater comparability across studies and facilitate meta-analytic synthesis. Third, equity-driven approaches are essential, particularly by involving caregivers with low digital literacy, limited access to technology, and diverse cultural contexts who are often underrepresented in current research. Fourth, future interventions should explore hybrid care models that integrate digital platforms with professional coaching and peer support, thereby combining technological scalability with human guidance. Finally, innovation remains critical, particularly through the application of AI-driven personalization and adaptive learning technologies, which could tailor interventions to caregivers' evolving needs and caregiving contexts (Bosco, 2025; Ferrero-Sereno, 2025).

6.0 Conclusion and Recommendations

This systematic review demonstrates that mobile health and internet-based interventions hold promise in improving dementia caregivers' knowledge, fostering more positive attitudes, and enhancing caregiving practices, complementing prior research that has predominantly focused on caregivers' quality of life and psychoemotional outcomes.

While preliminary evidence affirms digital interventions as valuable adjuncts to traditional caregiver support, substantial methodological heterogeneity and reliance on self-reported measures limit certainty. Advancing the field requires methodological rigor, inclusivity, and systemic integration to ensure sustainable improvements in dementia caregiving knowledge, attitudes, and practices.

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Paper Contribution to Related Field of Study

This paper contributes to the field of environment–behaviour studies by synthesising evidence on how digitally mediated environments influence caregiving behaviour among informal dementia caregivers. By examining mobile health and internet-based interventions through a Knowledge, Attitude, and Practice (KAP) framework, this review highlights the role of virtual environments in shaping behavioural outcomes, empathy, and caregiving competencies. The findings extend environment–behaviour discourse beyond physical settings to include digital care ecosystems, demonstrating how technology-enabled platforms function as behavioural support environments. The study further informs policy and design considerations for scalable, community-based digital interventions that strengthen caregiver capacity and well-being.

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