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Review

Digital Dementia: Smart Technologies, mHealth Applications and IoT Devices, for Dementia-Friendly Environments

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Abstract

The global increase in dementia cases, which is predicted to exceed 152 million by 2050, poses substantial challenges to healthcare systems and caregiving structures. Concurrently, the expansion of mobile health (mHealth) technologies offers scalable, cost-effective opportunities for dementia care. This study systematically reviews 100 publicly available dementia-related mobile applications on the Apple App Store (iOS) and the Google Play Store (Android), categorised using the Mobile App Rating Scale (MARS), as well as the targeted end-users, Internet of Things (IoT) integration, data protection, and cost burden. Applications were evaluated for their utility in cognitive training, memory support, carer education, clinical decision-making, and emotional well-being. Findings indicate a predominance of carer resources and support tools, while clinically integrated platforms, cognitive assessments, and adaptive memory aids remain underrepresented. Most apps lack empirical validation, inclusive design, and integration with electronic health records, raising ethical concerns around data privacy, transparency, and informed consent. In parallel, the study identifies promising pathways for energy-optimised IoT systems, Artificial Intelligence (AI), and Ambient Assisted Living (AAL) technologies in fostering dementia-friendly, sustainable environments. Key gaps include limited use of low-power wearables, energy-efficient sensors, and smart infrastructure tailored to therapeutic needs. Application domains such as cognitive training (19 apps) and carer resources (28 apps) show early potential, while emerging innovations in neuroadaptive architecture and emotional computing remain underexplored. The findings emphasize the need for co-designed, evidence-based digital solutions that align with the evolving needs of people with dementia, carers, and clinicians. Future innovations must integrate sustainability principles, promote interoperability, and support global aging populations through ecologically responsible, person-centred dementia care ecosystems.

Keywords: dementia-friendly environments; Internet of Things (IoT); smart healthcare systems; digital health technologies; sustainable aging infrastructure

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1. Introduction

Dementia, a neurodegenerative syndrome, is marked by gradual cognitive deterioration, impairments in reasoning, memory deficits, increasing dependency, behavioural shifts, or diminished mobility [1]. While symptom progression may vary across domains, these changes invariably compromise an individual's ability to maintain independence. The

Alzheimer's Association (2024) reports a striking 145.7% increase in dementia incidence from 2000 to 2020 [2]. Supporting the Global Dementia Observatory notes a new dementia diagnosis occurring every three seconds, which projects that dementia cases will triple from 57.4 million in 2020 to 152.8 million by 2050 [3]. This exponential rise in prevalence places considerable strain on formal healthcare infrastructures and informal caregiving networks, prompting an urgent need to explore scalable, accessible, and cost-efficient interventions [2].

A substantial and unsustainable rise in associated economic costs parallels the escalating global prevalence of dementia. In 2020, global dementia expenditures were estimated at $1.3 trillion, with projections indicating an increase to $2.8 trillion by 2030, driven by rising incidence, ageing populations, and prolonged disease trajectories [4]. In the United Kingdom alone, national forecasts suggest a surging dementia-related cost from £42 billion in 2024 to £90 billion by 2040, underscoring the disproportionate economic impact [2]. Longitudinal economic analyses conducted between 2015 and 2025 further evidence escalating societal and financial burdens of dementia across all continents. Table 1 presents a comparative overview of dementia-related economic costs by continent over the last decade.

Table 1. Direct and Indirect dementia related costs over the last decade (2015–2025) [2,5–7].

No.	Continent	2014 Expenditure (USD Billions)	2025 Projected Expenditure (USD Billions)	Direct Costs (%)	Indirect Costs (%)
1.	North America	226	360	42%	58%
2.	Europe	227	289.5	38%	62%
3.	Asia	150	240	35%	65%
4.	South America	20	45	30%	70%
5.	Africa	15	25.5	25%	75%
6.	Australia & Oceania	12	22.8	40%	60%
7.	Antarctica	Data unavailable			

Economic demands stem from both direct and indirect components: direct costs include expenditures for diagnosis, pharmacological and non-pharmacological treatments, institutionalisation, and long-term medical care; while indirect costs encompass the economic value of informal caregiving, productivity losses among family carers, and broader social care expenditures. This approach of cost analysis provides a more granular understanding of dementia's economic footprint and emphasises the urgent need for globally coordinated development of stage-specific responses. Figure 1 provides a continent-wise (except Antarctica), comparative outlook on the total, direct and indirect dementia costs.

Interestingly, during the rise of dementia incidence, simultaneously is a progressive advancement and global penetration of mobile health (mHealth) technologies, particularly smartphone-based applications, which show promising interventions for dementia care delivery. These digital tools have demonstrated potential in supporting a wide array of needs, including cognitive screening, behavioural symptom tracking, medication adherence, environmental safety, and carer education [8–10]. However, despite the proliferation of such applications in clinical and consumer domains, there remains a dearth of comprehensive evidence mapping core functionalities across the dementia trajectory [11–13].

Addressing this gap requires a systematic, user-centred evaluation of publicly accessible digital applications, particularly those available on mainstream platforms (Apple App Store (iOS) and Google Play Store (Android)) without institutional barriers. This approach ensures inclusivity and relevance for the general population, particularly informal carers and older adults who may lack access to specialised healthcare services. By focusing on digital apps that are already in widespread circulation, such evaluations also offer im-

mediate translational impact, bridging the divide between technological innovation and practical utility [14].

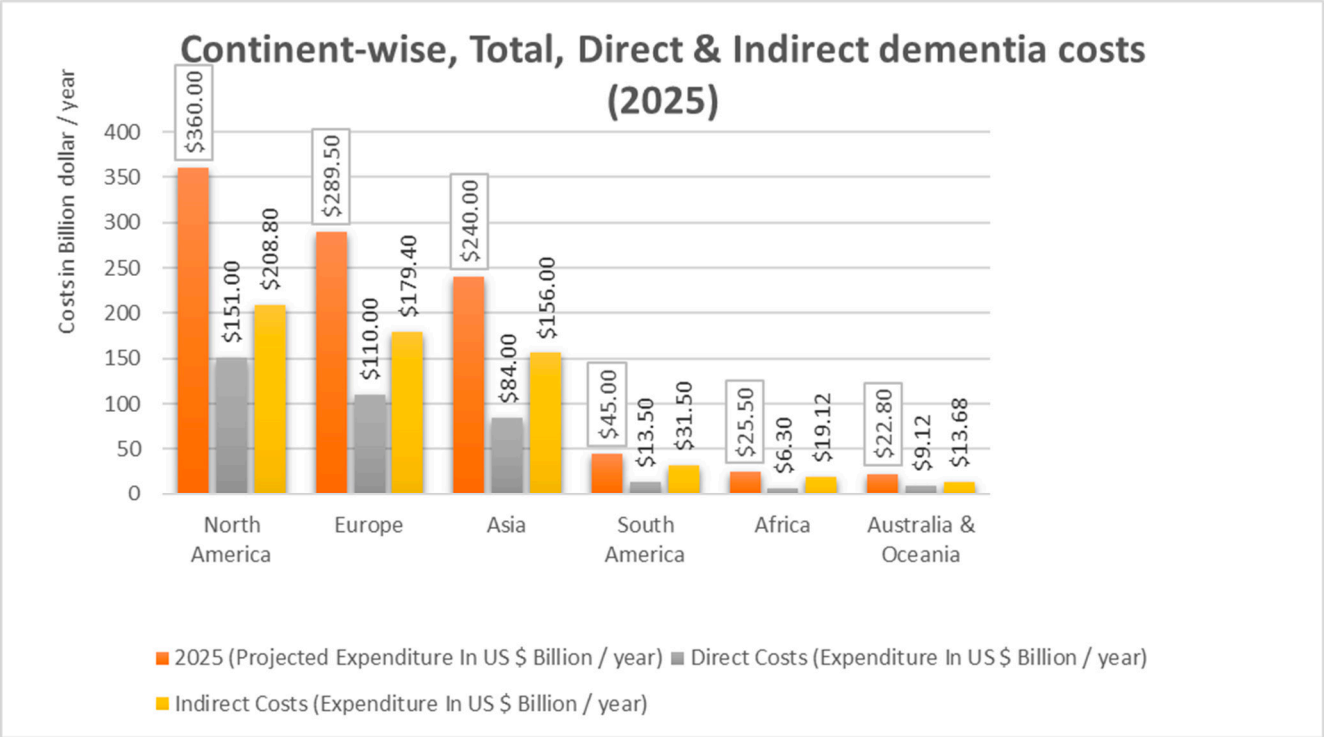

Figure 1. Continent-wise, Direct & Indirect dementia costs (2025) [2,5–7].

The concept of dementia-friendly environments has undergone a significant transformation over the past two decades, shifting from a predominantly architectural concern to a multifaceted, interdisciplinary approach that incorporates physical design, digital technologies, and social engagement strategies. This evolution reflects a growing awareness that people living with dementia (PLwD) not only experience cognitive decline but also profound changes in how they interact with their surroundings [15,16]. Historically, dementia care has emphasised institutional models and pharmacological management, often overlooking how environmental design can influence cognitive function, emotional well-being, and behavioural symptoms [17,18]. Recent evidence supports that well-designed environments, which are characterised by simplicity, familiarity, and sensory cues, can mitigate agitation, reduce confusion, and promote autonomy [19].

Recognising this shift, global policy frameworks, most notably the World Health Organisation's *Global Action Plan on the Public Health Response to Dementia 2017–2025*, emphasise the critical role of creating dementia-friendly communities that support individuals across all stages of the condition [1]. The integration of assistive technologies within these environments aligns with broader goals of ageing in place and person-centred care. Non-pharmacological interventions, including environmental modification and the deployment of digital tools, can complement medical treatment while preserving dignity, enhancing safety, and fostering social inclusion [20].

Central to this paradigm shift is the digital transformation of care environments. The convergence of architecture, health informatics, and ambient intelligence has led to the emergence of smart, responsive settings that dynamically adjust to individual needs. A broad range of technologies, including Internet of Things (IoT), Artificial Intelligence (AI), Ambient Assisted Living (AAL) systems, and virtual/augmented reality (VR/AR), are being deployed to support cognitive function, monitor health parameters, and reduce carer

burden [21]. For instance, smart home technologies combine motion sensors, wearable devices, and voice interfaces to monitor routines, detect anomalies, and provide real-time feedback [22]. These systems are increasingly viewed not just as aids, but as integral components of therapeutic environments that enhance autonomy and peace of mind for both individuals with dementia and their carers [23,24].

The development and implementation of such technologies are underpinned by robust theoretical foundations drawn from cognitive architecture and environmental psychology. Cognitive architecture explores how environmental stimuli such as spatial layout, lighting, and colour affect mental processes like attention, orientation, and memory [25,26]. This framework is particularly relevant in dementia care, where the decline in cognitive resources increases reliance on external cues. Simultaneously, environmental psychology highlights the therapeutic potential of biophilic design, multisensory stimulation, and emotional safety, with naturalistic elements shown to reduce stress and promote well-being [19].

Together, these developments point to a new vision of dementia care; one that is proactive, context-aware, and deeply rooted in both empirical evidence and user-centred design. The integration of digital technologies into dementia-friendly environments promises to reshape how care is delivered and experienced, offering new pathways to independence, dignity, and quality of life.

2. Digital Tools for Dementia

Initial investigations into digital approaches for dementia care examined the practicality and potential effectiveness of delivering cognitive training through digital means. For example, a preliminary study indicated that such interventions were indeed viable for individuals with Mild Cognitive Impairment (MCI), highlighting their promise in enhancing cognitive abilities. However, the authors emphasised the necessity of larger-scale studies to validate these findings [27]. Popular platforms like Lumosity [28], MindMate [29], and Peak [30] emerged as accessible tools, incorporating gamified exercises aimed at strengthening cognitive domains such as memory, attention, and executive functioning [31]. Empirical evidence from a study assessing Lumosity's impact reported measurable improvements in participants' memory performance, concentration levels, and response speed [32]. While these interventions have demonstrated short-term cognitive benefits among healthy older adults, their long-term effectiveness in altering the progression of dementia remains inconclusive [33]. A meta-analysis of randomised controlled trials revealed that brain gaming did not show significant improvement in standardised tests of cognitive function for older adults with cognitive impairments [32,33]. Nonetheless, their widespread adoption among early-stage patients and at-risk individuals indicates a growing interest in non-pharmacological, accessible interventions that can be seamlessly integrated into daily routines [34]. A systematic review highlighted that digital cognitive interventions are increasingly being utilised as non-pharmacological approaches to support cognitive health in older adults with MCI or early-stage dementia [27,32–34].

Beyond cognitive stimulation, digital applications have been developed to support carers, who often bear the brunt of the emotional, physical, and financial burdens associated with dementia care [35,36]. These applications typically offer educational resources, symptom tracking tools, and peer support networks [37,38]. Studies have shown that technology-based dementia education can significantly reduce carer depression and distress, highlighting the potential of digital tools to alleviate carer burden [39,40]. However, the adoption of these applications is often hindered by disparities in digital literacy, particularly among older carers, and the variability in the quality and clinical oversight of the content provided [37,39–42].

In the clinical realm, digital tools have been introduced to aid healthcare professionals (HCPs) in the diagnosis and management of dementia. For instance, the PredictND tool, a Clinical Decision Support System (CDSS), has been shown to assist clinicians in the differential diagnosis of dementia, enhancing diagnostic confidence and accuracy [43]. Applications such as Alzheimer's Pocketcard and ConsultGeri offer diagnostic support and reference guidelines. The "Try This:®" series by the Hartford Institute for Geriatric Nursing provides evidence-based assessment tools for older adults, including those with dementia, to support clinical decision-making [44]. Despite their potential, the integration of these apps into clinical workflows and Electronic Health Records (EHR) remains limited, often due to concerns regarding data privacy, interoperability, and regulatory compliance. Challenges such as data exchange, security, and privacy hinder efficient interoperability of EHRs, affecting the seamless integration of digital tools into clinical practice [45]. This gap underscores the need for more advanced clinical decision-support systems and diagnostic platforms that can be seamlessly incorporated into existing healthcare infrastructures. The development and implementation of digital technologies for the early detection of dementia require careful consideration of HCP perspectives to ensure successful adoption in clinical practice [41,46].

The role of digital technologies in early detection and cognitive assessment (CA) is an area of growing interest [47,48]. Digital assessments offer advantages such as improved scalability, measurement reliability, and ecological validity, enabling the capture of subtle cognitive changes in preclinical Alzheimer's disease [49]. Mobile applications designed to replicate traditional neuropsychological tasks, such as delayed recall and visuospatial ability, have been developed for large-scale population screening [47]. For instance, mobile app-based CAs have demonstrated feasibility and validity in community samples of older adults, supporting their use in large-scale screening efforts [47–49]. Like PRODEMOS and GameChanger have been incorporated into research studies; however, many of these applications lack validation against established instruments like the Mini-Mental State Examination (MMSE) or Montreal Cognitive Assessment (MoCA), raising concerns about their reliability and clinical utility [50]. A scoping review highlighted that while digital CAs show promise, their validation against standard tools like MMSE and MoCA is often lacking, necessitating further research to establish their clinical utility [49,50].

Memory aids (MA) and environmental support apps represent a promising yet underutilised sector within digital dementia care [50]. Applications offering task reminders, routine prompts, and visual MA are designed to support independent living among individuals in the early to moderate stages of dementia [51,52]. For instance, electronic MA have been shown to assist with prospective memory tasks, enhancing daily functioning in individuals with dementia [53]. However, these apps often lack adaptability and fail to respond dynamically to changes in user behaviour or cognitive status [54,55]. The integration of AI and machine learning could enhance personalisation and responsiveness, though such advancements are currently limited [54–56].

Mental wellness applications have also gained traction, particularly in addressing behavioural and psychological symptoms associated with dementia, such as anxiety, agitation, and depression [57]. While general wellness apps like Calm, Insight Timer, and Headspace are not specifically designed for dementia, they are frequently used by patients and carers for stress management and sleep disturbances [56]. Research supports the effectiveness of mindfulness and relaxation strategies in improving quality of life and carer resilience [55,57]. However, the lack of tailored content for cognitively impaired users limits the broader applicability of these apps [56].

Ethical and data governance concerns pose significant barriers to the adoption of digital technologies in dementia care [58–61]. The sensitivity of health data, particularly

in vulnerable populations, necessitates robust safeguards around informed consent, data storage, and third-party access [58,60]. Ethical design must be a foundational principle in the development of assistive technologies for dementia, ensuring that technological progress does not outpace ethical and legal safeguards [58,60,61].

Despite the expanding landscape of digital applications in dementia care, several systemic limitations persist [55]. The quality of available applications varies significantly, with many lacking peer-reviewed evidence or regulatory oversight [50]. For instance, a systematic review evaluating 17 dementia care apps using the MARS found that while functionality and aesthetics scored moderately well, information quality and engagement were notably lower, with subjective quality scores averaging 2.26 out of 5. This underscores the need for standardised evaluation metrics to ensure app quality and reliability [62].

Additionally, app design often fails to incorporate principles of inclusive design, rendering them inaccessible to users with sensory, motor, or cognitive impairments. A scoping review highlighted that many digital apps for dementia care do not adequately address the unique needs of individuals with cognitive decline, emphasising the importance of person-centred and inclusive design approaches [63].

Furthermore, digital applications tend to be fragmented in functionality, with most apps addressing isolated aspects of dementia care, such as cognitive training, scheduling, or education. Rarely do applications provide a comprehensive, integrated platform that addresses the multifactorial needs of users across the dementia trajectory. This fragmentation increases the burden on users to navigate and manage multiple tools simultaneously, potentially undermining adherence and reducing overall impact [46,58,62,63].

3. Methodology

Previous studies have advocated the use of structured evaluation frameworks such as the MARS to objectively assess app quality across domains like engagement, functionality, aesthetics, and information accuracy [64,65]. Such frameworks ensure that app assessments move beyond surface-level impressions and instead capture meaningful indicators of effectiveness, safety, and user experience.

Given these considerations, the present study undertakes a systematic evaluation of the top 100 dementia-related mobile applications, downloaded from both iOS and Android platforms, to assess the breadth of digital technologies available for individuals at risk of developing dementia, patients already diagnosed, carers, family members, and HCP. The objective was to analyse the functionalities and effectiveness of these applications in addressing the needs of various end-users across the disease trajectory.

To ensure inclusivity and real-world applicability, the search criteria were deliberately confined to publicly accessible mobile applications, thereby encompassing only those digital tools readily available for widespread use by the general population. By applying the MARS framework where available and focusing exclusively on tools accessible to the public, the review aims to generate a functionality map aligned with the dementia care continuum and tailored to the diverse needs of its stakeholders. This work is positioned to fill a critical gap in the literature by providing evidence-based insights that inform carers and individuals with dementia about high-quality digital supports, guide developers in the creation of clinically relevant and user-centred mHealth solutions, and assist policymakers and clinicians in integrating effective mobile applications into broader dementia care frameworks.

3.1. Search Strategy

A systematic search was conducted across two major digital distribution platforms: iOS and Android. Search was conducted manually using the standard store interfaces

and their native ranking algorithms. No Boolean operators or special query syntax were used. Short, everyday terms were chosen to reflect how middle-to-older adults typically search: dementia, dementia care, dementia support, dementia app, Alzheimer, Alzheimer's, Alzheimer support, memory loss, memory help, memory app, cognitive training, carer support, and elder care. Only English-language listings were checked because of time and resource limits. Apps were kept if they were publicly available on iOS or Android, aimed at people living with or at risk of dementia, carers, family members, or health professionals, and offered features for any stage of dementia care, such as assessment, symptom support, cognitive training, education, or caregiving tools. Apps were excluded if they were not on iOS/Android, did not target these groups, were not in English, or did not clearly relate to dementia. Table 2 outlines the inclusion and exclusion criteria applied in the selection of mHealth applications evaluated in this study.

Table 2. Inclusion & Exclusion Criteria of the mHealth apps.

Parameter	Inclusion	Exclusion
Availability	Were available on publicly accessible Android or iOS mobile platforms	Not available on Android or iOS platforms
Target Population	Targeted individuals at risk of or living with dementia, carers, family members, or HCP	Untargeted individuals
Language	They were available in English.	Not available in English
Feature	Had identifiable features supporting any stage of dementia care.	No identifying features of degenerative decline

3.2. Application List

A structured search was conducted in April 2025 across iOS and Android platforms, using the inclusion and exclusion criteria mentioned above. For each eligible app, key details were recorded in a standard form: app, developer, platform, store category, price model, star rating and rating count, version, description, icon, and the presence and contents of the App Privacy section (iOS) or Data Safety section (Google Play), including links to any developer privacy policy.

3.3. Deduplication Process

Duplicates were removed manually. Two listings were treated as the same app if they shared the same name and developer, or if they were clearly the same product across stores or regions. Evidence included a matching icon, near-identical apps, similar descriptions, and the same features. When a duplicate was found, one record was kept, and its details were merged. This included noting availability on both platforms and aligning version and rating data. The extra copies were removed, and a cross-reference was kept for traceability. If identity could not be confirmed because of generic names or incomplete or conflicting metadata, the records were kept separate and flagged for recheck. This process produced a clean, searchable, and reproducible app list while reducing the risk of merging different products.

3.4. Data Privacy, Consent and Regulatory Disclosures

Each included app was examined against publicly available, user-facing materials: the iOS "App Privacy" panel, the Google Play "Data safety" section, linked developer privacy policies and terms of use, and in-app notices visible on first run, settings, help, or account pages. Where an app existed on both platforms, both listings were checked. Evidence was limited to what an ordinary user can see prior to or during use; technical white papers or marketing pages were not treated as substitutes for a privacy policy.

In the privacy and policy review, each app was screened across an eight item assessment rubric to capture user-visible safeguards and disclosures: (1) regulatory claims, defined as explicit mention of GDPR and/or HIPAA compliance; (2) data collection, i.e., whether the store listing or linked policy describes data types collected (contact, identifiers, usage, health); (3) storage modality, recorded as Local-only, Remote/cloud, Hybrid, or Not stated based on explicit language in store policies; (4) account requirement, indicating whether sign-in is needed to use core features; (5) user control, documenting the presence of a data-deletion or account-removal pathway (in-app control, email request, web portal); (6) interoperability, noting any claim of EHR connectivity; (7) server-location disclosure, indicating whether hosting or processing geography is named; and (8) consent presentation, capturing any consent or privacy notice shown at first use or before data entry, such as a consent screen, opt-in checkbox, or clear explanation of data use.

Table 3 provides a per-app annotation for the items above, allowing readers to see whether basic data-protection information (privacy policy link, data-collection description, consent notice, data-deletion mechanism) is clearly communicated to users. Summary counts are reported in Results. Store listings and policies can change over time and may vary by region. The approach does not constitute a legal audit or technical penetration test. All codes reflect verifiable, user-visible disclosures at the time recorded, maximising transparency and reproducibility.

Table 3. Dementia App List. Created on 20 April 2025 and last updated on 3 July 2025.

No	Type	App Name	Description & Features	Platforms Available	End User	MARS: (1–5)	User Downloads	IoT/Wearable Integration	Data Handling Clarified to User with Consent	Cost
1	TA [1]	A Simple Day	Provides structured daily activities for PLwD.	Android	PLwD	5.0	100+	No wearable/IoT features	Yes, policy link provided.	Free
2	TA	A Walk Through Dementia	Simulates the experience of living with dementia to educate carers and the public.	Android & iOS	Carer/Public	4.7	10k+	No smartwatch or home-IoT connect	Yes, App privacy provided.	Free
3	Care [2]	Accessible Alzheimer's and Dementia Care	Offers information and resources for Alzheimer's and dementia caregiving.	iOS	Carer/Public	4.5	Not disclosed	No wearable/IoT features	Yes, but App-Privacy details not provided.	Free
4	RA [3]	Alternative Treatments for Alzheimer's Disease	List alternative treatment options for Alzheimer's disease.	Android & iOS	Public/PLwD	4.0	Not listed	No wearable/IoT features	Not stated	Free
5	CTA [4]	AMI (Advancing Mental Invigoration	Bilingual cognitive exercises aimed at improving memory and flexibility in older adults.	iOS	Public/PLwD/Carer	3.7	Not disclosed	No wearable/IoT features	Not stated	Free
6	MWA [5]	AmuseIT	Promotes conversation through quiz questions and images, designed for dementia patients to stimulate memories.	Android & iOS	PLwD/Carer	3.0	500+	No wearable/IoT integration	Yes, shows "No data collected."	iOS GBP 3.09
7	CA [6]	ASZHWELL	An app for pre-post Alzheimer's Patients	Android & iOS	PLwD/Carer	4.7	10k+	Yes, integrates medication dispensers and wearables	Yes, App-Privacy + policy link.	$7.99
8	RA	Alzheimer: Causes, Diagnosis, and Management	Provides a guide for the causes, diagnosis, and management of Alzheimer's.	Android & iOS	Public	4.0	Not listed	No wearable/IoT integration	Not stated	Free

Table 3. *Cont.*

No	Type	App Name	Description & Features	Platforms Available	End User	MARS: (1–5)	User Downloads	IoT/Wearable Integration	Data Handling Clarified to User with Consent	Cost
9	TA	Alzheimer's Daily Companion	Offers daily caregiving tips and reminders for Alzheimer's carers.	iOS	Carer	3.0	10k+	No wearable/IoT integration	Not stated	Free
10	RA	Alzheimer's Guide	Provides general information and caregiving resources for Alzheimer's.	Android & iOS	Public	2.5	Not listed	No wearable/IoT integration	Not stated	Free
11	RA	AA: Science Hub	Latest Alzheimer's & dementia science news and expert viewpoints.	Android & iOS	Public/ HCP [8]	2.3	Not listed	No wearable/IoT integration	Not stated	Free
12	RA	Alzheimer's Disease	Provides general information about Alzheimer's disease.	iOS	Public, Carer	2.1	Not disclosed	No wearable/IoT integration	Yes, App-Privacy section	Free
13	TA	Alzheimer's Disease @ PoC (Provider side)	Clinical decision support content for Alzheimer's disease (diagnosis, treatment, care management).	iOS	HCP	3.0	Not disclosed	No wearable/IoT integration	Yes, App-Privacy section is available	Free
14	RA	Alzheimer's Disease Pocketcard	Quick reference guide for carers and professionals dealing with Alzheimer's.	Android & iOS	Carers + HCP	5.0	5k	No wearable/IoT integration	Yes, App-Privacy section is available	Free
15	RA	Alzheimer's Exam Review App 2020	Provides exam preparation and clinical knowledge review for Alzheimer's disease.	Android	HCP	5.0	Not listed	No wearable/IoT integration	Yes, App-Privacy section is available	Free
16	RA	Alzheimer's Risk Calculator	Help users assess their risk of developing Alzheimer's disease.	Android & iOS	Public	3.5	10+	No wearable/IoT integration	Not stated	Free
17	TA	ALZ APP	Games to help people with Alzheimer's/dementia bond with loved ones & carers.	Android & iOS	PLwD & Carer	3.7	50+	No wearable/IoT integration	Yes, App-Privacy section is available	Free
18	RA	AlzU	Offers education about Alzheimer's disease with scientific updates.	Web program	PLwD/Carer	5.0	Not listed	No wearable/IoT integration	Not stated	Free
19	Care	Balance: Alzheimers Caregiving	Offers support and tools for Alzheimer's carers to manage care tasks.	iOS	Carers	5.0	Not disclosed	No wearable/IoT integration	Not stated	Free
20	CTA	Beat-D	Supports cognitive stimulation and training for dementia patients.	Android & iOS	PLwD/Carers	2.0	1	No wearable/IoT integration	Not stated	Free
21	Care	Alzheimers Products	List useful products for Alzheimer's care.	Website resource	Public	2.0	Not listed	No wearable/IoT integration	Yes, App-Privacy section is available	Free
22	CTA	BrainSHIELD	Provides a brain health program to protect against dementia.	iOS	Public	3.7	Not disclosed	No wearable/IoT integration	Yes, App-Privacy section is available	Free
23	MWA	Calm:	Relaxation techniques, guided meditation, and sleep stories.	Android & iOS	Public	5.0	iOS 1.9M & 600k in google play	Yes, support for Apple Watch and Wear OS	Yes, App privacy and full policy available	$14.99/ month
24	Care	Carely	Keeps families coordinated with updates, shared schedules, notes, and photos for dementia care.	Android & iOS	PLwD/carer	2.9	10k+	No wearable/IoT integration	Yes, App-Privacy section is available	In app purchases

Table 3. *Cont.*

No	Type	App Name	Description & Features	Platforms Available	End User	MARS: (1–5)	User Down-loads	IoT/Wearable Integration	Data Handling Clarified to User with Consent	Cost
25	Care	Care4Dementia	Guidance for carers on challenging behaviours in dementia (what they look like, why, and what to do).	Android & iOS	PLwD/carer	4.0	100+	No wearable/IoT integration	Yes, App-Privacy section is available	Free
26	Care	Carers Matter by GLSS	Provides support and resources for informal carers (education, tips, song-based prompts; web app available).	Android	Carer	3.0	Not listed	No wearable/IoT integration	Not stated	Free
27	CTA	CogniCare	Provides memory training exercises for patients with early-stage dementia	iOS	PLwD, Carer	3.2	Not disclosed	No wearable/IoT integration	Yes, App-Privacy section is available	Free
28	Care	ConsultGeri: Dementia	Step-by-step diagnosis & management guide; evidence-based resources	iOS	physicians, nurses, HCPs, & home carer	3.6	Not disclosed	No wearable/IoT integration	Yes, App-Privacy section is available	Free
29	CTA	Constant Therapy	Personalized cognitive, memory, and speech therapy activities designed by clinicians.	Android, iOS, Amazon Firestick	Adults, (SLP/therapist).	4.5	100k+	No wearable/IoT integration	Yes, App privacy and full policy available	$29.99
30	RA	Dementia CareAssist	Guide for carers to manage dementia-related behaviours; practical tips and resources.	Android & iOS	Carer	3.0	100+	No wearable/IoT integration	Yes, App clarifies that no data is collected.	Free
31	Care	Dementia Care and Connect:	Rate/find dementia-friendly places; community reviews of venues.	iOS	Public/PLwD/ Care	4.5	Not disclosed	No wearable/IoT integration	Not stated	Free
32	Care	Dementia Carer Solutions (DCS)	Tips and professional advice for managing ~25 common dementia behaviours.	Android & iOS	Carers	5.0	Not listed	No wearable/IoT integration	Not stated	Free
33	RA	Dementia Emergency	Offers critical emergency information for carers of dementia patients.	iOS	Public/PLwD/ Care	2.0	Not disclosed	Yes, integrated with apple watch	Not stated	Free
34	RA	Dementia Environ-ment Assess-ment Tool	Evaluates home environments for dementia-friendliness and provides recommendations for improvement.	University website	Public/PLwD/ Care	2.9	34	No wearable/IoT integration	Not stated	Free
35	RA	Dementia Friendly Home	Interactive guide showing practical changes to make a home safer and easier to navigate for PLwD.	iOS	Individuals, carers, & families	1.6	Not disclosed	No wearable/IoT integration	Yes, App-Privacy section is available	Free
36	Care	Dementia Guide Expert	Comprehensive guide for dementia carers and HCP.	Android & iOS	Carer + HCP	5.0	5000+	No wearable/IoT integration	Yes, App privacy details are provided.	Free
37	RA	Dementia News and Chat	Provides a platform for dementia carers to share experiences and tips.	iOS	Carer	2.0	Not disclosed	No wearable/IoT integration	Not stated	Free
38	Care	Dementia Overview	Provides an overview of dementia symptoms, causes, and treatment options.	iOS	Public	3.7	Not disclosed	No wearable/IoT integration	Not stated	Free
39	TA	Dementia Personal Outcomes v.2	Allows carers to track personal outcomes and well-being of dementia patients.	Android	Care	3.0	Not listed	No wearable/IoT integration	Not stated	Free

Table 3. *Cont.*

No	Type	App Name	Description & Features	Platforms Available	End User	MARS: (1–5)	User Downloads	IoT/Wearable Integration	Data Handling Clarified to User with Consent	Cost
40	RA	Dementia Risk Calculator	Calculates the risk of developing dementia based on user input.	iOS	Public (self-assessment style app)	3.6	Not disclosed	No wearable/IoT integration	Not stated	Free
41	Care	Dementia Understanding Stress and Distress	Helps carers understand and manage stress related to dementia care.	iOS	Carers	3.0	Not disclosed	No wearable/IoT integration	Not stated	Free
42	RA	DementiAssist	Practical advice for common dementia behaviours: causes and suggested actions for carers.	Android & iOS	Carers	3.0	Not listed	No wearable/IoT integration	Not stated	Free
43	Care	Dem Konnekt—Dementia Care App	Provides screening tools, carer education, daily activities/brain games, a reminiscence album, a carer community, and chat access to dementia experts.	Android & iOS	Carers	2.5	Not listed	No wearable/IoT integration	Not stated	Free
44	RA	Deva World	A virtual world app to help carers engage with dementia patients	iOS	Carers	3.4	Not disclosed	No wearable/IoT integration	Yes, data safety details are provided.	Free
45	TA	Dementia Training Australia: Behaviours	Provides behavioural management tools for dementia patients.	Android & iOS	PLwD	2.5	Not listed	No wearable/IoT integration	Not stated	Free
46	TA	Dementia Training Australia Medications	Offers a medication management tool for carers of dementia patients.	Android & iOS	Carer	2.5	Not listed	No wearable/IoT integration	Yes, App privacy is maintained, as data is not collected	Free
47	CTA	Elevate	Focusing on boosting critical thinking, memory, and communication skills.	Android & iOS	Public	4.8	26 Million	Yes, Elevate Dash on Apple Watch:	Yes, App privacy statement is provided	$39.99
48	RA	Free Alzheimer's and Dementia News	Offers news and updates on dementia and Alzheimer's research.	iOS	Public/Carers	2.0	Not disclosed	No wearable/IoT integration	Not stated	Free
49	MWA	Flower Garden	Virtual gardening experience: plant seeds, water, watch flowers bloom; make/share bouquets.	iOS	Public	3.6	Not disclosed	Yes, displays the Apple Watch icon	Yes, App privacy is provided	$2.99
50	CTA	G30—A Memory Maze	Memory games are designed to stimulate cognitive function in dementia patients.	Android & iOS	Public/PLwD	4.8	50k	No wearable/IoT integration	Yes, App privacy is provided	$3.99
51	CTA	Game Changer	Play short brain-games for ~5 min daily for a month to contribute data to dementia research.	Android & iOS	Public	3.1	111	No wearable/IoT integration	Yes, App privacy is provided	Free
52	CA	The Memory Clinic	Digital support for memory assessment: intake questions, tablet-based cognitive test, option to involve a relative; results interpreted for clinicians.	Android & iOS	Patient/Carer	3.7	Not listed	No wearable/IoT integration	Yes, App privacy is provided	Free
53	MA [7]	GreyMatters	Encourages reminiscing through a digital "Life Storybook"	iOS	PLwD	2.6	Not disclosed	No wearable/IoT integration	Not stated	in app purchase

Table 3. *Cont.*

No	Type	App Name	Description & Features	Platforms Available	End User	MARS: (1–5)	User Down-loads	IoT/Wearable Integration	Data Handling Clarified to User with Consent	Cost
54	MWA	Happify	Mood improvement and stress reduction using CBT and science-based games.	Android & iOS	Public	4.5	3300	No wearable/IoT integration	Yes, App privacy is provided	$139/year
55	MWA	Headspace:	Provides meditation and mindfulness exercises to reduce stress,	Android & iOS	Public	4.0	39 million	Yes, Apple watch connectivity.	Yes, App privacy is provided	$69.99/ year
56	RA	Healthy Brains	Brain Check-up with a Brain Health Index (BHI), tips based on the "six pillars," progress tracking.	iOS	Public,	2.2	Not disclosed	No wearable/IoT integration	Not stated	Free
57	CTA	Hello Brain	Encourages everyday "Brain Buffs," short, evidence-based actions to support brain health.	Android, iOS, web, print.	Public	2.1	Not listed	No wearable/IoT integration	Not stated	Free
58	MA	House of Memories	Reminiscence app: explore objects from the past (images, sounds, descriptions) to spark conversation and memory.	Android & iOS	PLwD/Public	4.3	32	No wearable/IoT integration	Yes, App privacy is provided and states no data collected	Free
59	RA	How to Prevent Alzheimer	Provides lifestyle tips to potentially prevent Alzheimer's.	Android & iOS	Public	2.8	Not listed	No wearable/IoT integration	Not stated	Free
60	RA	Iridis	Assist carers in assessing how dementia-friendly a home or care setting is (lighting, contrast, noise, layout) and gives evidence-based recommendations.	iOS	Carer, families, HCP	4.6	Not disclosed	No wearable/IoT integration	Yes, App privacy policy is provided	$15.99/ month
61	MWA	Insight Timer	A meditation app offering thousands of free guided meditations and sleep tracks.	Android & iOS	Public, Carer	4.9	10 Million+	Yes, Apple watch is a requirement	Yes, App privacy policy is provided	$59.99/ year
62	TA	It's Done!	Task tracker for daily activities like locking doors or taking medication, with reminders and notifications.	Android & iOS	Public/PLwD/ Carer	4.1	500+	Yes, Apple watch connect is present.	Yes, App privacy policy is provided	$2.99
63	TA	Jigsaw Puzzle Real	Jigsaw puzzle app with a variety of puzzle sets, offering cognitive stimulation for people with dementia through solving familiar images.	Android & iOS	Public, PLwD	4.7	10 million+	No wearable/IoT integration	Yes, App privacy policy is provided	$6.99
64	RA	Living and Dying Well with Dementia	Focuses on palliative care and improving the quality of life for dementia patients.	iOS	PLwD/Carer	3.7	Not disclosed	No wearable/IoT integration	Not stated	Free
65	Care	Lotsa Helping Hands	Help carers and family members coordinate care	Android & iOS	Carers	2.8	10k+	No wearable/IoT integration	Yes, App privacy policy is provided	Free
66	CTA	Lumosity	Offers brain games designed to improve memory, attention, and problem-solving skills.	Android & iOS	Public/PLwD/ Carer	4.9	10 million +	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	$69.99/yr
67	TA	Map Habit	Care management platform provides visual guides and step-by-step instructions for daily routines.	Android & iOS	PLwD, Carers, Public, Care organizations	4.8	50+	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	Paid. Cost not openly avail-able

Table 3. *Cont.*

No	Type	App Name	Description & Features	Platforms Available	End User	MARS: (1–5)	User Down-loads	IoT/Wearable Integration	Data Handling Clarified to User with Consent	Cost
68	MA	Medisafe	A medication reminder app that helps users track their medication schedule.	Android & iOS	Public/PLwD/ Carer	4.7	5 million+	Yes, Apple watch connect is available.	Yes, App privacy & data privacy policy is provided	$39.99/ year
69	MA	Memory Lane	Encourages social interactions through photos, videos, and shared stories, especially for older adults.	Android & iOS	Older adults/carers/ families	3.9	50k+	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	Free soft-ware
70	TA	Memory Clock	Task reminder app that allows carers to send alerts for daily tasks.	Android	PLwD with care partner	3.2	98k+	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	Free
71	CTA	Memory Matrix	A dementia prevention app that enhances concentration, memorization, and mental imagery.	Android & iOS	Public/PLwD/ Carers	4.5	10k+	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	in app pur-chases
72	CTA	Memory Maze	Engages patients in memory-stimulating activities.	Android & iOS	Public/PLwD/ Carers	2.5	50+	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	Free
73	CTA	MEternally (Jigsaw Puzzle Real)	Large library of jigsaw images; option to make puzzles from your own photos (useful for reminiscence).	Android & iOS	Public/PLwD/ Carers	4.7	Not stated	No wearable/IoT integration	Not stated	in app pur-chases
74	CTA	Mind Mate Essential	Brain games & cognitive training plus exercise videos, nutrition advice, reminders/diary	iOS	Public/PLwD/ Carer	4.8	Not disclosed	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	Free
75	MWA	Mindmate	AI mental-wellness companion: AI chat, breathing exercises, AI-generated meditations, journaling, and mood tracking.	iOS	Public	3.6	Not disclosed	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	Free
76	TA	Much Too Young Virtual Reality	Immersive VR experience to raise awareness about early-onset dementia.	iOS	Public/Carers	4.0	Not disclosed	Yes, VR wearable integrated	Not stated	Free
77	MWA	My Reef 3D	Virtual reef aquarium with 40+ fish; feed fish, customize tanks; calming visual interaction (often recommended for dementia-friendly relaxation)	iOS	Public/Dementia Friendly Use	4.1	Not disclosed	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	$2.99
78	RA	Natural Ways to Prevent Alzheimer's Disease	Lists natural home remedy tips, that claim to reduce Alzheimer's risk.	Android	Public	3.1	Not listed	No wearable/IoT integration	Not stated	Free
79	TA	Nymbl Training	Fall-prevention balance program that pairs light physical exercises with simple cognitive (dual-task) games; ~10 min/day.	Android & iOS	Older adults (typically 50–60+)	4.8	100k	No wearable/IoT integration	Yes, the App privacy & data privacy policy is provided	Free via health-care
80	CTA	Peak	Includes games developed with the Brain-TA with 45+ games across memory, attention, problem-solving, mental agility, language, etc.	Android & iOS	Public	4.7	10 million+	Yes, Apple Watch requirement	Yes, the App privacy & data privacy policy is provided	$34.99

Table 3. *Cont.*

No	Type	App Name	Description & Features	Platforms Available	End User	MARS: (1–5)	User Down-loads	IoT/Wearable Integration	Data Handling Clarified to User with Consent	Cost
81	MA	Pillboxie	Another medication tracker that visually represents pill schedules to aid memory.	iOS	Public/PLwD/ Carer	3.8	Not disclosed	Yes, it can be integrated with the iPod touch	Yes, the App privacy & data privacy policy is provided	$1.99
82	MWA	Piano with songs	Music-based cognitive stimulation through interactive piano lessons helps with memory and stress reduction.	iOS	Public	4.6	Not disclosed	No wearable/IoT integration	Yes, the App privacy & data privacy policy is provided	$69.99/ year
83	CA	PRODEMOS	Coach-supported apps via self-management of seven dementia risk factors (e.g., weight, diet, etc.) with goal setting, progress tracking, education, and in-app chat.	Study only app	Adults 55–75 years	3.2	Not Listed	No wearable/IoT integration	Not stated	Free for trial partici-pants
84	MA	Promenade	Revisiting memories together. Both the PLwD and the carer use the app together to revisit old memories.	iOS	Used together, PLwD and carer	4.7	Not disclosed	No wearable/IoT integration	Not stated	$4.99
85	CTA	Reactive NHS	Monitors brain health with regular cognitive tests/puzzles and supplies a brain-training program; summarised results are shared with GPs via a clinician portal to flag people who may need assessment.	NHS research channel	Older adults, NHS pilot participants	2.6	Not listed	No wearable/IoT integration	Not stated	Free for pilot partici-pants
86	TA	RemindMecare	Personalises care with activities, life-story media, schedul-ing/notifications, and care-circle connectivity for PLwD and their carers.	Web enterprise	PLwD, Carers, family members	3.3	Not listed	No wearable/IoT integration	Yes, the App privacy & data privacy policy is provided	$399.99 one time
87	TA	Sea Hero Quest	A short 3D navigation game that lets anyone contribute anonymized data to dementia research on spatial orientation (one of the earliest abilities affected).	Android & iOS	Public	4.6	10k+	Yes, VR devices integrated	Yes, App privacy & data privacy policy is provided	Free
88	CTA	SingFit	A music therapy app that helps individuals with dementia engage in therapeutic singing, improving cognitive and emotional well-being. Ideal for speech and occupational therapy.	Android & iOS	PLwD, carers, HCP	3.9	500+	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	Paid, multi-ple plans
89	CTA	Silvia App	A multi-domain lifestyle app designed for dementia prevention. It has been shown to be effective in promoting cognitive functioning in older adults.	Android & iOS	Public, Older adults, at risk individuals, carers	3.7	100k+	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	$69.99/ year

Table 3. *Cont.*

No	Type	App Name	Description & Features	Platforms Available	End User	MARS: (1–5)	User Downloads	IoT/Wearable Integration	Data Handling Clarified to User with Consent	Cost
90	RA	Relish Wellbeing 2.0	Activity planning & documentation for care home teams, plus relatives/family communication; library of dementia-friendly activity ideas.	Android & iOS	Carers, care home staff	4.8	5k+	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	$82.99/ month
91	FA [7]	Sworkit	Customizable home workouts (strength, cardio, yoga, stretching) with plans; includes senior-friendly programs.	Android & iOS	Older adults and public	4.7	15 million+	Yes, can be integrated with Apple Watch, Fitbit, Google Fit	Yes, App privacy & data privacy policy is provided	$59.99/ year
92	TA	Spaced Retrieval Therapy	Memory TA using spaced retrieval methods to help users recall valuable information.	Android & iOS	HCP/Carer with patient	4.6	500+	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	$4.99
93	Care	Symptom guide Dementia	Learn about dementia symptoms and management strategies; choose from a large library of symptoms to track & share reports with family/clinicians.	iOS	Carers and family of PLwD	2.4	Not disclosed	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	Free
94	MA	Timeless	Uses AI for facial recognition to help patients remember loved ones, events, and appointments.	iOS	PLwD and carers	1.8	Not disclosed	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	Free
95	RA	The Dementia-Friendly Home	Practical tips and room-by-room guidance to make a home safer and easier to navigate for a person living with dementia.	iOS	Patient/Carer	3.2	Not disclosed	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	Free
96	RA	Understanding Dementia	Introductory learning resources to build knowledge of dementia; includes real stories from people with dementia and carers.	Android & iOS	Health & Social Care Staff, Carers, Public Learners	2.4	Not listed	No wearable/IoT integration	Not stated	Free
97	RA	Verily Connect	Connect dementia patients and carers to virtual healthcare resources.	Android & iOS	Family Carers in rural communities	3.2	Not listed	No wearable/IoT integration	Not stated	Free
98	CTA	Word Search Colorful	Word search puzzles to enhance cognitive abilities, focusing on language and memory skills.	Android & iOS	Public	4.7	12 million+	No wearable/IoT integration	Yes, App privacy & data privacy policy is provided	$39.99/year
99	RA	Young Onset Dementia (YOD)	Provides information, signposting, and practical support for people with young-onset dementia and their carers.	Android & iOS	People with young-onset dementia, family carers, and HCP	3.0	50+	No wearable/IoT integration	Yes, the App privacy & data privacy policy is provided	Free
100	TA	YuGro Assist App	Assists carers with dementia-related challenges and care routines.	Android & iOS	Carers/family & PLwD	3.4	Not shared	No wearable/IoT integration	Not stated	Free

[1] TA: Training App. [2] Care: Focus is on carers. [3] RA: Resource App. [4] CTA: Cognitive Training App. [5] MWA: Mental Wellness Apps. [6] Cognitive Assessment. [7] Memory Aid. [8] FA: Fitness Apps.

3.5. Evaluation Approaches

The evaluation applied the Mobile App Rating Scale (MARS) through a structured, consensus-driven process rather than statistical aggregation. After search and screening (April 2025), two independent evaluators reviewed each included app on separate devices and operating systems (one iOS, one Android) under typical consumer network conditions. The evaluators offered complementary experiences and training: one evaluator has medical training, and the other evaluator has prior dementia caregiving experience. Before formal scoring, both completed standardised MARS familiarisation (handbook and video tutorial) and a calibration exercise on a pilot set of 10 apps. Item-level discussions during calibration aligned interpretations of the four MARS domains: Engagement, Functionality, Aesthetics, and Information, and clarified how to apply the 1–5 anchors (1 = inadequate to 5 = excellent) to dementia contexts.

Each app was then tested in its public store version. The evaluators interacted with all core features and recorded device/OS details. To reduce expectancy and popularity bias, they did not consult user star ratings or reviews while scoring and relied only on in-app behaviour and developer documentation accessible from the app or its store page. For each domain, evaluators first produced independent, itemised ratings with short justifications tied to observable behaviour (e.g., task completion steps, error states, text legibility, navigational clarity, evidence citations, privacy notices, and in-app help). Where relevant, scenario-based tasks were used to probe common use cases in dementia care (e.g., launching a cognitive activity, locating crisis information, adjusting font size or contrast).

Reliability was checked using the two reviewers' original scores given before any discussion. First, agreement between the two reviewers was summarised across the four MARS areas for each app. Exactly matching scores and scores within a one-point difference were tagged with an overall agreement score with a 95% range to show how close the two sets of scores were. Differences of $\geq$2 points on any item triggered a reconciliation step. Disagreement handling followed a debated-consensus protocol. The two primary evaluators reviewed specific evidence (screenshots, screen recordings, and time-stamped notes) and discussed sources of discrepancy (e.g., platform-specific behaviour, accessibility, etc). When consensus was not reached after this step, a third reviewer adjudicated by examining the same evidence, and after consensus, an average score including both the reviewers' final scores was incorporated. The final domain scores were established by consensus and recorded as the ratings for analysis and reporting. Provisional individual scores were retained in the audit trail for transparency and were combined after a debated consensus using inferential statistics. The goal was defensible expert judgment rather than a statistical estimate. A repeat review for the updated apps was undertaken in July 2025.

This approach reflects clinical relevance and lived-experience validity over purely statistical agreement. By requiring explicit evidence for each domain judgment and resolving discrepancies through structured debate and, when needed, third-party adjudication, the process yields clear, defensible MARS ratings that reflect how dementia-focused apps function for real users across platforms.

3.6. IoT Connectivity

IoT connectivity was assessed with a single, repeatable protocol focused on user-visible evidence and hands-on verification. For each app, both platform listings (App Store and Google Play), the developer's support/FAQ pages, and in-app settings/help were checked for explicit mentions of device pairing or companion experiences. Connectivity counted as Yes only when the app: (a) advertised an Apple Watch or Wear OS companion app; (b) listed named wearables (e.g., Fitbit, Garmin, Polar) or home devices (e.g., Alexa, Google Home, HomeKit devices, BLE beacons, fall detectors, bed/door sensors) with usage

instructions; or (c) exposed a pairing flow in the app (e.g., "Add device," "Connect watch," "Pair sensor") that completed or attempted discovery over Bluetooth Low Energy.

Health data sync via Apple Health or Google Fit was logged, but not by itself treated as wearable connectivity unless the app also claimed a watch app or third-party device sync. VR viewers and phone-only features did not qualify. When evidence was present, reviewers recorded the device category (watch, fitness tracker, medical sensor, smart speaker/home), specific brands or models if named, the protocol observed or stated (BLE/NFC/Wi-Fi), the data exchanged (e.g., steps, heart rate, sleep, prompts), the direction of sync (device→app, app→device, bidirectional), and whether pairing required an account or cloud service.

On iOS and Android test devices, reviewers attempted the advertised pairing steps; success, failure states, and permission prompts (Bluetooth, Motion & Fitness, Local Network) were documented with screenshots and timestamps, along with app version, build, OS, and region. Vague claims ("works with smartwatches") or only implied by marketing were coded Not stated unless a concrete device or pairing UI was shown. Final labels were Yes, or Not stated; "Yes" required direct, verifiable indications as above, and "Not stated" was used when thorough checks found no pairing claims or UI while the app otherwise functioned normally.

4. Results

Table 3 presents a comprehensive overview of 100 mobile applications designed to support individuals affected by dementias, including people living with dementia, family carers, and healthcare professionals. App-level review revealed substantial overlap in both intended users and functional focus across the dementia trajectory as some apps were designed primarily for people living with dementia, others targeted informal caregivers or the wider public, and many addressed cross-cutting aims such as stress reduction, general wellbeing, or cognitive assessment. Because these applications span diverse functions; including cognitive stimulation, daily task support, caregiving guidance, education and awareness, and relaxation; each app was assigned a single primary functional goal and classified into one of eight mutually exclusive categories: Resource Apps (RA), Cognitive Training Apps (CTA), Care apps (Care), Task Assistance for people living with dementia (TA, PLwD), Mental Wellbeing Apps (MWA), Memory Aid (MA), Cognitive Assessment tools (CA), and Fitness App for older adults (FA, seniors). This primary-goal framework approximates how users are likely to encounter and employ these apps in practice, enables aggregated psychometric and governance analyses within conceptually coherent groups, and preserves the interpretability of comparisons across categories despite the inherently overlapping nature of real-world app functionality. Platforms span Android, iOS, and web-based access, with most apps freely available and a minority offering in-app purchases or paid versions, while user feedback, operationalised through MARS ratings and download counts, indicates reach. Overall, this landscape illustrates the growing integration of mHealth apps into dementia care, with an emphasis on accessibility, targeted support, IoT integration, and the potential to enhance quality of life and caregiving effectiveness.

Table 4 presents the cross-tabulation of dementia-related digital apps (n = 100) by platform availability and functional classification. Figure 2 shows applications are grouped into five platform categories (y axis): both Android and iOS, iOS only, Android only, website-based, and dementia research apps against eight predefined functional types (x axis): RA, CTA, TA (PLwD), Care, MWA, MA, CA, and FA. For each platform category, the table reports the absolute number of apps belonging to each functional type, together with a platform-wise total, while the final row summarises category-wise totals across the full sample. This structure allows simultaneous examination of both the distribution of app functions and their alignment with specific deployment platforms, thereby pro-

viding an overview of where particular types of support (e.g., cognitive training, carer support, or informational resources) are most heavily represented within the current digital dementia landscape.

Table 4. Cross tabulation of app from categories (x axis) vs. available platforms (y axis).

Platform\Category	RA	CTA	TA (PLwD)	Care	MWA	MA	CA	FA	Total Apps
Both Google Play Store and iOS	13	14	11	6	5	3	2	1	55
iOS only	11	4	3	7	4	4	0	0	33
Google Play Store only (Android)	2	0	3	1	0	0	0	0	6
Website-based applications (no native apps)	2	0	1	1	0	0	0	0	4
Research Apps	0	1	0	0	0	0	1	0	2
Total apps across App Categories	28	19	18	15	9	7	3	1	100

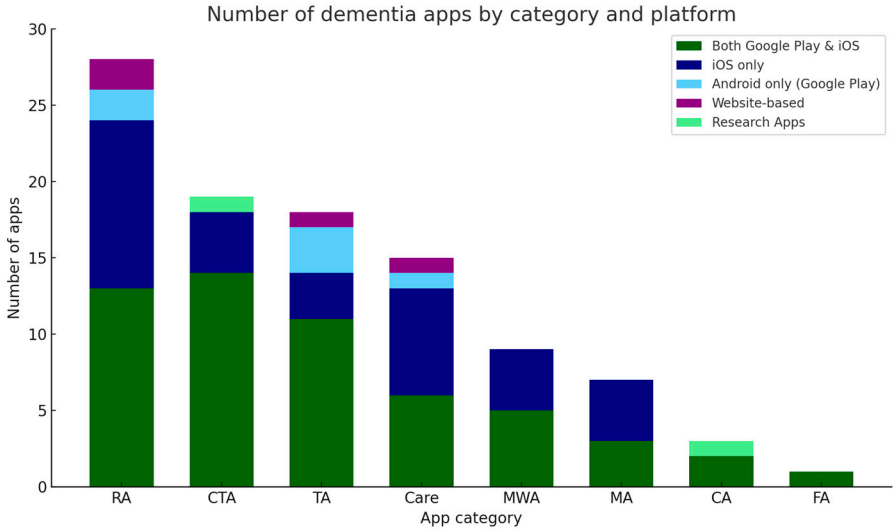

Figure 2. Presents the categorical apps across platforms.

Table 5 summarises the distribution of app quality scores across the eight functional categories of dementia-related digital apps. For each category, the table reports the number of apps (n), central tendency (mean and median), dispersion (standard deviation and variance), observed range (minimum and maximum scores), and an approximate 95% confidence interval for the mean. Sample sizes range from a single Fitness App (FA; $n = 1$) to 28 for RA, with intermediate Ns for CTA, TA (PLwD), Care, MWA, MA, and CA apps.

Table 5. Average MARS Score by App Category.

Category	*n*	Mean	Median	SD	Variance	Min	Max	95% CI
RA	28	3.26	3.05	1.05	1.10	1.60	5.00	2.87–3.65
CTA	19	3.80	3.90	1.01	1.02	2.00	4.90	3.35–4.25
TA	18	3.83	3.85	0.86	0.74	2.50	5.00	3.43–4.23
Care	15	3.59	3.60	1.03	1.06	2.00	5.00	3.07–4.11
MWA	9	4.14	4.10	0.67	0.45	3.00	5.00	3.70–4.58
MA	7	3.69	3.90	1.10	1.21	1.80	4.70	2.88–4.50
CA	3	3.87	3.70	0.76	0.58	3.20	4.70	3.01–4.73
FA	1	4.70	4.70	0.00	0.00	4.70	4.70	NA

Mean quality scores span from 3.26 (RA) to 4.14 (MWA), with most medians clustering between 3.5 and 4.0, indicating moderate-to-good, rated performance across categories. Standard deviations and variances suggest greater variability among RA, Care, and MA

apps compared with the more tightly clustered scores in the MWA group. The 95% confidence intervals indicate the precision of the mean estimates, which are narrower in categories with larger Ns (e.g., RA, CTA, TA) and wider where sample sizes are small (e.g., MA, CA); no confidence interval is reported for FA (n = 1), where such an estimate would not be meaningful. A graphical representation is provided in Figure 3.

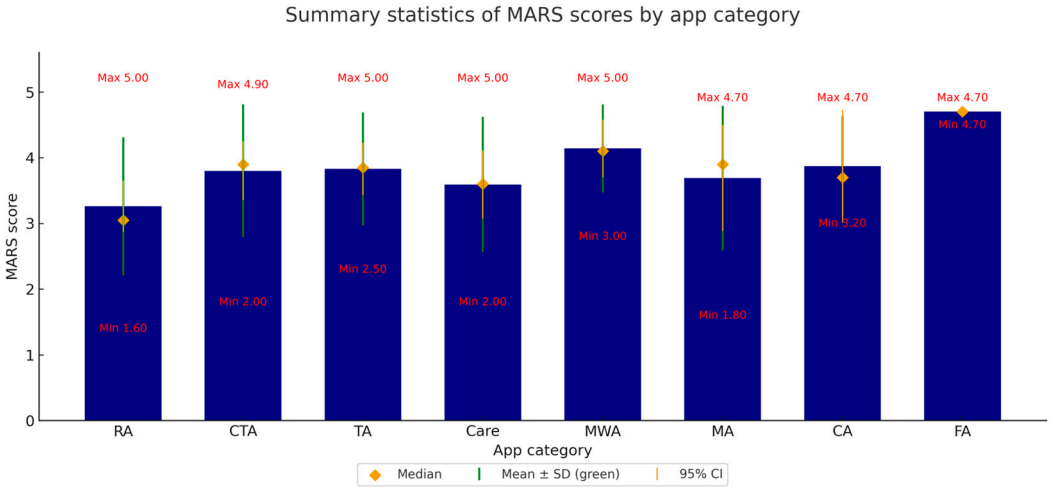

Figure 3. MARS distribution across app categories.

Figure 3 shows the mean MARS score for each app category (RA, CTA, TA, Care, MWA, MA, CA, FA) as bars, with standard deviation shown as green lines. Thin vertical error bars indicate the 95% confidence interval for the mean (except for FA, where a CI cannot be calculated). Diamond markers represent the median, while the labelled minimum and maximum values show the full observed range for each category. Together, these elements allow direct comparison of central tendency (mean and median), variability (standard deviation and confidence intervals), and score range (min–max) across all app categories.

Figure 4 presents the distribution of dementia-related applications by category and cost model, showing the number of free and paid apps in each group. RA include 26 free and 2 paid apps, CTA includes 9 free and 10 paid, TA shows 13 free and 5 paid, Care reveals 14 free and 1 paid; MWA show 1 free and 8 paid, MA reveal 3 free and 4 paid; CA shows 2 free and 1 paid; and FA (PLwD) reveals 0 free and 1 paid. In total, the chart depicts 68 free applications and 32 paid applications across all categories.

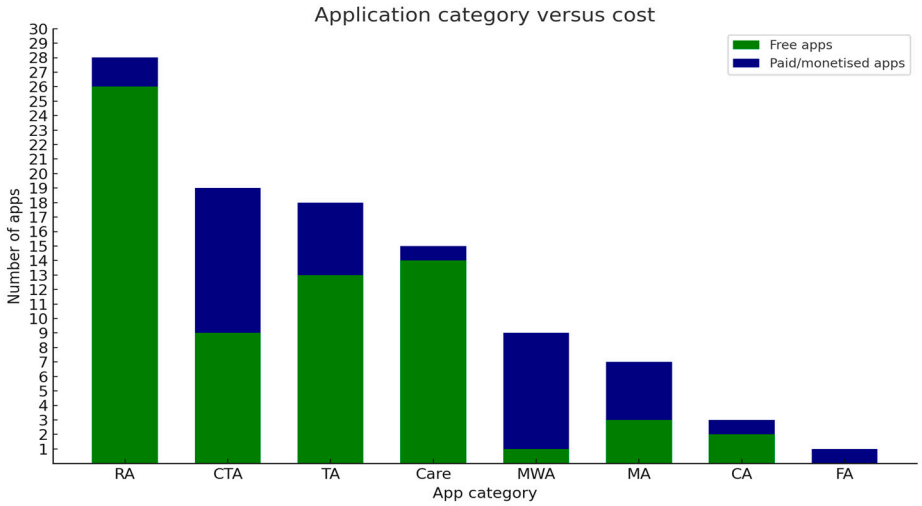

Figure 4. Cost model.

Across the 32 paid or monetised apps, 24 were available on both Android and iOS, including 9 with an upfront one-time payment, 2 with a monthly subscription, 8 with an annual subscription, 3 using in-app purchases, 1 with undisclosed costs, and 1 offering multiple paid options. A smaller subset of paid apps was restricted to iOS (n = 7), comprising 4 apps requiring an upfront one-time payment, 1 with a monthly subscription, 1 with an annual subscription, and 1 monetised via in-app purchases. Only one paid app was provided as a web-based application with an upfront one-time fee, and no paid apps were Android-only. Table 6 presents an overview of these pricing structures.

Table 6. Cost breakdown of apps across platforms.

Platform\Cost Model	One-Time Payments	Monthly Subscription	Annual Subscription	In-App Purchases	Paid: Cost Not Listed	Multiple Plans	Platform Totals
Both Android and iOS	9	2	8	3	1	1	24
iOS only	4	1	1	1	0	0	7
Website-based applications	1	0	0	0	0	0	1
Android only	0	0	0	0	0	0	0
All paid apps	14	3	9	4	1	1	32

Table 7 summarises 100 dementia-related mobile applications by category, primary focus, intended users, and stage of dementia. The distribution is: RA (n = 28; all stages), Cognitive Training (n = 19; early–mid), TA (n = 18; all stages), Carer-focused (n = 15; all stages), Mental Wellness (n = 9; all stages), MA (n = 7; early–mid), CA (n = 3; preclinical–early), and FA (n = 1; prevention–early). Key users span the public, carers, PLwD, families, health-care professionals (HCP), and care staff. Total = 100 apps.

Table 7. A Functional Category Correlated Approach.

Category (Type)	Primary Focus	Key End Users	Dementia Stage Focus	No. of Apps	Mobile Applications
RA	Education, Resources, Information access	Public; Carers, PLwD (patients), Families, HCP, care-home/health & social-care staff.	All stages	28	Alzheimer's Risk Calculator, AlzU, Dementia CareAssist, Understanding Dementia, Verily Connect, The Dementia-Friendly Home, Iridis, Natural Ways to Prevent Alzheimer's Disease, Free Alzheimer's, Dementia News, Iridis, Living and Dying Well with Dementia, Relish Wellbeing 2.0, Young Onset Dementia (YOD), Alzheimer's Disease Pocketcard, Dementia Environment Assessment Tool
CTA—Cognitive Training	Cognitive Stimulation	At-risk individuals, early-stage patients; Carers; HCP; older adults	Early to mid-stage	19	AMI (Advancing Mental Invigoration), Beat-D, BrainSHIELD, CogniCare, Constant Therapy, Elevate, G30—A Memory Maze, Game Changer, Hello Brain, Lumosity, MEternally (Jigsaw Puzzle Real), Memory Matrix, Memory Maze, Peak, Reactive NHS, SingFit, Silvia App, Word Search Colorful, Hello Brain (web/print).
TA (PLwD)	Skill-building and procedural training	PLwD; Carers/Carers; HCP; Public; families; care organizations; older adults	All stages	18	A Simple Day; A Walk Through Dementia, Alzheimer's Daily Companion, Alzheimer's Disease @ PoC (Provider side), Dementia Personal Outcomes v.2, Dementia Training Australia, Behaviours, Dementia Training Australia Medications, It's Done!, Jigsaw Puzzle Real, Map Habit, Memory Clock, Much Too Young Virtual Reality, Nymbl Training, RemindMecare, Sea Hero Quest, Spaced Retrieval Therapy, YuGro Assist App; ALZ APP.

Table 7. *Cont.*

Category (Type)	Primary Focus	Key End Users	Dementia Stage Focus	No. of Apps	Mobile Applications
Care—Carer-focused	Emotional and practical support	Carers/Carers; family; HCP; PLwD; Public.	All stages	15	Accessible Alzheimer's and Dementia Care, Alzheimer's Guide; Balance, Alzheimers Caregiving; Carely, Care4Dementia, Carers Matter by GLSS, ConsultGeri: Dementia; Dementia Care and Connect, Dementia Carer Solutions (DCS), Dementia Overview; Dementia Understanding Stress and Distress, Dem Konnekt—Dementia Care App, Lotsa Helping Hands, Symptom guide Dementia, Dementia Guide Expert.
MWA—Mental Wellness	Mindfulness, mood regulation	Public; Carers; PLwD	All stages	9	AmuseIT; Calm, Flower Garden, Happify, Headspace; Insight Timer, Mindmate, My Reef 3D, Piano with songs.
MA	Memory support, reminders	PLwD; Carers/Carers; families; Public; older adults	Early to mid-stage	7	GreyMatters, House of Memories, Medisafe, Memory Lane, Pillboxie, Promenade, Timeless.
CA	Cognitive screening and tracking	Patients; Carers; older adults	Preclinical to early stage	3	ASZHWELL, PRODEMOS, The Memory Clinic.
FA	Physical activity, motor-cognitive health	Older adults; Public.	Prevention to early-stage	1	Sworkit.

Of the 100 apps reviewed, 14 (14%) reported integration with an IoT or wearable device, whereas 86 (86%) did not. Eleven apps (11%) connected specifically to Apple Watch or iPod touch, and three (3%) supported other device classes, including a medication dispenser wearable and two VR-enabled applications. An overview of apps with IoT features is provided in Table 8. Table 8: Overview of app with IoT features.

Table 8. App Categories with IoT connectivity.

Category (Type)	Primary Focus	Key End Users	Type of Connectivity	No. of Apps	Mobile Applications
RA–	Carer emergency info	Public; Carers, PLwD (patients), Families, HCP, care-home/health & social-care staff.	Apple Watch	1	Dementia Emergency
CTA–	Cognitive Stimulation	At-risk individuals, early-stage patients; Carers; HCP; older adults	Apple Watch	2	Elevate, Peak
TA (PLwD)	Skill-building and procedural training	PLwD; Carers/Carers; HCP; Public; families; care organizations; older adults	Apple Watch, VR headsets,	3	It's Done!, Sea Hero Quest, Much Too Young Virtual Reality
MWA	Mindfulness, mood regulation	Public; Carers; PLwD	All stages	4	Calm, Flower Garden, Headspace; Insight Timer.
MA	Memory support, reminders	PLwD; Carers/Carers; families; Public; older adults	Apple watch, iPOD	2	Medisafe, Pillboxie.
CA	Cognitive screening and tracking	Patients; Carers; older adults	Medication dispensers; wearables	1	ASZHWELL
FA	Physical activity, motor-cognitive health	Older adults; Public.	Apple Watch; Fitbit; Google Fit	1	Sworkit.

Figure 5 presents a stacked bar chart that compares the total number of apps in each category with the subset that supports IoT/wearable connectivity. In every category, the navy segment (non-IoT apps) dominates, with only a small dark-green segment represent-

ing IoT-enabled apps: 1 RA, 2 CTA, 3 TA, 4 MWA, 2 MA, 1 CA, and 1 FA app. Overall, the figure shows that IoT-supported solutions constitute only a small fraction of the available dementia-related apps in each functional category.

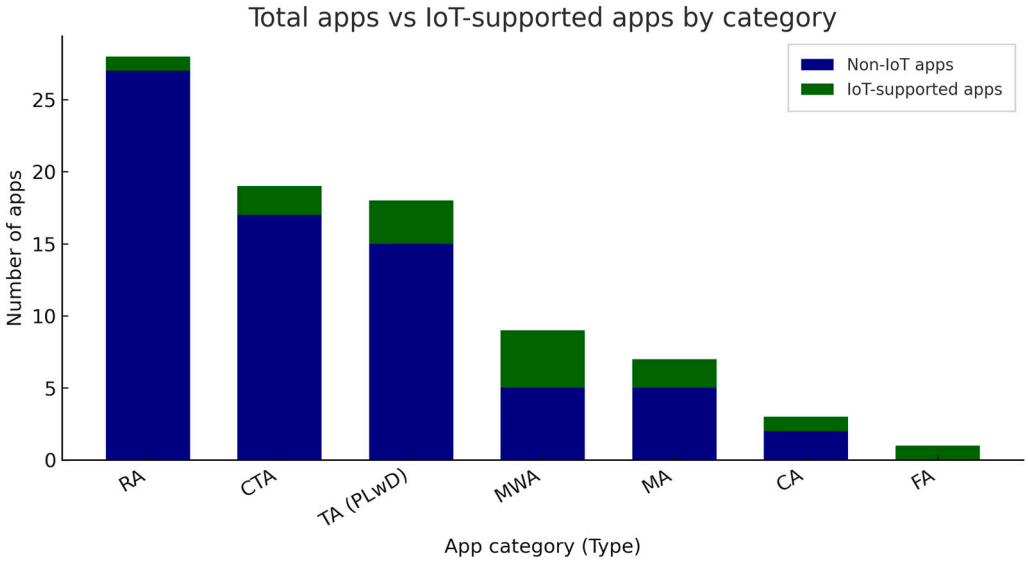

Figure 5. App Categories with IoT & non IoT support.

5. Discussion

This review provides a contemporary map of dementia-focused mobile applications available on iOS and Google Play. Using the MARS framework alongside functional categorisation, end-user targeting, pricing models, privacy transparency, and IoT connectivity, it offers a multidimensional view of what people with dementia, and their caregivers are likely to encounter in current app stores.

The discussion is structured to reflect the analytic sequence. First, an intra-categorical analysis is conducted where apps are examined within their functional categories, integrating descriptive and inferential statistics with interpretive commentary. This is followed by a synthesis of common strengths and limitations and a critical appraisal of user-facing governance features, using the eight-item rubric described in the Methodology. Subsequent sections address app footprint and reach, IoT integration, and cost structures, culminating in an integrated categorical overview of the ecosystem. Next, an inter-categorical analysis compares MARS scores, governance indices, download footprints, IoT integrations, and cost models, alongside a summary of app characteristics with particular attention to end users and dementia stages. Finally, key limitations of the review, such as app-store volatility, the snapshot nature of the search, and the inherent subjectivity of expert ratings, are discussed to delineate the scope of the conclusions and guide future replications.

5.1. Category Overview and Focus

Within the 100-app corpus, offerings concentrate in RA (n = 28), CTA (n = 19), and TA for PLwD (n = 18), with Care apps (n = 15) being well represented. Smaller segments include MWA (n = 9) and MA (n = 7), while CA (n = 3) and FA (n = 1) are uncommon. Taken together, the marketplace skews toward education, psychosocial support, and day-to-day skill-building rather than validated assessment or integrated clinical pathways. This distribution frames the subsection that follows, which considers implications for usability and real-world value, the strength of the supporting evidence, and readiness for IoT-enabled, context-aware support.

5.1.1. RA—28 Apps

RAs apps form a large and heterogeneous subset of the catalogue, comprising 28 applications focused on dementia-related information, risk, environments, and care navigation. Overall quality on the MARS is moderate: mean 3.26 on a 1–5 scale (median 3.05, SD 1.05, range 1.6–5.0; 95% CI 2.87–3.65). Approximately one quarter of RAs score ≥ 4, about one third lie between 3 and <4, and roughly two fifths score < 3, indicating a small cluster of high-performing apps, a substantial mid-range, and a sizeable tail of lower-quality apps. Platform coverage is broad but uneven: 13/28 apps run on both Android and iOS, 11 are iOS-only, 2 are Android-only, and 2 are web-based without native clients. End-user targeting is dominated by unpaid carers, with the public as the next most frequent group; a minority explicitly reference people living with dementia, healthcare professionals, families, or care-home staff. Taken together, these patterns position RAs as informational apps at the interface between lay and professional knowledge.

Among the 28 resource-oriented dementia apps, advantages mainly include efficient knowledge consolidation, targeted features, and innovative delivery methods that go beyond static information. General educational tools such as Alzheimer's Guide, Alzheimer's Disease (GoLearningBus/WAGmob), Living and Dying Well with Dementia, and Young Onset Dementia (YOD) compile core information on pathophysiology, symptom progressions, caregiving strategies, and psychosocial issues into structured, lay-friendly modules that can be accessed when needed. Professional resources like Alzheimer's Disease Pocketcard and Alzheimer's Exam Review App 2020 distil diagnostic criteria, staging schemes, and examination topics into compact reference tools and question banks that support point-of-care recall, while Alzheimer's Disease further enhances learning through bite-sized lessons and quizzes. Prevention and risk-focused apps, such as Alzheimer's Risk Calculator, Dementia Risk Calculator, and Healthy Brains, use interactive calculators and self-administered "brain check-ups" to highlight modifiable risk factors and provide personalised feedback, whereas 'How to Prevent Alzheimer, Alternative Treatments for Alzheimer's Disease, and Natural Ways to Prevent Alzheimer's Disease' present dementia through lifestyle and complementary approaches, making self-help content more accessible. Environmental design tools: Iridis, Dementia Environment Assessment Tool, Dementia Friendly Home, and The Dementia-Friendly Home convert research-based dementia design principles into structured audits and room-by-room recommendations that support practical home or facility modifications and ageing-in-place. Psychosocial and activity-focused apps like Deva World and Relish Wellbeing 2.0 offer immersive virtual environments and curated, dementia-specific activities that improve engagement and foster relationship-centred care. Carer-support platforms including Dementia CareAssist, DementiaAssist, Dementia Emergency, Verily Connect, and Young Onset Dementia (YOD) provide guidance for behavioural and crisis management, peer or rural-specific support, and tailored signposting-extending specialist advice to areas with limited services. Finally, research and news platforms such as AA: Science Hub, Free Alzheimer's and Dementia News, Dementia News and Chat, and the course-based AlzU channel combine dementia-related research updates, structured educational modules, and community discussions into single digital points, helping clinicians, carers, and interested laypeople stay informed about new evidence.

Critically, these benefits are offset by ongoing limitations in evidence quality, scope, and governance across the same-named apps. Content in general educational tools like Alzheimer: Causes, Diagnosis, and Management, Alzheimer's Guide, Alzheimer's Disease (GoLearningBus/WAGmob), Understanding Dementia, and Living and Dying Well with Dementia is often text-heavy, with unclear authorship, referencing, and update cycles, increasing the risk that diagnostic, biomarker, or treatment information becomes outdated; similarly, Alzheimer's Disease Pocketcard and Alzheimer's Exam Review App 2020 have

not been thoroughly evaluated for impact on clinical decision-making or exam performance. Prevention-focused tools such as Alzheimer's Risk Calculator, Dementia Risk Calculator, and Healthy Brains depend on population-based algorithms or proprietary indices that lack clinical validation for individual prognostication, and they may cause unwarranted anxiety or false reassurance, while apps like How to Prevent Alzheimer, Alternative Treatments for Alzheimer's Disease, and Natural Ways to Prevent Alzheimer's Disease sometimes prioritise "natural" or complementary strategies based on weak or insufficient evidence, risking overstatement of benefits or displacement of guideline-based care. News and discussion apps, including AA: Science Hub, Free Alzheimer's and Dementia News, and Dementia News and Chat, often lack transparent editorial standards, formal moderation frameworks, or outcome data, creating potential for information overload or the spread of poorly filtered findings. Environmental design tools—Iridis, Dementia Environment Assessment Tool, Dementia Friendly Home, and The Dementia-Friendly Home are primarily supported by expert consensus and usability studies rather than psychometric validation or controlled trials demonstrating measurable improvements in safety or quality of life. Psychosocial and support platforms such as Deva World, Relish Wellbeing 2.2.0, Dementia CareAssist, DementiAssist, Dementia Emergency, Verily Connect, and Young Onset Dementia (YOD) often depend on sustained digital engagement, adequate literacy, and local infrastructure, which may exclude more vulnerable users; their empirical support is generally limited to small studies, qualitative reports, or early-stage trials.

User-visible governance is similarly thin. As detailed in Table 3, only 11 of 28 RA (39.3%) present an affirmative privacy or consent cue (e.g., App Privacy/Data Safety link or an explicit "no data collected" notice), whereas 17 of 28 (60.7%) are marked "not stated." No app offers an explicit GDPR or HIPAA claim, and disclosures of server location or EHR interoperability are absent. Evaluated against the study's eight-item privacy rubric, evidence in this category reduces to whether a basic notice exists, rather than demonstrating substantive governance.

Reach appears modest where figures are available. Of 28 RA, only six disclose numeric downloads, yielding a combined lower-bound of $\geq$10,194 installs, a median of 75, and a distribution concentrated below 1000 installs (three <100; one 100–999; two 1k–9k). The remaining 22 of 28 (78.6%) provide no figures, precluding reliable aggregation and suggesting reliance on web readership rather than large mobile footprints. Together, these characteristics indicate that RA prioritise low-risk, static knowledge dissemination over scaled, interactive deployment, and they seldom surface the consent mechanisms or regulatory assurances required for higher-risk, data-processing use cases.

In RA (n = 28), verifiable IoT integration is rare: 1/28 (~3.6%) presents a concrete pairing; Dementia Emergency's Apple Watch companion, while the remaining apps report no wearable or home-sensor connectivity. Cost is dominated by free distribution across the catalogue, with only isolated subscription pricing (Iridis at $15.99/month) and no recorded in-app purchases. This profile indicates low-burden, reference-oriented apps with minimal device integration and negligible direct cost to end users.

5.1.2. CTA—19 Apps

Among the 19 CTAs evaluated, the overall MARS mean was 3.80 (SD = 1.01; variance = 1.02), with a median of 3.90, minimum 2.00, maximum 4.90, and a total score range of 2.90; the 95% confidence interval (3.35–4.25) lies entirely above the mid-point of the 1–5 scale, and the coefficient of variation is $\approx$0.27. Taken together, the proximity of mean and median and the moderate dispersion indicate that CTAs cluster in the mid-to-upper quality band, while the wide range reveals substantial variation between individual apps, so they cannot be considered interchangeable. Platform analysis shows that 14/19 CTAs

(≈73.7%) were available on both Google Play and iOS, 4/19 (≈21.1%) were iOS-only, and 1/19 (≈5.3%) was deployed as a research app outside commercial stores, with none Android-only or purely web-based—implying good cross-platform reach but some access bias towards iOS users and research cohorts.

CTAs offer clinically oriented platforms such as Constant Therapy and MindMate, which deliver large libraries of language, memory and executive-function exercises with automated difficulty adaptation and remote monitoring, thereby increasing therapy dose and enabling home-based rehabilitation that would be difficult to achieve with clinic visits alone. Multidomain programs such as Silvia and AMI extend this model by combining cognitive exercises with lifestyle components (physical activity, diet, sleep, stress-management and, in AMI's case, multilingual training), in line with multidomain prevention frameworks, and have reported improvements in proximal outcomes including cognitive test performance, self-reported memory failures, stress, anxiety and health-related quality of life in at-risk older adults. Commercial brain-game ecosystems (Peak, Elevate, Lumosity, Decoder and Memory Matrix) demonstrate that gamified, adaptive tasks can be delivered at scale and can enhance performance in targeted domains such as processing speed and sustained attention in healthy or mildly impaired users. Research- and risk-focused apps (e.g., GameChanger/Mezurio, REACTIVE, BrainSHIELD) exploit smartphones, high-frequency self-administered tasks, and advanced diagnostics to generate digital biomarkers and risk profiles, supporting earlier detection and stratification. Finally, psychosocial and arts-based apps such as SingFit and MEternally, along with narrative or leisure games (e.g., G30—A Memory Maze, Word Search Colourful), broaden the construct of "training" to include engagement, mood, identity and social connection, which are highly relevant to quality of life in people living with dementia.

Limitations include a limited empirical base and are often misaligned with marketing claims. For instance, the more robust studies for Constant Therapy, Silvia, and Decoder/Peak largely involve post-stroke, MCI or generally healthy samples, with very few long-duration trials in people with established dementia, and most outcomes confined to proximal cognitive scores or self-report rather than hard endpoints such as time to institutionalisation, functional independence or caregiver burden. Generic commercial brain-training products (e.g., Elevate, Lumosity, Word Search Colourful, Memory Maze/Matrix) have been repeatedly criticised for overstating benefits; the Lumosity FTC case exemplifies the gap between prevention claims and the modest, task-specific gains actually demonstrated, with limited evidence of generalisation to real-world functioning or disease modification. Many apps in this group are not dementia-specific and are more suitable for people with preserved attention, language, sensory function, and digital literacy. Their interfaces, instructions and cognitive load are frequently unsuitable for individuals with moderate–severe impairment without substantial caregiver mediation. Others (Beat-D, GameChanger, REACTIVE, BrainSHIELD) are fundamentally assessment or environmental-audit platforms rather than therapeutic interventions, yet are conflated with "training," blurring the distinction between measurement and treatment. Across the ecosystem, integration with formal care pathways is minimal, which rarely extends to EHR, multidisciplinary team workflows or personalised care plans. Other limitations include platform restrictions and subscription-based access, which further reinforce inequities.

Across the 19 apps: Ami (Advancing Mental Invigoration), Beat-D, BrainSHIELD, CogniCare, Constant Therapy, Elevate, G30—A Memory Maze, GameChanger, Hello Brain, Lumosity, Memory Matrix, Memory Maze, MEternally, MindMate, Peak, REACTIVE, SingFit, Silvia, and Word Search Colourful, the key limitations cluster around evidence quality, target specificity, and accessibility. For Ami, Silvia, MindMate, Constant Therapy, Peak and SingFit, existing studies are small, often short-term, and focus on intermediate

cognitive or self-reported outcomes, with no robust data that they slow dementia progression or delay loss of functional independence; most work has been conducted in selected, relatively high-functioning cohorts, limiting generalisability. Elevate, Lumosity, Memory Matrix, Memory Maze and Word Search Colourful are generic commercial brain games or word puzzles with little dementia-specific evaluation and, in the case of Lumosity and some "prevent Alzheimer" branding, a history of claims that exceed the available evidence and risk fostering unrealistic expectations. CogniCare, Hello Brain, MEternally, G30 and SingFit are oriented toward carers, lifestyle change, reminiscence, or psychosocial engagement; any cognitive benefits for people with dementia are indirect and unevaluated, and outcomes are often extrapolated from broader lifestyle or music-therapy literature rather than app-specific trials. Across almost all apps, long-term follow-up, head-to-head comparisons with non-digital interventions, and clinically meaningful endpoints (institutionalisation, carer burden, quality-adjusted survival) are lacking, and details of data protection, regulatory status and potential adverse effects (e.g., frustration, over-reliance, inappropriate "prevention" messaging) are seldom systematically reported. Finally, most designs presuppose adequate vision, hearing, literacy, fine motor skills, and access to up-to-date smart devices, which restricts usability in people with moderate–severe dementia and in low-resource or digitally marginalised settings.

Governance signals are shallow but visible for many CTA entries. In Table 3, most listed CTAs expose a basic App Privacy/Data Safety link or policy (e.g., Elevate, G30, Game Changer, Memory Matrix, Memory Maze, Peak, Lumosity, Word Search Colourful), while a minority are "not stated" (e.g., Hello Brain, MEternally). No CTA row shows an explicit GDPR/HIPAA claim, and none disclose server location or EHR interoperability, indicating notice-level transparency without deeper regulatory assertions.

Reach is heavy-tailed where install bands are disclosed. Across CTAs with numeric figures (n = 8/19), the combined lower-bound installs are $\geq$58 million, driven by general-market apps (Elevate 26M; Peak 10M+; Lumosity 10M+; Word Search Colourful 12M+), while dementia-specific entries remain niche (G30 50k; Memory Matrix 10k; Memory Maze 50+; Game Changer 111). Median disclosed installs $\approx$5.0M (IQR $\approx$ 5.1k–11M), reflecting extreme skew. By contrast, RA report few numeric install bands in Table 3, often "not disclosed/not listed," limiting reliable aggregation; where stated, values are small (e.g., YOD 50+).

IoT readiness is sparse: two CTAs advertise Apple Watch integration (Elevate, Peak), while others show no wearable pairing, constraining continuous, context-aware use cases. Monetisation is mixed among CTAs with stated pricing (n = 10/19): free 30% (Game Changer, Hello Brain, Memory Maze), free-with-IAP 20% (Memory Matrix, MEternally), and paid/subscription 50% (Elevate, G30, Peak, Lumosity, Word Search Colourful). Subscriptions typically unlock expanded content, personalised plans, and longitudinal tracking, while one-off paid apps (e.g., G30) grant full access post-purchase. Advertising is rare. The mix concentrates recurring-revenue models in high-reach, general-market apps, with dementia-specific apps skewing free or low cost.

Taken together, the CTA segment shows strong consumer penetration via a few mass-market products, limited IoT enablement, and privacy disclosures that stop at basic notice. For translational value in dementia care, priorities include formal trials against gold-standard measures, first-use consent that names data uses and deletion paths, and explicit regulatory posture and hosting geography, particularly where longitudinal cognitive data are processed.

5.1.3. TA (For PLwD)—18 Apps

Within the TA (PLwD) apps evaluated for people living with dementia TA (PLwD); $n = 18$), the overall MARS mean was 3.83 (SD = 0.86; variance = 0.74), with a median of 3.85, a minimum of 2.50, a maximum of 5.00, a total range of 2.50, and a 95% confidence interval of 3.43–4.23. The close alignment of mean and median, together with a moderate coefficient of variation (≈0.22), indicates a relatively symmetric distribution centred in the upper quality band, suggesting that most TA-PLwD apps achieve broadly "good" quality, while still accommodating a small number of notably lower- and higher-performing outliers. In terms of platform availability, 11 of 18 TA-PLwD apps (61.1%) were available on both Google Play and iOS, 3/18 (16.7%) were iOS-only, 3/18 (16.7%) were Android-only, and 1/18 (5.6%) was delivered as a web-based application, with no TA-PLwD app distributed solely as a research prototype. Taken together, these data position TA (PLwD) as a relatively high-quality, broadly cross-platform subset of dementia apps, designed to provide structured, technology-mediated training to support everyday functioning, memory, and routine management in people already living with dementia.

Across the 18 TA for people living with dementia TA (PLwD), key features cluster around support for everyday functioning, education, and engagement rather than narrow cognitive drills. Several apps (e.g., It's Done!, Memory Clock, MapHabit, RemindMeCare) focus on structuring and cueing daily routines through reminders, visual step-by-step "maps," and remote scheduling of prompts, thereby aiming to support independence and reduce carer supervision. Others primarily deliver training and guidance to carers and professionals: Alzheimer's Daily Companion, Dementia Personal Outcomes v.2, Dementia Training Australia's Behaviours and Medications apps, and Alzheimer's Disease @Point of Care all provide information on responsive behaviours, medication use, person-centred outcomes, and evidence-based management. A further subset targets awareness and experiential understanding: A Walk Through Dementia and Much Too Young VR use immersive media to model lived experience, while Sea Hero Quest captures large-scale spatial navigation data and Spaced Retrieval Therapy translates an established rehabilitation method into a structured, app-based protocol. Some apps, such as ALZ APP, Jigsaw Puzzle Real, Nymbl Training, MEternally-style activity apps, and YuGro Assist App contribute leisure, reminiscence, falls-prevention exercises, and structured wellbeing tracking, collectively illustrating a broad, multidomain approach to supporting PLwD and their carers.

Limitations include sparse empirical evaluation and existing studies, which are also typically small, short-term, and focused on feasibility, usability, or proximal outcomes (e.g., task performance, carer knowledge), with little evidence for sustained effects on functional independence, behavioural symptoms, caregiver burden, institutionalisation, or disease trajectory. Many apps (Elevate-style puzzles, Jigsaw Puzzle Real, ALZ APP) are generic or entertainment-oriented products repurposed for dementia use without dementia-specific design or trials. Several apps rely on relatively complex interfaces, VR hardware, or modern tablets/smartphones and assume adequate vision, hearing, motor skills, and digital literacy, which can exclude those with more advanced cognitive or physical impairment and families in low-resource settings.

From a governance perspective, user-visible safeguards skew toward basic privacy statements rather than comprehensive disclosures: Table 3 shows many TA link to an App Privacy or Data Safety page, yet explicit GDPR or HIPAA assertions, server-location details, EHR interoperability claims, and clear in-app consent flows are "Not stated."

In TA, the reach is to a long-tail market with one outlier. Downloads are predominantly skewed towards high-tech apps ($n = 2$, Jigsaw Puzzle Real at 10 million+ installs and Nymbl Training at 100k downloads), with Mid-scale apps at 10k–99k downloads ($n = 4$, A Walk Through Dementia, Alzheimer's Daily Companion, Memory Clock, and Sea Hero Quest).

Lower-scale apps at 100–9.9k (n = 5) include It's Done! (500+), Spaced Retrieval Therapy (500+), Map Habit (50+), A Simple Day (100+), and ALZ APP (50+).

IoT enablement in TA remains limited. Three of eighteen TA (16.7%) evidence verifiable device pairing, confined to Apple Watch and VR headsets (It's Done! and Sea Hero Quest for watch-based support and Much Too Young Virtual Reality for immersive training and awareness). This profile suggests sporadic, single-device integrations rather than broad wearables or home-sensor interoperability.

As for pricing, the majority (n = 14), 71.4% are free to download, but a smaller subset (21.4%) requires an upfront fee (e.g., It's Done! US $2.99; Jigsaw Puzzle Real US $6.99) or have a recurring paid model without an upfront price (Map Habit). 7.1% are free only via healthcare subsidy (e.g., Nymbl Training). These mixes favour broader access but do not guarantee clinical quality or data protection.

5.1.4. Care (Carer Support Apps)—15 Apps

Within the Care apps category (n = 15), the overall MARS mean was 3.59 (SD = 1.03; variance = 1.06), with a median of 3.60, a minimum of 2.00, a maximum of 5.00, a total range of 3.00 and a 95% confidence interval of 3.07–4.11; the close correspondence between mean and median, together with a moderate coefficient of variation (≈0.29), suggests a roughly symmetric distribution centred in the mid–upper quality band, but with appreciable spread indicating the coexistence of both relatively weak and very high-quality care apps. At a population level, care apps tend to achieve at least acceptable to superior quality, while the wide range cautions against treating individual apps as interchangeable. In terms of platform availability, 6 of 15 care apps (40.0%) were available on both Google Play and iOS, 7/15 (46.7%) were iOS-only, 1/15 (6.7%) was Android-only, and 1/15 (6.7%) was delivered as a web-based application, with no care apps classified as research-only apps, indicating generally good cross-platform coverage but with a marked skew towards the Apple ecosystem.

Dementia "Care" apps are mostly designed to support the caregiving context rather than the person with dementia, covering three broad domains: (1) practical coordination of care, (2) education and decision support, and (3) psychosocial and behavioural support. Coordination apps such as Carely and Lotsa Helping Hands provide shared calendars, activity feeds, and messaging that help distribute tasks (visits, appointments, meals, transport) across family, friends, and sometimes professional staff, reducing reliance on a single primary carer and improving transparency. Educational and clinical-support apps like ConsultGeri: Dementia, Dementia Guide Expert, Accessible Alzheimer's and Dementia Care, Dementia Overview, and dementia-specific stress/distress apps translate professional guidelines and expert knowledge into accessible, point-of-need formats for clinicians and/or family carers. Others, such as Care4Dementia, Dementia Carer Solutions, and Dementia: Understanding Stress and Distress, focus specifically on behavioural and psychological symptoms of dementia (BPSD), providing behaviour descriptions, potential triggers, and non-pharmacological response strategies, which align well with contemporary person-centred care models. Overall, these apps broaden access to structured information, can be carried in the pocket into real-world care situations, and often complement existing training materials from reputable organisations (e.g., professional geriatric societies, dementia research centres, social-care councils).

Limitations include static functionality with long text sections, checklists, or tip libraries with minimal interactivity, personalisation, or integration into care pathways. Few apps capture structured data on symptoms, behaviours, or caregiver burden, and no EHR integration. Additionally, thin empirical evidence base with occasional usability or descriptive reports, and no robust trials evidencing BPSD reduction, or delayed institutionalisation,

or improved carer quality of life, or changes in prescribing and care practices. Furthermore, many apps are either highly professional-facing (e.g., ConsultGeri) or highly generic (e.g., coordination-only apps without dementia-specific content), so they may miss the needs of family carers with limited clinical literacy, or of people with dementia themselves, who often encounter interfaces with small fonts, low contrast, complex navigation, or cognitive load that has not been adapted for impairment.

Within Care apps (n = 15), 7/15 (46.7%) present a user-visible privacy/consent cue, typically an App Privacy/Data Safety panel or linked policy (Accessible Alzheimer's and Dementia Care, ConsultGeri: Dementia, Carely, Care4Dementia, Dementia Guide Expert, Lotsa Helping Hands, Symptom guide Dementia). The remaining 8/15 (53.3%) have not made data protection and privacy standards visible to the users at first use. No listings in this group make explicit GDPR/HIPAA claims, disclose server location, advertise EHR interoperability, state data deletion mechanisms or offer deletion options.

As for the reach, only 4/15 apps disclose numeric installs, yielding a combined lower-bound $\geq$ 25,100 and a median of ~7500 across those with figures. Values are Carely ($\geq$10,000), Care4Dementia ($\geq$100), Dementia Guide Expert ($\geq$5000), and Lotsa Helping Hands ($\geq$10,000). The other 11/15 (73.3%) report "Not disclosed/Not listed," limiting precise aggregation and indicating modest mobile footprints relative to web-first caregiver resources.

IoT integration for Care apps is absent. Free apps account for 14/15 (93.3%), while 1/15 (6.7%) is free-to-download with in-app purchases (Carely). No paid-upfront or subscription pricing is present for Care Apps.

In summary, Caregiver-focused apps (n = 15) emphasise no-cost, low-burden distribution but reveal thin governance and limited scale: fewer than half surface a basic privacy notice, none claim GDPR/HIPAA compliance or EHR connectivity, three-quarters have no visible download data, and none integrate with wearables or home sensors. The cost profile enhances access, yet absent interoperability and sparse disclosures constrain suitability for data-intensive caregiving workflows.

5.1.5. MWA—9 Apps

MWA (n = 9) achieved the highest overall quality ratings on the MARS, with a mean score of 4.14 on a 1–5 scale (median 4.10), indicating that, on average, these apps fall within the "good–very good" quality range. The distribution is relatively narrow (SD 0.67; variance 0.45), with scores spanning from 3.0 to 5.0 and a 95% confidence interval of 3.70–4.58, suggesting both high central tendency and comparatively low dispersion. In practical terms, this implies that most MWA apps deliver consistently strong performance across MARS domains, with few outliers of inferior quality. From a deployment perspective, platform availability is broadly favourable; five of the nine MWA apps are available on both Android and iOS, and the remaining four are iOS-only, with no Android-exclusive, web-only, or research-only apps. This pattern reflects a strong presence on the major commercial app stores, with a slight skew towards the Apple ecosystem, and positions MWA as a relatively mature, high-quality segment of the dementia-related mHealth landscape.

Across the nine MWA, AmuseIT, Calm, Flower Garden, Happify, Headspace, Insight Timer, MindMate, My Reef 3D, and Piano with Songs, several advantages emerge. Collectively, they offer low-barrier, home-based access to a broad spectrum of wellness mechanisms, including guided meditation and mindfulness (Calm, Headspace, Insight Timer), structured positive-psychology and CBT-inspired activities (Happify), dementia-oriented cognitive stimulation and self-management (AmuseIT, MindMate), and calming sensory or leisure experiences (Flower Garden, My Reef 3D, Piano with Songs). Mainstream mental-health apps in this group (Calm, Headspace, Happify) are among the few with

peer-reviewed evidence for reductions in stress, anxiety, and depressive symptoms in general adult samples, while AmuseIT and MindMate are explicitly designed for older adults and people with cognitive impairment, incorporating dementia-friendly interface choices (e.g., high contrast, large buttons, simple flows). Leisure-oriented apps provide visually and/or musically rich activities that support relaxation, engagement, reminiscence, and shared experiences between people with dementia and carers. Taken together, these MWAs broaden the digital toolkit from purely "cognitive training" towards a more holistic focus on mood, engagement, routine support, and subjective well-being.

Limitations of MWA (except AmuseIT and MindMate) include that these apps assume relatively intact attention, language, sensory function, and app-navigation skills. Most apps have complex menus, dense text, or visually busy interfaces that can quickly exceed the cognitive bandwidth of many users with moderate impairment. Evidence for Calm, Headspace, Happify, and Insight Timer comes largely from mid-life, digitally literate populations, with almost no trials in dementia diagnosed participants. For dementia-specific apps (AmuseIT, MindMate) and dementia-recommended leisure apps (Flower Garden, My Reef 3D, Piano with Songs), empirical support is mostly anecdotal or based on tiny feasibility studies, with no robust data on clinically meaningful endpoints such as agitation, quality of life, caregiver burden, or progression. None of these apps integrates deeply with clinical pathways (e.g., shared care plans, clinician dashboards), regulatory status is generally "wellness," and many rely on subscription models or in-app purchases that may limit sustained use in more disadvantaged groups. As a category, MWAs therefore offer promising and often engaging adjuncts for emotional and sensory support, but they should not yet be regarded as evidence-based treatments for dementia-related mental health or behavioural problems.

Data governance is well visible in MWA (n = 9, 100%, 9/9). All nine provide an affirmative user-facing privacy cue via the App Privacy/Data Safety panel or a linked policy (Calm, Headspace, Insight Timer, Happify, Flower Garden, My Reef 3D, Mindmate, Piano with Songs, and AmuseIT). None make explicit GDPR/HIPAA claims, disclose server location, or advertise EHR interoperability, or offer data deletion details, indicating notice-level transparency without deeper regulatory assertions.

Reach is heavy-tailed. Numeric installs are disclosed for 5 of 9 apps (55.6%): two general-market apps account for ≈ 95.14% of disclosed installs (Headspace 39,000,000+; Insight Timer 10,000,000+), and adding Calm (≈2.5 million across stores) lifts the concentration to ≈99.99%. The remaining disclosed apps (Happify (3300) and AmuseIT (500+)) sit orders of magnitude lower. The lower-bound mean across the five with figures is ≈10.30 million, while the median is 2.5 million, confirming a heavy-tailed distribution where a few products dominate reach. Four of nine apps report no download details, but unless their installs are improbably large, the inference largely reflects mainstream wellness platforms rather than dementia-specific adaptations.

IoT connectivity is concentrated in smartwatches. Four of nine MWA (44.4%) show verifiable pairings: Calm supports Apple Watch and Wear OS; Headspace lists Apple Watch; Insight Timer indicates Apple Watch; Flower Garden displays the Apple Watch icon. IoT integrations with fitness-tracker, medical-sensor, smart-speaker, or home-sensor links are lacking, revealing an overall gap towards dementia friendly environments.

Most MWA are monetised: subscriptions 5/9 (55.6%); Calm ($14.99/month), Headspace ($69.99/year), Insight Timer ($59.99/year), Happify ($139/year), Piano with Songs ($69.99/year), with an average listed cost ≈$103.8 per year when Calm is annualised. One-time paid apps are 3/9 (33.3%) at low price points; Flower Garden ($2.99), My Reef 3D ($2.99), and AmuseIT (£3.09). Only 1/9 (11.1%) is free: MindMate. In practice, most apps have recurring fees that require account creation and entail ongoing data retention. This

model incentivises paywalled engagement features and raises equity concerns for carers and PLwD unless costs are subsidised or institutionally covered.

In summary, MWA presents strong surface-level privacy signalling and mid-to-high consumer reach driven by mainstream apps, with moderate watch-based IoT adoption and a predominantly paid/subscription cost structure. The absence of explicit regulatory claims and interoperability disclosures, alongside limited non-watch IoT, suggests high usability and scale but constrained suitability for data-intensive or clinically integrated workflows without additional governance and integration work.

5.1.6. MA—7 Apps

MA apps (n = 7) demonstrated moderate overall quality on the MARS evaluation, with a mean score of 3.69 on a 1–5 scale (median 3.90, SD 1.10, variance 1.21), and observed values ranging from 1.8 to 4.7, the 95% confidence interval for the mean (2.88–4.50) indicates substantial uncertainty around the point estimate, reflecting both the small sample size and considerable heterogeneity in quality. In practical terms, while several MA apps achieve high-quality ratings approaching the "good–very good" range, others fall markedly lower, pulling down the mean and signalling uneven performance across engagement, functionality, aesthetics, and information quality domains. Platform distribution for MA apps is similarly asymmetric: three of seven are available on both Android and iOS, whereas four are iOS-only, with no Android-exclusive, web-only, or research-only MA apps identified. This pattern indicates reasonable but incomplete cross-platform coverage and a skew towards the Apple ecosystem, with implications for accessibility in settings where Android devices predominate.

MA apps show several convergent strengths. Medication-management apps such as Medisafe and Pillboxie exemplify clear, visually intuitive scheduling and reminder paradigms, combining flexible dosing schedules, refill alerts, etc, which support routine formation. Reminiscence and engagement-oriented apps (Memory Lane, GreyMatters, House of Memories, Promenade) leverage structured, high-salience visual and auditory stimuli, such as personal photos, themed image sets, historical objects, and music to scaffold identity, conversation, and interaction, often in formats that can be quickly deployed in care homes or family visits. Several apps are explicitly co-designed or informed by clinical, gerontological, or museum-education expertise, and early evaluations.

Simultaneously, limitations constrain their role as "medical assessment" technologies. With the partial exception of Medisafe and emerging work around Memory Lane, empirical evidence is sparse, methodologically limited (small samples, short follow-up, soft endpoints), and rarely extends to clinical guidelines, cost-effectiveness, or impact on service use. Platform coverage is uneven (several apps are iOS-only or iPad-only), and long-term maintenance is uncertain, raising concerns about sustainability and security. Integration with clinical workflows, EHR, or objective outcome tracking is minimal, and benefits frequently depend on sustained caregiver facilitation and access to compatible hardware. Furthermore, in apps where advanced functionalities are present, such as Timeless's facial-recognition-based identification, they introduce heightened privacy and data-protection risks that are not matched by equally detailed, user-facing governance.

Evidence in MA (MA; n = 7) is basic and user-visible rather than regulatory. Four apps (n = 4, 66.7%) display an App Privacy/Data Safety panel or linked policy (Medisafe, Memory Lane, Pillboxie, and House of Memories), while GreyMatters and Promenade (n = 2, 33.3%) do not share a listed policy. No claims on GDPR/HIPAA compliance, declares server location, or claims EHR interoperability.

Numeric installs are disclosed for three of seven MA apps (42.9%): Medisafe 5,000,000+, Memory Lane 50,000+, and House of Memories 32, yielding a combined lower-bound reach

of ≥5,050,032. The remaining four report no count, limiting aggregation and skewing the distribution toward a single general-market product (Medisafe).

Verifiable pairing is limited to two of seven (28.6%) and centres on lightweight ecosystems: Medisafe connects to Apple Watch companion; Pillboxie connects to iPod touch integration. No other IoT integration was found. Device coverage is therefore narrow and consumer-oriented rather than clinical.

Six of the seven MA have disclosed pricing. Free/no-IAP accounts for 33.3% (2/6; Memory Lane, House of Memories), paid-upfront or subscription for 50.0% (3/6; Pillboxie $1.99, Promenade $4.99, Medisafe $39.99/year), and freemium with in-app purchases for 16.7% (1/6; GreyMatters). This split indicates low direct cost for basic reminiscence apps and a subscription model only, where ongoing adherence features are present.

Collectively, these limitations position MA apps as promising but currently peripheral supports, whose clinical utility and safety will depend on more rigorous validation, clearer regulatory framing, and deeper integration into routine dementia care pathways.

5.1.7. CA—3 Apps

Cognitive Assessment (CA) apps (n = 3) showed relatively high but heterogeneous quality on the MARS, with a mean score of 3.87 on a 1–5 scale (median 3.70, SD 0.76, variance 0.58) and values ranging from 3.2 to 4.7. The corresponding 95% confidence interval for the mean (3.01–4.73) is wide, reflecting both the small sample size and underlying variability, and indicates that while some CA apps approach the superior quality range, others perform more modestly across engagement, functionality, aesthetics, and information domains. From an implementation perspective, platform availability is mixed: two of the three CA apps are available as native Android and iOS applications, while one is a research-only tool without routine app-store deployment. This pattern suggests an emerging but still immature segment, with promising quality signals tempered by limited numbers and incomplete mainstream distribution.

CA apps (n = 3) share several notable strengths. The Memory Clinic app offers a full digital memory clinic workflow from patients' complete structured history and self-administered cognitive testing from at home, where relatives can provide informant reports, and results feed into nursing and physician-led consultations, all within a CE-marked, GDPR-compliant framework. Geras Solutions Cognitive Test (GSCT) itself has been validated against MoCA in memory clinic and community samples, with good sensitivity and specificity for cognitive impairment, demonstrating that clinically meaningful assessment can be delivered via smartphone/tablet outside traditional clinic settings. PRODEMOS complements this by focusing on multidomain risk profiling and modification as it delivers an app-based self-management of vascular and lifestyle risk factors, supported by remote health coaches and a dedicated research/assessor portal, which has shown statistically significant improvements in dementia risk scores in a large international RCT. Together, these apps illustrate a category that is comparatively evidence-rich, clinically oriented, and well-integrated with professional workflows, using validated instruments, structured portals for clinicians, researchers, and secure data handling to support remote cognitive and risk assessment at scale.

Limitation such as the evidence for The Memory Clinic's cognitive test is drawn largely from Swedish cohorts and early-phase studies, so generalisability to other languages, health systems, and lower-literacy or more diverse populations remains uncertain. Long-term effects on time to diagnosis, treatment decisions, and outcomes are limited. PRODEMOS, though rigorously evaluated, primarily demonstrates modest changes in risk score rather than incident dementia or cognitive decline, with substantial recruitment and retention challenges in underserved groups and heavy dependence on smartphone access, digital

literacy, and coach capacity. Both systems are embedded in specific national and research infrastructures, limiting immediate transferability and routine availability outside trial or contracted settings.

CA Apps are developed to evaluate cognitive function using structured screening apps or self-administered checklists. These applications are intended for early detection of cognitive impairment and monitoring progression over time, often relying on metrics like memory recall, attention span, or visuospatial ability. Some apps are modelled after validated neuropsychological tests, while others are used in research contexts, such as clinical trials for dementia prevention. These apps are especially valuable for HCPs and researchers, though they may also be utilised by individuals at risk or their families as a preliminary self-assessment instrument. Their limited availability is a major concern given the emphasis on early diagnosis in dementia care guidelines, underscoring the need for more robust, validated, and clinician-endorsed digital screening solutions.

Two of three apps provide an affirmative user-visible privacy/consent cue: ASZHWELL and The Memory Clinic. None of the three entries declares GDPR/HIPAA compliance, server location, or EHR interoperability. This pattern indicates surface-level privacy signalling without explicit regulatory claims in a category that can capture sensitive cognitive data.

Numeric installs are disclosed for 1 of 3 apps (ASZHWELL 10k installs). Verified device pairing appears in 1 of 3 apps (ASZHWELL integrates "medication dispensers and wearables). The Memory Clinic and PRODEMOS show no wearable or home-sensor connectivity. This points to early, device-adjacent experimentation in CA, but not yet a consistent pipeline for sensor-informed assessments.

Free distribution accounts for 66.7% ($n = 2/3$). The Memory Clinic (free) and PRODEMOS (free for trial participants). Paid is 33.3% ($n = 1/3$) ASZHWELL at $7.99. No in-app purchases or subscriptions are present, implying low direct cost but also few monetised feature tiers.

Collectively, this signals a nascent market segment with constrained scale, minimal device integration, and governance disclosures that stop short of formal compliance claims; an evidence-sensitive gap given the clinical ambitions of CA.

5.1.8. FA (For Elders)—1 App

Fitness applications, particularly in older adults, in the preliminary stages of physical decline, constitute a growing domain within mobile health, promoting physical activity and mobility, which are both essential to dementia prevention and symptom management. These platforms often incorporate dual-task training, integrating physical and cognitive exercises shown to enhance motor coordination and neurocognitive function. Although only a limited number of mobile apps are explicitly designed for individuals with dementia, these apps demonstrate promise for older adults and at-risk populations by supporting fall prevention, cardiovascular health, and routine engagements, all factors directly and indirectly benefiting cognitive well-being. However, the unsupervised use of such applications raises important safety concerns. Individuals with cognitive impairment may be susceptible to falls, overexertion, or misuse, particularly in the absence of clinical oversight. Given these risks, the integration of FA into dementia care should be approached cautiously, emphasising supervised implementation and the inclusion of safety features tailored to the functional limitations of this population.

FA for seniors are represented by a single product, Sworkit. It provides a basic App Privacy/Data Safety notice but no explicit GDPR/HIPAA claims, no server-location disclosure, and no EHR interoperability. Reported reach is high at $\geq$15,000,000 installs. IoT

pairing is present with Apple Watch, Fitbit, and Google Fit. Pricing is subscription-only at $59.99 per year.

Overall, Sworkit pairs a strong consumer reach with watch and tracker connectivity. Regulatory signalling is limited, and clinical integration is minimal; therefore, use in dementia care should be supervised. Supervision should include brief pre-participation screening for falls and cardiovascular risk and caregiver oversight of progression.

5.2. Combined Analysis

Across categories, MARS scores indicated generally moderate-to-good quality, with important variation in central tendency and precision. RA had the lowest mean score (3.26; 95% CI 2.87–3.65), consistent with a broad spread that included a substantial proportion of lower-rated apps. CTA; mean 3.80, (95% CI 3.35–4.25), TA (PLwD); 3.83, (95% CI 3.43–4.23), Care apps (95% CI 3.59–3.07–4.11), MA; 3.69, (95% CI 2.88–4.50), and CA; 3.87, (95% CI 3.01–4.73) all clustered in a similar mid-to-upper range, with overlapping confidence intervals that suggest broadly comparable perceived quality. MWA showed the highest mean score among multi-app categories (4.14, 95% CI 3.70–4.58), with a confidence interval that did not overlap that of RA, indicating a materially higher average rating. FA achieved a mean of 4.70, but this estimate is based on a single app (n = 1) and should be interpreted cautiously. Overall, these patterns point to relatively stronger user-perceived quality for wellbeing- and assessment-focused apps, with RAs occupying the lower end of the quality spectrum.

Reach is highly heterogeneous and often poorly documented across categories. Among (RA), only 6/28 disclose downloads, giving a combined lower-bound of $\geq$10,194 installs with a median of 75 and most apps below 1000 installs, suggesting niche uptake. For (CTA), 8/19 with data yield $\geq$58 million installs, driven almost entirely by mainstream products (e.g., Elevate, Peak, Lumosity, Word Search Colourful), while dementia-specific apps remain in the tens to low tens of thousands. TA (PLwD) shows a long-tail profile with one very high-volume outlier (Jigsaw Puzzle Real, 10M+), a few mid-scale apps (e.g., Nymbl Training, 100k) and many dementia-focused apps in the 100–9.9k range. Care apps (4/15 with data) reach a combined $\geq$25,100 installs with a median around 7500. Mental Wellbeing Apps (MWA) are dominated by Headspace, Insight Timer and Calm (all $\geq$ 10M), and MA by Medisafe ($\geq$5M), while CA remains nascent, with only one app (ASZHWELL) reporting ~10k installs.

This pattern underscores a stark contrast between mainstream, general-market platforms and dementia-specific applications. High headlines install counts for CTA, MWA, and MA are largely attributable to a small number of non–non-dementia-specific products, whereas dementia-focused apps in RA, TA, Care, and CA tend to have modest or unreported mobile footprints. Inference is further constrained by extensive non-disclosure of download bands (e.g., 22/28 RA, 11/15 Care, 4/9 MWA, 4/7 MA), reliance on lower-bound store thresholds rather than exact counts, and the absence of data on active users, retention or engagement, all of which limit the validity of cross-category comparisons and may mask important equity gaps. The emerging picture is of an ecosystem where dementia care increasingly depends, in practice, on a small number of large, generic mHealth platforms, while purpose-built dementia apps remain low-visibility and sparsely adopted, thus raising questions about discoverability, sustainability, and the real-world population impact of the dementia-specific digital tools.

Across categories, IoT implementation is sparse, fragmented, and heavily concentrated around consumer wearables rather than dementia-specific sensing ecosystems. In RAs (n = 28), only one application, Dementia Emergency, offers verifiable pairing with Apple Watch, while no other apps report wearable or home-sensor connectivity. CTA shows a

similarly narrow profile, with just two general-market apps (Elevate and Peak) advertising Apple Watch integration. TA apps for people living with dementia (n = 18) demonstrate slightly higher but still limited enablement: three apps pair with Apple Watch or VR headsets (It's Done!, Sea Hero Quest, Much Too Young Virtual Reality), indicating sporadic, single-device use rather than systematic exploitation of sensor data. Care apps show no IoT integration at all. MWA has the most visible activity, but still in a constrained form: four of nine (Calm, Headspace, Insight Timer, Flower Garden) link to Apple Watch and/or Wear OS, again privileging mainstream smartwatch ecosystems. MA apps show pairing in only two of seven apps (Medisafe with Apple Watch; Pillboxie with iPod touch–style functionality), and CA apps reveal early experimentation in a single case (ASZHWELL linking to medication dispensers and wearables) without broader home- or clinic-based sensor networks. Overall, IoT is treated as a peripheral, consumer-wearable add-on rather than a core design principle, largely limited to smartwatch-based notifications or lightweight interaction. This pattern underscores a substantial missed opportunity to build sensor-informed, context-aware, and proactive support across the dementia app ecosystem.

Across app categories, cost models showed marked variation in the balance between free and paid dementia-related applications (Figure 4). Overall, two-thirds of apps were free (68/100), but this pattern was not uniform. RA were predominantly free (26/28), with only Iridis and Relish Wellbeing 2.0 requiring payment, and the remaining 26 apps available at no cost. Carer-focused apps (Care) showed a similar pattern, with just one paid app (Carely) and fourteen other carer-support apps offered free of charge. TA also skewed free (13/18), with five paid products (It's Done!, Jigsaw Puzzle Real, Map Habit, RemindMeCare, and Spaced Retrieval Therapy) alongside 13 free TA. In contrast, CTA and MWA were largely monetised: all 10 paid CTAs (Constant Therapy, Elevate, G30—A Memory Maze, Lumosity, Memory Matrix, MEternally, Peak, SingFit, Silvia App, and Word Search Colourful) outnumbered the nine free CTAs, while eight of nine MWAs (AmuseIT, Calm, Flower Garden, Happify, Headspace, Insight Timer, My Reef 3D, and Piano with songs) were paid, with only one free option. MA similarly showed a higher proportion of paid offerings, with GreyMatters, Medisafe, Pillboxie, and Promenade monetised (4/7), and three additional MA apps available for free. CA apps and FA were mostly or exclusively paid for; three CA apps, only ASZHWELL was monetised (1/3), and the single Fitness App, Sworkit, was also paid. This distribution indicates that informational and carer-support resources are more likely to be freely accessible, whereas interactive, training, wellness, and assessment functionalities are more frequently tied to paid or revenue-generating models.

The analysed mobile applications span a wide spectrum of functional categories, with RA representing the largest segment, comprising 28 applications. This is followed by CTA (19 apps) and TA (18 apps), while Carer Support Applications (Care) account for 15 apps. The prominence of RA and Care categories underscores the prevailing emphasis on knowledge dissemination, psychosocial support, and care coordination for individuals affected by dementia and their informal support networks. By contrast, CTA and TA categories are oriented towards mitigating neurocognitive decline and reinforcing procedural competencies through structured stimulation and guided behavioural interventions, respectively. Despite their clinical relevance, MA and CA apps remain markedly underrepresented, with only seven and three applications, respectively. These apps are essential for aiding memory retention and facilitating early detection of cognitive impairment, which are cornerstones of proactive dementia management. The relative scarcity of applications in these categories indicates a pressing need for innovation, particularly in the development of AI-enabled, user-personalised memory supports and scalable cognitive screening technologies.

From an end-user perspective, most applications are directed toward carers and patients, reflecting the shift toward empowering informal care ecosystems and promoting

patient engagement through accessible mobile solutions. Carer-focused apps (Care category) support emotional resilience, care coordination, and daily task management, while CTA, TA, and MA apps primarily target individuals living with dementia, particularly in early to mid-stages. Table 9 presents an overview of the targeted dementia trajectory.

Table 9. Apps for key end-users across the dementia trajectory.

Category	Primary Focus	Key End-Users	Dementia Stage Focus
RA (28)	Education/information/Resources	Public, carers, family	All stages
CTA (19)	Cognitive stimulation	At-risk, early-stage	Early to mid
TA (18)	Training/skills for PLwD	Carers, PLwD, family members, community support	All stages
Care (15)	Caregiving support, routines, strategy, connections	Informal carers, family members, support staff	All stages
MWA (9)	Relaxation, calmness, Emotional wellness, Focused attention	Public, PLwD, carers, family members	All stages
MA (7)	Memory support, routines, reminders	PLwD, carers, family members	Early to mid
CA (3)	Cognitive screening	PLwD, HCPs,	Preclinical to early
FA (1)	Physical health	PLwD, Carers, Family members, Community support staff	Prevention/early

Additionally, while increasing attention has been given to modifiable risk factors in dementia prevention, Mental Wellness Applications (MWA, 9 apps) and Fitness Applications for Seniors (FA, 1 app) remain sparse. Given the growing evidence linking physical activity, mindfulness, and emotional regulation to reduced dementia risk and improved quality of life, these domains represent important but underdeveloped areas within the current app landscape.

5.3. Limitations of the Apps Assessment

This review provides a time-bound snapshot of English-language iOS and Android apps; store listings, features, and policies may have changed since assessment. Identification relied on simple, platform-native search queries rather than exhaustive Boolean strategies, so omissions are possible. Evaluation of privacy and governance drew exclusively from user-visible materials (App Privacy/Data Safety panels, linked policies, and in-app notices) and was not a legal or technical audit. IoT capability was credited only when an explicit companion app, named device, or pairing interface was demonstrable, a conservative criterion that may undercount connectivity.

Download metrics were constrained by platform reporting. iOS does not disclose install counts, and Google Play provides only banded ranges rather than exact values. Consequently, analyses emphasised aggregate lower bounds rather than precise totals or comparable central tendencies.

Algorithmic transparency was limited across commercially available dementia-related apps. Detailed information on model architecture, training data, or decision logic was rarely disclosed and is not generally required for non–non-medical-device software. Most listings provided only high-level statements about data use or “personalisation,” precluding robust appraisal of algorithmic processes. Given this paucity, algorithmic transparency was not

coded in Table 3 and is instead considered qualitatively as a conceptual and ethical issue, distinct from the objectively verifiable features used in the analysis.

Usability characteristics were not comprehensively codified. Attributes such as error tolerance, navigational complexity, and text size/contrast are evaluator-dependent and device-specific, limiting objectivity and reproducibility; accordingly, these features were not coded in Table 3. The quantitative analysis was confined to verifiable, standardised indicators, while interface-level usability issues are addressed qualitatively in the narrative synthesis.

Taking it all together, this review reveals several critical deficiencies in the digital dementia ecosystem. The paucity of CA apps, limited development of memory aid technologies, and the marginal availability of clinician-oriented apps suggest an urgent need for more comprehensive and clinically integrated digital health solutions. In parallel, the underrepresentation of wellness and fitness interventions calls for a broader conceptualisation of dementia care; one that integrates not only symptom management but also preventive and lifestyle-based strategies to support cognitive health across the ageing continuum.

6. Digital Applications for Achieving Dementia-Friendly Environments

Designing dementia-friendly environments is an increasingly interdisciplinary endeavour, combining insights from cognitive science, architecture, and digital innovation. Recent advances in smart technologies, IoT, AI, and emotional computing are enhancing the adaptability, safety, and emotional resonance of living spaces for individuals with dementia. Grounded in the principles of cognitive architecture and biophilic design, these digital applications strive to create environments that foster autonomy, reduce stress, and improve the overall quality of life [19].

6.1. Cognitive and Architectural Foundations of Dementia-Friendly Design

The foundation of dementia-supportive environments lies in cognitive architecture, which postulates that spatial design profoundly influences psychological responses such as attention, stress, and emotional regulation. Architectural elements such as natural lighting, rhythmic patterns, colour schemes, and biophilic features are not merely aesthetic but also serve as cognitive scaffolds for people experiencing memory loss or perceptual difficulties. These strategies align closely with evolutionary psychology, highlighting humans' intrinsic preference for environments that feel safe and familiar [18,19].

As digital apps permeate these design paradigms, they extend the reach of inclusive architecture into virtual, hybrid, and intelligent systems. Smart city infrastructures and universal design principles are increasingly harnessed to bridge physical and cognitive gaps for people with dementia [66]. Accessibility is now viewed as a primary design criterion rather than an afterthought, accommodating a broad spectrum of users with differing literacy levels, technological familiarity, and cultural needs [67].

6.2. Assistive Robotics and Wearable Technologies

Robotic systems and wearable devices are gaining traction as integral components of dementia care. These technologies collect vital data such as heart rate, sleep cycles, and movement patterns, and relay this information to carers or AI platforms for further analysis. The integration of spatial sensors with mobile robots enables intuitive human–machine interaction for physical activity, therapy, and emotional stimulation [19,68].

The therapeutic potential of robots in dementia care is supported by biometric studies showing that such interactions enhance engagement and emotional stability in elderly users. Additionally, user-centred initiatives like the PASSO project have introduced multisensory rehabilitation devices for mobility-impaired users, particularly those with Parkinson's

disease, showing the broader applicability of these tools across age-related conditions [69]. Indoor acoustic optimisation, originally studied in the context of autism spectrum disorder, has also informed the development of sensor-integrated spaces that reduce auditory stress, benefiting dementia patients in both residential and institutional settings [70].

6.3. Intelligent Environments and Emotional Responsiveness

Smart buildings equipped with AI, sensor arrays, and adaptive controls are transforming dementia care by enabling real-time interaction between users and their surroundings. Neuroadaptive architecture, a concept that merges neuroscience with responsive design, employs subtle biofeedback systems to monitor mental states and adjust environmental factors like lighting, acoustics, or temperature accordingly [26,71]. This creates environments that are not only physically accommodating but also emotionally intelligent.

Active Assisted Living (AAL) systems take this a step further by integrating behaviour detection and cognitive support tools directly into residential spaces. Moving beyond passive monitoring, these systems now feature active feedback mechanisms that learn from behavioural patterns to prevent risk and enhance comfort. For example, sensor-based monitoring can detect restlessness or changes in movement patterns that often precede cognitive decline [19,21].

Moreover, emotional computing is expanding the boundaries of user-centred design. Technologies that respond to affective states, such as mood-driven lighting, adaptive audio environments, and AI chatbots, enhance psychological well-being and social connectedness [72,73]. These tools are especially beneficial for users who face difficulties in sensory processing, as is common in dementia and other cognitive conditions [74].

Remote health assessment systems have become foundational in managing dementia-related symptoms, especially considering global ageing trends. Smart homes now serve as dynamic platforms that support not just physical safety but also psychological and functional independence [22]. Wearable health monitors and brain–computer interfaces offer real-time feedback that carers can use to make informed decisions about care and intervention strategies [75].

Digital twins: virtual models of patient journeys, are emerging as powerful tools for understanding individual responses to treatment and environment. By integrating multimodal data sources, these AI-powered systems allow clinicians to simulate outcomes, adjust treatment plans, and address issues of trust and personalisation in technological care [73].

Participatory design frameworks are essential in aligning these innovations with real-world needs. Co-design with patients, carers, and HCP ensures that emerging technologies are both ethically grounded and practically viable.

6.4. Virtual and Augmented Reality for Cognitive Engagement

Virtual and Augmented Reality (VR/AR) technologies are redefining spatial and emotional experiences in dementia care. Simulations of familiar environments like childhood homes or historical landmarks can stimulate autobiographical memory and support emotional well-being [4,76]. The Adaptive Virtual Neural Architecture (AVN) model, for instance, provides immersive experiences that respond to users' emotional and cognitive states, promoting deeper engagement and recall [77].

AR systems such as NavMarkAR help reduce spatial disorientation by overlaying visual markers in real-world environments, significantly enhancing user autonomy [23,24,78]. Meanwhile, custom VR environments allow patients to practice routine tasks, like cooking or navigating hallways, within safe, controlled simulations [24,78].

Multisensory interaction is vital in maintaining emotional balance and spatial awareness for people with dementia. Integrating sensory elements such as lighting, texture, and scent aligns with biophilic design principles and has been shown to improve spatial orientation and reduce anxiety [25].

These sensory systems now work in tandem with AI and machine learning algorithms to create personalised, context-aware experiences. Emotion-sensing tools monitor facial expressions, speech patterns, and body movements to adjust the environment dynamically, offering real-time support in response to emotional shifts [79].

7. Opportunities, Challenges and Future Directions

The digital transformation of dementia care presents significant opportunities to enhance early detection, self-management, and carer support through scalable, accessible mHealth applications. These tools, particularly when integrated into everyday devices like smartphones, can expand care beyond institutional boundaries, addressing disparities in access, especially in underserved or rural areas.

Key opportunities lie in the use of AI and adaptive algorithms for personalised interventions. Emerging models can dynamically adjust task difficulty, monitor behavioural changes, and generate predictive insights for risk mitigation (e.g., wandering or medication non-adherence). Moreover, combining cognitive training, behavioural tracking, and educational content into unified platforms could support holistic, continuous care across the dementia trajectory. Advances in gamification, voice-assisted navigation, and culturally adaptive design further improve engagement among diverse ageing populations.

However, critical challenges persist. Many apps remain functionally fragmented, targeting narrow aspects of dementia care without offering integrated, end-to-end solutions. This compartmentalisation increases cognitive and logistical load for users and carers, often reducing adherence. Furthermore, clinical validation remains inconsistent; numerous apps lack evidence-based development or comparative testing against gold-standard assessments like MMSE or MoCA, raising concerns about diagnostic accuracy and utility [80].

Ethical concerns are paramount, particularly regarding informed consent, data privacy, and algorithmic transparency in a cognitively vulnerable population. Despite progress, many apps fall short of meeting data protection standards such as GDPR or HIPAA [81] compliance. Usability is also a limiting factor; apps often neglect inclusive design, limiting accessibility for users with sensory or motor impairments [82].

Future development must prioritise co-design with users, clinical validation through rigorous trials, and regulatory oversight to distinguish clinically meaningful tools from unvetted products. Emphasis should be placed on building interoperable platforms that support data exchange with EHR, enhancing continuity between informal and formal care. Expanding innovation into currently underserved domains such as emotional wellness, physical activity, and late-stage support is also crucial, given their proven impact on quality of life [83–85].

Lastly, digital equity must guide future directions. To ensure global relevance, developers should prioritise multilingual support, low-bandwidth functionality, and culturally sensitive content. By addressing fragmentation, ethical compliance, and inclusivity, digital applications can evolve into central components of a resilient, person-centred dementia care ecosystem.

8. Conclusions

This comprehensive review of the digital dementia care landscape reveals a rapidly evolving but fragmented ecosystem of mobile health applications. The analysis of

100 dementia-related apps across multiple categories demonstrates both the promise and limitations of current digital interventions in addressing the complex needs of individuals with dementia, their carers, and HCP.

The dominance of RA (28 apps) and prevalence of Carer Support tools (15 apps) reflect the sector's emphasis on information dissemination and psychosocial support, acknowledging the critical role of informal care networks. However, significant gaps persist in essential domains. The underrepresentation of MA (7 apps) and CA apps (3 apps) is particularly concerning, given their fundamental importance in supporting daily functioning and enabling early detection, cornerstones of effective dementia management.

The review highlights a critical disconnect between technological potential and clinical integration. While CTA (19 apps) is abundant, many lack rigorous validation against established neuropsychological assessments, raising questions about their clinical utility.

Emerging opportunities in AI adaptive algorithms and integrated platforms offer pathways toward more personalised, responsive care solutions. The potential for smart environments, assistive robotics, and virtual reality interventions presents exciting possibilities for creating truly dementia-friendly ecosystems that extend beyond traditional clinical boundaries.

However, realising this potential requires addressing fundamental challenges in fragmentation, clinical validation, and ethical compliance. The current landscape's compartmentalised approach increases user burden and reduces adherence, while inconsistent evidence bases undermine confidence in digital interventions. Privacy concerns and accessibility barriers further limit adoption among vulnerable populations.

Future development must prioritise co-design methodologies, rigorous clinical validation, and regulatory oversight to distinguish meaningful innovations from unvetted products. Emphasis on interoperability, inclusive design, and digital equity will be essential for creating sustainable, person-centred solutions that truly enhance quality of life across the dementia trajectory.

The transformation of dementia care through digital innovation holds immense promise, but success depends on bridging the gap between technological capability and clinical need through evidence-based, ethically grounded, and user-centred development approaches.

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Abbreviations

The following abbreviations are used in this manuscript:

CDSS	Clinical Decision Support System
iOS	Apple App Store
Android	Google Play Store
IoT	Internet of Things
AI	artificial intelligence
AAL	Ambient Assisted Living
AVN	Adaptive Virtual Neural Architecture

MARS	Mobile App Rating Scale
MCI	Mild Cognitive Impairment
TA	Training App
Care	Focus is on carers
RA	Resource App
CTA	Cognitive Training App
MWA	Mental Wellness Apps
CA	Cognitive Assessment
MA	Memory Aids
HCP	Healthcare Professionals
FA	Fitness Apps
PLwD	People Living with Dementia
mHealth	Mobile Health

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