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A decade of apps for ADHD management: a scoping review

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ABSTRACT

Attention Deficit Hyperactivity Disorder (ADHD) is a prevalent neurodevelopmental disorder typically treated with pharmacotherapy; alternatives such as mobile apps have emerged to support individuals with ADHD. This review utilised the Arksey and O'Malley scoping framework to assess mobile apps for ADHD, examining their characteristics, target users, treatment modalities, techniques, gamification elements, and medical endorsements. We analyzed records from the past decade (2013–2023) across eight digital libraries and two virtual app stores (Google Play Store and Apple's App Store). From 3,474 potentially relevant apps, 46 were analyzed and categorised as commercial or non-commercial, and categorised into video game and non-video game mobile apps. Addressing four primary research questions, the study revealed significant insights: 29.7% of ADHD mobile apps that focused on cognitive treatment, 14.8% aided clinical diagnosis, and cognitive (13.66%) and executive functions (11.8%) techniques were the most commonly prioritised treatment methods. Notably, only two of the 35 commercial mobile apps received medical endorsements, while levels and statistics emerged as the most popular gamification elements. Therefore, this study highlights the widespread availability of mobile mental health apps for individuals with ADHD and their caregivers and underscores the need for future research to integrate mobile apps into ADHD diagnosis and treatment.

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ADHD; biofeedback; digital therapeutics; human-computer interaction; mobile apps; video games

1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a prevailing neurodevelopmental condition that impacts approximately 5% of children (Sayal et al. 2018). This disorder is defined by persistent symptoms of inattention or hyperactivity-impulsivity, extending into adolescence and adulthood (Krause et al. 2006). ADHD has a significant impact on both individuals and their families (Zhao et al. 2019). Although diagnostic methods have evolved, clinical assessment by a specialist remains the primary approach, adhering to DSM-5 criteria (Weis, Till, and Erickson 2017). The current ADHD diagnostic approach entails assessing medical history, school performance, and conducting a physical examination (Wolraich et al. 2019) on the patient – with vital signs, motor coordination, and neurologic functions being evaluated.

Early ADHD diagnosis gives patients access to appropriate clinical interventions or treatment modalities. In psychology, treatment modalities refer to the various therapeutic approaches and methods used by mental health professionals to address individuals' psychological, emotional, and behavioural issues. These modalities are designed to help individuals improve their mental well-being, cope with distressing symptoms, and enhance their overall quality of life. As for ADHD treatment, pharmacotherapy guidelines (Overview) recommend both stimulant and non-stimulant medications; however, these treatments are constrained by side effects, administration challenges, and limited efficacy in alleviating daily impairments (Weiss et al. 2018). Consequently, various non-pharmacological interventions have emerged (Caye et al. 2019; Guo, Assumpcao, and Hu 2022; Lambez et al. 2020; Moore et al. 2019; Núñez-Jaramillo, Herrera-Solís, and Herrera-Morales 2021; Ogundele and Ayyash 2023; Russell et al. 2021), encompassing psychosocial, body-centered, neurocognitive, and cognitive-behavioural approaches.

Recent technological advancements have facilitated the integration of technology into various aspects of human life. Technological innovations, including eye tracking, brain-computer interfaces, computer software, internet-based therapies, computer games, and mobile applications, have been applied to the identification

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and treatment of ADHD (Kollins et al. 2021). Clinical management of ADHD often involves a combination of pharmacological and non-pharmacological approaches tailored to the patient's age, symptom severity, and needs (National Institute for Health and Care Excellence 2018). Hence, incorporating mobile apps and video games into existing ADHD interventions is a promising and flexible alternative to diagnose and treat this condition, as it allows for a multimodal approach alongside traditional identification and treatment methods.

Extending this perspective, research on collaborative technologies for neurodivergent children has emphasised the significance of inclusive and participatory design processes. Baykal, Van Mechelen, and Eriksson (2020) conducted a review of 35 articles from 1992 to 2019, revealing the prevalence of tangible and embodied interaction technologies and emphasising the need for standardised evaluation criteria and inclusive studies. Similarly, Börjesson et al. (2015) conducted a review of 88 studies from 1995 to 2014, identifying a lack of participatory design processes and advocating for the involvement of children with diverse developmental conditions to ensure effective and user-friendly technology products. In their review of 66 publications from 2005 to 2019, Spiel and Gerling (2021) identified the prevalence of the medical model of disability in Human-Computer Interaction (HCI) games and recommended a shift towards participatory design that incorporates neurodivergent perspectives. Furthermore, Stefanidi et al. (2023) examined 185 papers, spanning from 1990 to 2017, which focused on the agency of autistic children in technology research. They identified significant gaps in how the agency of autistic children is conceptualised and called for improved methodological clarity and inclusive approaches that value autistic perspectives. Finally, Stefanidi et al. (2023) conducted a comprehensive review of 189 literature reviews in HCI from 1982 to 2022. This review provided a detailed analysis of the types of contributions and identified methodological gaps. Additionally, it proposed future opportunities for meta-work in HCI, such as improved reporting standards and clearer terminologies. In conclusion, these studies emphasise the significance of inclusive and participatory design processes and comprehensive evaluation frameworks for the effective design and evaluation of ADHD mobile apps. These frameworks are crucial for ensuring that mobile apps meet the specific needs and preferences of children with ADHD, thus fostering better engagement and outcomes.

These findings are particularly relevant given the numerous reviews examining the use of technologies for ADHD identification and treatment. Powell, Parker, and Harpin (2018) conducted a systematic review (2012–2017) of 14 papers, highlighting the use of mobile apps, computer software, games, tablets, and Wii remotes in ADHD management for individuals under 18. Another review by Guan Lim, Lim-Ashworth, and Fung (2020) (2019–2020) identified technologies like Xbox Kinect, brain-based computer interface, and internet therapies. Păsărelu, Andersson, and Dobrean (2020) reviewed 109 mobile apps (2017–2019) for ADHD assessment and treatment, finding limited empirical support. Peñuelas-Calvo et al. (2022) reviewed 22 papers (2017–2019) on video game-based interventions for children with ADHD, mostly using PCs. Cibrian et al. (2022) analyzed 36 papers from 2004 to 2020. Despite the long period covered, this review does not exclusively focus on mobile apps for ADHD self-regulation but encompasses different types of technologies (e.g. computers, mobile devices, wearables). Jiang et al. (2022) evaluated the use of mobile gaming apps for ADHD treatment across 19 studies (2011–2022). Stefanidi et al. (2022) reviewed 27 papers (no specified period) on ADHD-related HCI systems. Other non-systematic reviews exist (Pandian et al. 2021; Tsakou and Drigas 2022), while the remaining reviews are generally focused on mental disorders rather than ADHD (Chan and Honey 2022; Domínguez-Lucio et al. 2023; Jones, Morris, and Deruyter 2018; Oudshoorn et al. 2020; Tsikinas and Xinogalos 2019; Valentine et al. 2020; Welch et al. 2022).

Our paper offers a comprehensive analysis of mobile apps for ADHD management, providing a perspective that encompasses both commercial and non-commercial apps. The following six areas are examined: (1) functionalities, (2) treatment modalities, (3) treatment or screening techniques, (4) medical endorsement, (5) mobile app preference, and (6) challenges and future directions. Our review encompasses papers published between 2013 and 2023, offering a comprehensive analysis pertinent to clinical practice and ADHD research. This approach provides a more comprehensive view of the role of mobile apps in therapeutic interventions and early detection of ADHD, which may contribute to more effective management strategies.

While previous literature has documented the benefits of emerging technologies and made important contributions, there is still scope for a more detailed examination of the functionalities of mobile apps. Our review complements these works by analyzing non-pharmacological treatment modalities, such as clinical diagnostic tools, organisational strategies, behavioural interventions, parent training, and social skills development. In addition, we examined techniques such as

cognitive training, biofeedback, and cognitive behavioral therapy (CBT) and provided a detailed analysis of the therapeutic potential of various mobile apps. We also highlighted the role of healthcare professionals, therapists, and clinicians in supporting these mobile apps to improve their acceptance and reliability. Furthermore, we analyzed the integration of gamification elements in five dimensions: performance, ecological, social, personal, and fictional, to improve user engagement and treatment adherence.

The remainder of this article is structured as follows: Section 2 describes the research methodology, section 3 presents the results, and section 4 discusses the findings, challenges, and trends. Section 5 describes the limitations of this review, and section 6 includes our concluding remarks.

2. Research methodology

Scoping reviews are a valuable research method for rapidly collecting, synthesising, and evaluating data and identifying gaps in various research fields (Munn et al. 2018). Our review of current mobile apps for ADHD support is based on Arksey and O'Malley's (2005) methodological framework for scoping reviews but also considers Levac's recommendations (Levac, Colquhoun, and O'Brien 2010). We also follow the PRISMA model, as originally proposed by Moher et al. (2009), for reporting systematic reviews and meta-analyses, along with its PRISMA-ScR extension. Our findings are structured per the recommendations of Tricco et al. (2018). Our review has five phases: (1) identification of research questions, (2) identification of relevant studies, (3) selection of pertinent studies, (4) data charting, and (5) collation, summarisation, and communication of the results.

2.1. Research questions and motivation

Table 1 presents the four questions behind this research along with their corresponding motivations.

Table 1. Research questions and motivations.

Question ID	Question	Motivation
RQ1	What treatment modalities are employed in mobile apps that manage ADHD?	To identify the primary treatment modalities featured in ADHD mobile apps.
RQ2	What treatment techniques are commonly utilised by ADHD mobile apps?	To identify the main treatment techniques used in ADHD mobile apps.
RQ3	Which ADHD mobile apps are endorsed by healthcare providers, therapists, and/or physicians?	To identify the mobile apps that are endorsed by healthcare providers, therapists and/or physicians.
RQ4	What are the primary gamification elements incorporated in ADHD mobile apps?	To identify the primary gamification elements in ADHD mobile apps.

2.2. Study selection and eligibility

To assess the impact of changes in the classification of mental disorders, a specific period was established for the review of literature related to the development of mobile apps. This period spans from 2013 to 2023, coinciding with the publication of the DSM-5. The revision of the DSM-5 in 2022 confers further significance to this interval, enabling a more precise evaluation of how contemporary mobile apps align with the most recent definitions and standards in mental health. Additionally, it is important to consider that the development of mobile apps can require several years. Therefore, this period is essential for understanding how revisions in the classification of disorders have influenced the design and functionality of new mobile apps in the field of mental health.

We conducted a comprehensive search for mobile apps in both academic repositories and commercial virtual app stores. Specifically, we examined the Google Play Store and the Apple App Store for commercial mobile apps. For academic repositories, our search was expanded to include seven major sources: ACM Digital Library, IEEE Xplore, MDPI, PubMed, ScienceDirect (Elsevier), SpringerLink, and Wiley Online Library. Additionally, we utilised Google Scholar to further broaden our search scope. Table 2 contains all queries sorted alphabetically, presented according to the unique attributes of each search engine within the respective repositories.

Since Google Play Store and Apple App Store do not have advanced search engines, to conduct the search for commercial mobile apps, we employed the following keywords: ADHD, TDAH (Spanish acronym for ADHD), hyperactivity, and inattention.

2.3. Inclusion and exclusion criteria

During the search process, we found 3,476 potentially relevant results, 2,899 of these are non-commercial mobile apps and video games and the results were distributed across the seven repositories and Google Scholar. As can be seen in Figure 1, the preponderance of articles is concentrated within ScienceDirect (37.12%) followed by SpringerLink (14.66%) and IEEE Digital Library(9.56%). Subsequently, Google Scholar and PubMed, both of which function as freely accessible search engines, constitute notable platforms hosting a substantial number of papers, 531 and 224 articles respectively. In contrast, the Wiley Online Library,

Table 2. Queries in selected repositories.

Repository	Keywords
ACM Digital Library	[Title: 'adhd'] OR [Title: 'attention deficit'] OR [Title: 'hyperactivity'] AND [All: 'mobile app'] OR [All: 'mobile application'] OR [All: 'm-health'] OR [All: 'mhealth'] OR [All: 'video game'] OR [All: 'videogame'] OR [All: 'game'] OR [All: 'digital']
IEEE Digital Library	('ADHD' OR 'attention deficit' OR 'hyperactivity')AND ('mobile app' OR 'mobile application' OR 'm-health' OR 'mhealth' OR 'video game' OR 'videogame' OR 'game' OR 'digital')
MDPI	Title: 'ADHD' AND Full Text: ('mobile app' OR 'mobile application' OR 'm-health' OR 'mhealth' OR 'video game' OR 'videogame' OR 'game' OR 'digital')
PubMed	('ADHD' OR 'attention deficit' OR 'hyperactivity')AND ('mobile app' OR 'mobile application' OR 'm-health' OR 'mhealth' OR 'video game' OR 'videogame' OR 'game' OR 'digital')
ScienceDirect	Title, abstract, keywords:(('ADHD' OR 'attention deficit' OR 'hyperactivity'))AND ('mobile app' OR 'mobile application' OR 'm-health' OR 'mhealth' OR 'video game' OR 'videogame' OR 'game' OR 'digital')
SpringerLink	Title:(('ADHD' OR 'attention deficit' OR 'hyperactivity'))AND ('mobile app' OR 'mobile application' OR 'm-health' OR 'mhealth' OR 'video game' OR 'videogame' OR 'game' OR 'digital')
Wiley Online Library	('ADHD' OR 'attention deficit' OR 'hyperactivity')' in Title and '('mobile app' OR 'mobile application' OR 'm-health' OR 'mhealth' OR 'video game' OR 'videogame' OR 'game' OR 'digital')
Google Scholar	allintitle:('mobile app' OR 'mhealth' OR 'mobile application' OR 'videogame' OR 'technology' OR 'game' OR 'digital') AND ('Attention Deficit Hyperactivity Disorder' OR 'ADHD')

MDPI, and the ACM Digital Library exhibit the most modest representation in terms of related articles, accounting for 6.31%, 3.86%, and 2.45% of the overall distribution, respectively.

At the stage of identification, 2,569 records were excluded by reading their titles, retaining 330 articles based on the first exclusion criteria:

- EX1: Not related to ADHD
- EX2: Reviews
- EX3: Duplicates

The resulting articles were sorted according to their titles and abstracts, at the stage of Screening. Following an exhaustive review of the abstracts, 234 articles were excluded based on the following second exclusion criteria:

- EX4: Not focused on ADHD
- EX5: The complete text of the study is not available for retrieval.

Of the 96 papers selected, 2 could not be retrieved, meaning we were unable to obtain the full text for a detailed review. These instances occurred when articles appeared in search results but were inaccessible upon attempting retrieval. This situation was due to issues such as broken links or the articles no longer being available in the databases accessed. After examining the remaining 94 articles, 48 additional studies were excluded based on our final exclusion criteria, which included:

- EX6: Studies that did not specify the age group or the exact number of participants who evaluated the app.
- EX7: Papers that do not involve the creation or design of proprietary mobile apps
- EX8: Studies intended for platforms other than mobile devices

Finally, the scoping review comprised 46 records. We relied on the PRISMA 2020 model (see Figure 2) to

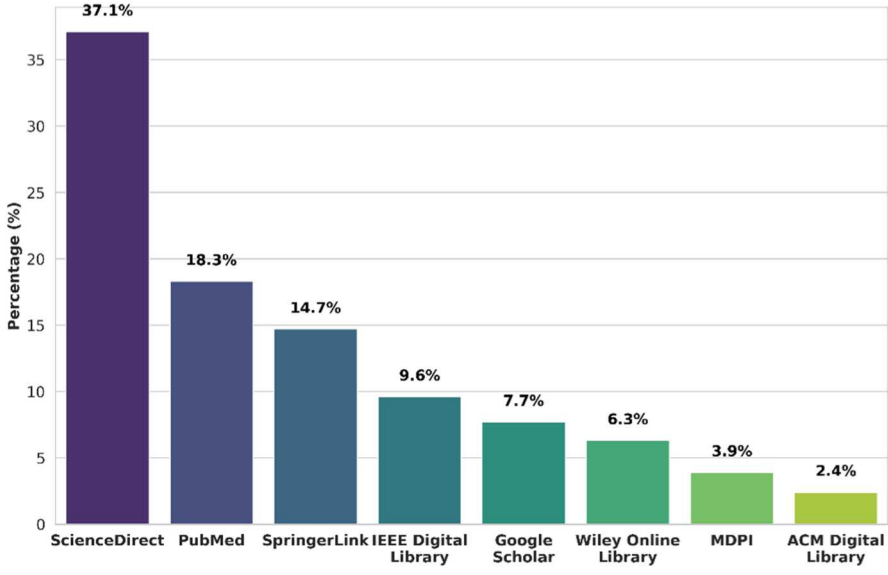


Figure 1. Distribution of research sources utilised in the study, depicting the percentage and number of articles obtained from each database.

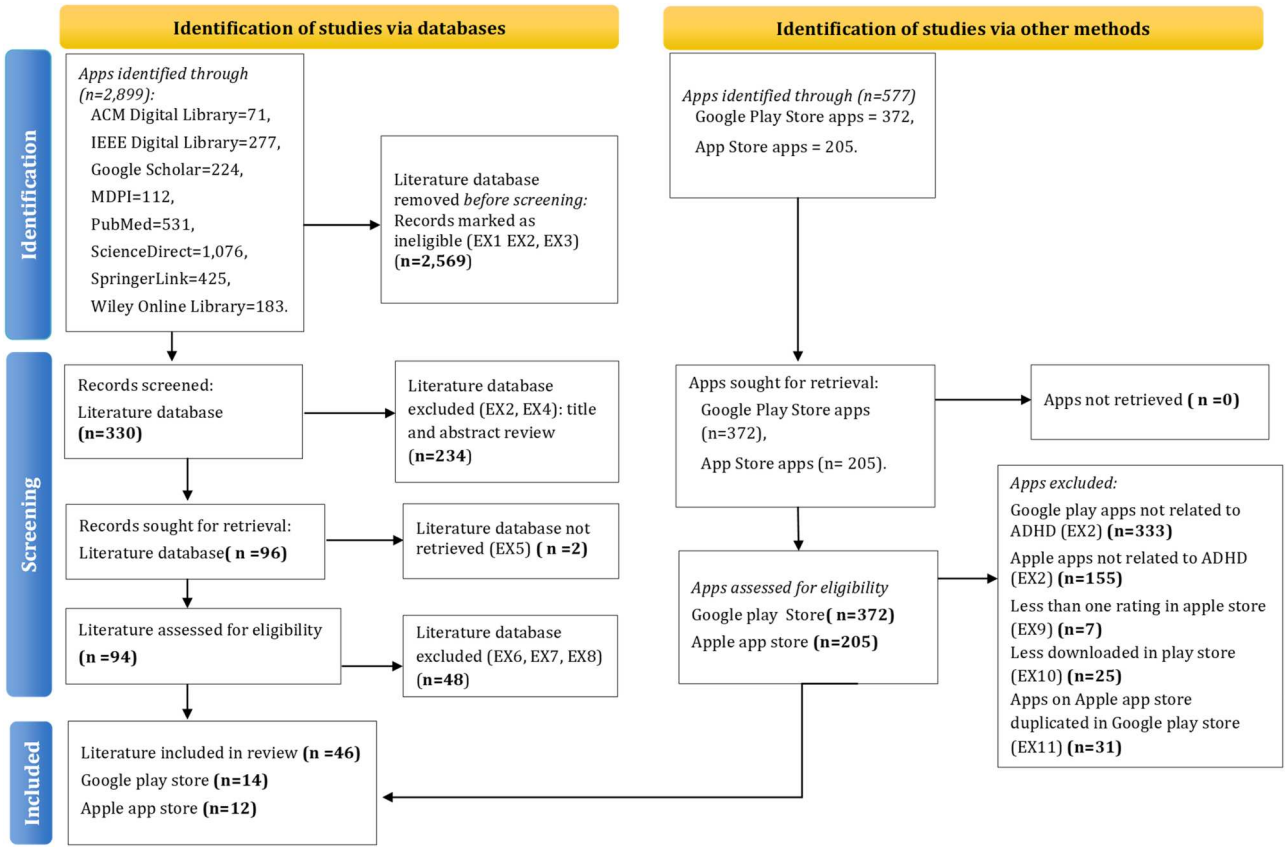


Figure 2. Study selection process – PRISMA flow diagram.

structure our findings. This model was developed to ensure transparent and comprehensive reporting of reviews, as cited in over 1,700 works (Page et al. 2021).

The remaining 577 of the 3,476 possible results are commercial mobile apps, identified in the virtual app stores: Google Play Store (372 results) and Apple App Store (205 results). To categorise these commercial mobile apps, our initial search was deliberately narrowed to include only those specifically designed for individuals with ADHD, thus distinguishing them from a broader spectrum of mobile apps intended for various purposes such as improving attention and concentration. The keywords employed in the search were ADHD, TDHA, hyperactivity, and inattention. At this stage, we found a total of 575 potentially related mobile apps, 372 on Google Play Store and 205 on App Store. Next, to refine our selection, we followed a series of steps. We focused on (a) identifying mobile apps featuring 'ADHD' in either their name or description; (b) compiling all mobile apps available across both platforms; (c) exclusively considering mobile apps that had garnered one or more ratings in the case of App Store apps **(EX9)** or had surpassed 1,000 downloads in the case of Google Play Store apps **(EX10).** This selection criterion is based on the relevance of download numbers as indicators of user engagement and market positioning. Data from *Fyresite* (Why 99.5% of consumer apps fail) show that 68.07% of applications on Google Play have fewer than 1,000 downloads, suggesting that most apps lack substantial user adoption *Appfigure* (How To Get Your First 1,000 Users) further supports that reaching 1,000 downloads is a critical milestone, as it enhances app visibility through Apple and Google's search algorithms. According to *Gilion* (Mobile App Metrics: Key Metrics for 2024), download numbers serve as key metrics for assessing market trends and app relevance. For example, ADHS – *CoachingZentrum* was removed from app stores before achieving this threshold, and the NIH app 'ADHD' has only reached 100 downloads since 2021, illustrating how limited adoption constrains impact. Finally, (d) when duplicates were identified on both platforms, Google Play Store apps were selected, as they typically offer broader access for analysis. **(EX11)**.

2.4. Data collection and analysis

We categorised relevant information from the studies and migrated it to structured tables for a thorough analysis. The database contained details on various

ADHD management applications, both commercial and non-commercial. We did not perform a randomised controlled selection, given the relatively small number of available applications; only 48 were reviewed. Information of interest for each application included treatment modalities, techniques used, medical endorsements, and gamification elements. Three subject matter experts (SMEs) oversaw the analysis to extract relevant information on the ADHD management applications. Key details included the specific treatment modalities applied, the techniques within these modalities, endorsements by healthcare professionals, and the gamification methods employed. In our categorisation process, we employed a priori coding, which involves creating a set of codes before examining the data. Unlike predetermined categories, a priori coding allows for a structured yet flexible approach to data analysis, ensuring that the collected data aligns with pre-established categories based on existing knowledge and literature, while still allowing for the identification of new and relevant aspects. This method was particularly useful in this study as it provided a framework to systematically identify and classify the diverse elements within ADHD management mobile apps, ensuring that all relevant aspects were thoroughly examined. However, during the analysis of gamification principles, our coding scheme for gamification included only the categories of Points, Objectives, Levels, and Statistics. These codes proved insufficient when attempting to capture the full range of gamification dynamics present in mobile apps. To address this, and in line with the flexibility allowed by a priori coding, we expanded our framework by incorporating elements from the taxonomy developed by Toda et al. (2019). By integrating these additional codes, we were able to enhance the depth and accuracy of our analysis.

3. Results

In accordance with the methodology detailed in Section 2.4, this section provides the results of the review of non-commercial and commercial ADHD mobile apps. These mobile apps were further classified into video game and non-video game categories. The distinction between video game and non-video game mobile apps was determined by the primary interaction mode described in each app. Video game mobile apps primarily involved game-like interactions and mechanics, while non-video game mobile apps used more traditional, non-gamified interfaces. Each category will be explained in detail in terms of treatment modality, treatment technique, gamification method, and medical endorsement.

1. **Treatment modality.** In the field of mobile apps designed to manage ADHD, 'treatment modality' refers to the overall methodology or structure used to manage the disorder. Since there is no standard categorisation for non-pharmaceutical treatment modalities, we propose the following classification based on priori coding from similar works (Caye et al. 2019; Guo, Assumpcao, and Hu 2022; Lambez et al. 2020; Moore et al. 2019; Núñez-Jaramillo, Herrera-Solís, and Herrera-Morales 2021; Ogundele and Ayyash 2023; Russell et al. 2021) and our findings: (a) clinical diagnostic aid, (b) organisation, (c) behavioural, (d) parent training, (e) social skills, (f) biofeedback (i.e. the mobile app uses any type to interact with the patient), (g) cognitive training, (h) cognitive behavioral therapy (CBT), and (i) time management skills.
2. **Treatment technique.** The term refers to particular methodologies or techniques employed within a specific modality with the intention of targeting discrete cognitive processes that are associated with ADHD. These were retrieved from their respective descriptions and they were grouped as follows: (a) auditory, (b) memorial, (c) cognitive, (d) sustained attention, (e) coordination, (f) logical exercise, (g) anticipation, (h) spatial reasoning, (i) strategy concentration, (j) selective attention, (k) focused attention, (l) visual perception, (m) spatial attention, (n) executive functions, and (o) survey/display information. Specifically, auditory techniques involve the use of auditory stimuli or cues to enhance cognitive processes, often leveraging sound-based interventions. Memory techniques focus on memory enhancement strategies, employing exercises and functions designed to improve retention and recall of information. Cognitive techniques involve activities that enhance problem-solving, decision-making, and critical thinking to improve overall mental capabilities and information processing. Sustained attention techniques focus on extending and maintaining cognitive attention for an extended period. Coordination techniques involve activities that improve motor skills and hand-eye coordination. Logical exercise techniques incorporate logical reasoning tasks to stimulate analytical thinking. Anticipation techniques include exercises designed to improve predictive thinking and anticipation of responses. Spatial reasoning techniques aim to improve spatial awareness and problem-solving in three-dimensional space. Strategic concentration techniques involve exercises aimed at improving strategic thinking and planning. Selective attention techniques focus on improving the ability to concentrate on

specific stimuli while ignoring others. Focused attention techniques aim to improve concentration on a singular task or stimulus. Visual perception techniques involve activities to refine the interpretation of visual information. Spatial attention techniques are specifically aimed at improving attentional processes in spatial contexts. Executive functions involve higher-order cognitive processes such as planning, organisation, self-regulation, and goal-directed behaviour, enhancing task and time management abilities. Survey/display information techniques involve activities that enhance the ability to effectively process and present information visually.

3. **Gamification**. The elements or game mechanics used by each mobile app to increase patient engagement and/or enjoyment. We followed the taxonomy developed by Toda et al. (2019) to identify and document the gamification attributes of each app. This classification comprises 21 game elements suitable for gamified educational environments. These elements are organised into five dimensions: Performance, Ecological, Social, Personal, and Fictional. The Performance dimension focuses on the response of the environment and incorporates elements such as Points, Progression, Levels, Statistics, and Acknowledgement. The Ecological dimension refers to the applied gamification environment and includes elements such as Chance, Imposed Choice, Economy, Rarity, and Time Pressure. The Social dimension focuses on the interactions between learners (mobile app users; in this case, ADHD patients) within the environment and includes elements such as Competition, Cooperation, Reputation and Social Pressure. The personal dimension revolves around the individual learner using the environment and includes elements such as Sensation, Objectives, Puzzle, Novelty, and Renovation. Finally, the Fictional dimension combines both the user and the environment, encompassing elements such as Narrative and Storytelling. It is important to note that certain mobile apps incorporate multiple forms of gamification.
4. **Medical Endorsement**. This refers to validation or endorsement provided by healthcare providers, therapists, and/or physicians. Medical endorsement involves an evaluation of the app's features, functionalities and/or methodologies to ensure they conform to recognised standards for the treatment of ADHD. This may include scrutiny of the incorporation of therapeutic approaches, adherence to clinical protocols, or the app's potential to complement traditional therapeutic interventions (Van Velthoven et al. 2018). In addition, medical approval may include an evaluation of the app's user interface, among other related issues. Medical approval adds a level of credibility to an ADHD app, assuring users, caregivers, parents, and healthcare professionals that the intervention is not only technologically sound but also conforms to medical practices. In this work, the term 'medical endorsement' is specifically limited to cases where there is obvious and explicit mention in the app's descriptions or documentation regarding its relationship to the medical field. Thus, a description of the type of medical endorsement is indicated. The incorporation of medical endorsement into the development process reflects a commitment to a collaborative approach between technology developers and healthcare experts, ultimately fostering a sense of trust among end users (Gessa, Sancha, and Jiménez 2021).

A noteworthy aspect of the studies analyzed is that they do not focus on a specific age group, but rather include participants from diverse age ranges to evaluate the mobile apps. Consequently, to enhance the structure of the information presented in this review and align with the age classification standards employed by the Google Play Store and App Store, we have categorised the age ranges based on the guidelines established by the American Medical Association (Age | National Institutes of Health (NIH)). Henceforth, the following categorisation will be used: (a) children (1–12 years of age), (b) adolescents (13–17 years of age), and (c) adults (18 years of age and above). In instances where the paper does not specify an age group, the term (d) *subjects* will be used.

3.1. Non-commercial ADHD mobile apps

This subsection covers non-commercial ADHD mobile apps, which refer to ADHD management applications that do not pursue commercial or for-profit purposes. These mobile apps were developed with a more altruistic approach, with the main intention of providing resources, tools, and support to people with signs and symptoms of ADHD, as well as their families, caregivers or healthcare professionals, without the main motivation of generating economic income. Specifically in this work, we considered only those mobile apps that have scientific support, i.e. those that have been the subject of scientific publication. These mobile apps may or may not be available for download, but their distinction lies in the fact that they have been subjected to more rigorous scrutiny as they have been presented in the scientific literature, which indicates a level of validation

Table 3. Summary of non-commercial video game ADHD tested on subjects.

Ref.	Treatment Modality	Treatment Technique	Gamification Element	Medical Endorsement
Alchalcabi, Eddin, and Shirmohammadi (2017)	Biofeedback	Focused attention Cognitive	Time pressure	Not reported
Shenjie et al. (2014)	Biofeedback	Sustained attention	Levels Competition	Not reported

and evaluation that goes beyond the commercial environment.

Table 3 highlights an important observation regarding certain studies that do not explicitly specify the age range at which the tests were conducted. For example, Alchalcabi, Eddin, and Shirmohammadi (2017) indicated that the application was tested on four subjects. This mobile app improved the ability to concentrate. The player aimed to collect yellow cubes. The player mentally issued commands, such as 'push' and 'neutral', to advance in the game. Shenjie et al. (2014) described a game mobile app that involves an EEG-driven interface where players use their attention levels to control a ball, and it was tested on four healthy subjects.

Meanwhile, Table 4 focuses on apps designed specifically for children. One prominent example is EndeavorRx, a personalised training regimen introduced by Kollins et al. (2020), which was evaluated in trials with 348 children to assess multitasking and cognitive performance. Also, Park, Lee, and Lee (2021) conducted a study with 233 children, evaluating behavioural responses using a bubble-popping task. In a study conducted by Liu et al. (2022) involved 120 children in an experiment using gesture-based interaction via a gaming app, and Graf et al. (2023) tested attention-sustaining abilities in 114 children through a mini-exploration game. Similarly, a study conducted by Schena et al. (2023) worked with 60 children, using an app to improve cognitive functions through navigation, impulse control, and puzzles. Also, Bul et al. (2015) studied 42 children, showing improvements in strategic thinking with a game focused on collecting rare minerals. Furthermore, educational apps were explored by Castro and Huamanchahua (2021) (35 children), focusing on math concepts, and Ha et al. (2022) tested an app with 21 children for enhancing attention, memory, and reasoning. Additionally, Munoz, Navarro, and Fabregat (2014) involved 20 children in developing logical-mathematical skills through a spatial video-displayed game, while Capelo et al. (2018) used Leap Motion technology in a study with 20 children to improve motor skills. The study conducted by Kanellos et al. (2019) tested an underwater-themed app with 75 children to manage ADHD symptoms, while Prins et al. (2013) involved 18 children in testing cognitive control functions through a role-playing video game. Likewise, Crepaldi et al. (2020) involved 16 children in a study focused on self-control, planning, emotional regulation, and attention. The mobile app incorporated well-known cognitive assessments such as the Flanker effect, the Stroop test, the Stop signal task, and the Conners Continuous Performance test, providing a rich, multidimensional intervention. Similarly, the research by Rijo et al. (2015) used a treasure-hunt-themed app with 12 children, designed to enhance visuospatial working memory, hand-eye coordination, and impulse control. The app's narrative and challenges were adapted to the cultural and educational backgrounds of the children. Wiguna et al. (2021), tested a video game app with 10 children in which players delivered fruits of specific colours to matching houses. The game was designed to enhance attention by integrating distracting and non-distracting stimuli. Likewise, Hu et al. (2021) developed an app that taught children to regulate their breathing through musical cues and bubble-blowing activities. Tested with 6 children, the app used a breath controller to translate pressure into different tones and bubbles, encouraging mindfulness and self-regulation. Furthermore, Park, Lee, and Lee (2021) conducted assessments with 2 children using a mobile app that analyzed facial expressions to teach emotional recognition and empathy. The app helped children engage with story characters and improve their ability to discern and react appropriately to different emotions. Similarly, in their research, Ruiz-Manrique, Tajima-Pozo, and Montañes-Rada (2014) tested a mobile app with 1 child, focusing on personalised cognitive training using the Tajima Cognitive Method (TCT). This app was designed to address several cognitive domains, providing weekly challenges tailored to each child's performance. Graf et al. (2023) developed a mobile app designed to enhance self-regulation in children with ADHD through training modules for both children and their parents. The app was tested by 10 families and included mini-games that aimed to improve executive function skills. Finally, Song et al. (2023) designed a mobile app for remote assessment of ADHD symptoms using six mobile games designed to challenge attention and working memory in children with ADHD. Fifteen children with clinically diagnosed ADHD participated in the study.

Table 4. Summary of non-commercial video game ADHD tested on children.

Ref.	Treatment modality	Treatment technique	Gamification element	Medical endorsement
Kollins et al. (2020)	Cognitive training	Memorial Visual perception Strategy concentration Spatial attention	Acknowledgement Storytelling Levels	Mobile app was approved by Duke University Health System, Cincinnati Children's Hospital Medical Center and Johns Hopkins Medical Center
Perochon et al. (2023)	Behavioural	Strategy concentration Executive functions Cognitive Visual perception	Sensation	Not reported
Liu et al. (2022)	Biofeedback	Cognitive Strategy concentration	Levels	Not reported
Bédiou et al. (2023)	Clinical diagnostic aid	Focused attention	Progression	Not reported
Schena et al. (2023)	Behavioural	Cognitive Coordination Visual perception Spatial attention Logical exercise Executive functions	Rarity	Speech therapists, neuropsychometricists, physiotherapists, neuropsychiatrists, neuropsychologists, phoniatrics, psychotherapists (the specific number of specialists involved is not stated)
Bul et al. (2015)	Behavioural	Anticipation Spatial reasoning	Objectives Levels Cooperation Time pressure Economy	The study is described as multidisciplinary, but the specific number of medical specialists involved is not specified.
Castro and Huamanchahua (2021)	Cognitive training	Logical exercise Sustained attention Cognitive	Levels	Not reported
Ha et al. (2022)	Cognitive training	Executive functions Cognitive Memorial	Levels	Not reported
Munoz, Navarro, and Fabregat (2014)	Cognitive training	Cognitive Logical exercise	Economy	Not reported
Capelo et al. (2018)	Biofeedback	Focused attention Spatial reasoning Spatial attention	Levels Sensation	Not reported
Kanellos et al. (2019)	Cognitive training	Cognitive Coordination Memorial Selective attention Sustained attention	Economy Narrative Objectives Progression	The mobile app was deployed and tested at the Sant Joan de Déu Children's Hospital in Barcelona.
Prins et al. (2013)	Cognitive training	Executive functions	Points Objectives	5 trainers/therapists
Crepaldi et al. (2020)	Behavioural	Spatial reasoning Spatial attention Cognitive	Progression Levels Imposed Choice Points Storytelling	Not reported
Rijo et al. (2015)	Cognitive training	Executive functions Coordination	Storytelling Narrative Sensation	Psychology
Wiguna et al. (2021)	Organisation	Auditory Coordination Spatial reasoning Executive functions	Sensation Points	Not reported
Hu et al. (2021)	Biofeedback	Auditory Coordination Strategy concentration	Points Economy Sensation	Not reported
Park, Lee, and Lee (2021)	Social skill	Cognitive Anticipation	Sensation Storytelling Sensation	Not reported
Ruiz-Manrique, Tajima-Pozo, and Montañes-Rada (2014)	Cognitive training	Cognitive	Levels	One psychiatrist
Graf et al. (2023)	CBT	Cognitive Executive functions Strategy concentration	Acknowledgement Narrative Progression Puzzles	Not reported
Song et al. (2023)	clinical diagnostic aid	Sustained attention Memorial Spatial reasoning Focused attention	Objectives Levels Progression Puzzles	Not reported

Table 5. Summary of non-commercial video game ADHD tested on adults.

Ref.	Treatment modality	Treatment technique	Gamification element	Medical endorsement
Stamatis, Mercaldi, and Kollins (2023)	Cognitive training	Memorial Visual perception Strategy concentration Spatial attention	Acknowledgement Storytelling Levels	Mobile app was approved by Duke University Health System, Cincinnati Children's Hospital Medical Center and Johns Hopkins Medical Center
Thomas, Vinod, and Guan (2013a)	Biofeedback	Memorial	Progression Levels	Not reported
Savulich et al. (2019)	Cognitive training	Sustained attention Visual perception Cognitive	Progression Sensation Storytelling Narrative	Not reported
Xinru (2023)	Cognitive training	Sustained attention Visual perception	Sensation	Not reported
Sonne and Jensen (2016)	Biofeedback	Anticipation Coordination Strategy concentration	Acknowledgement Sensation	Not reported
Mancera et al. (2017)	Cognitive training	Sustained attention Anticipation Selective attention Focused attention Cognitive	Objectives Levels Time pressure Points	Not reported

Table 5 highlights adult studies. Stamatis, Mercaldi, and Kollins (2023) adapted an application from Kollins et al. (2020) for 153 adults, finding that the Test of Variables of Attention (TOVA) showed improvements nearly seven times greater than in pediatric trials. Likewise, Thomas, Vinod, and Guan (2013a) developed a mobile game controlled by attention-related EEG signals to enhance attention and cognitive skills, tested on 16 adults. In a separate study, Savulich et al. (2019) created a Signals Intelligence-themed app challenging players with sustained attention visual tasks, assessed with 75 adults. In the study by Xinru (2023), integrated puzzles with narrative imagery to address dyslexic symptoms and enhance cognitive development, involving 48 adults in the study. Concurrently, Sonne and Jensen (2016) designed a blowfish-themed game evaluated with 16 adults. Finally, in the study by Mancera et al. (2017), developed a role-playing game to boost motivation and support the learning process, tested with 2 adults.

Finally, Table 6 includes mixed age groups. In a similar vein, Swarts et al. (2018) evaluated a mobile app designed according to DSM-V criteria to identify hyperactivity by guiding a panda through a river, tested on 40 children and adolescents. Likewise, Delgado-Gómez et al. (2020) developed an app where players control a raccoon jumping across gaps to assess attention, involving 32 children and adolescents. Similarly, the mobile app developed by Sujar et al. (2022) created a driving simulation app to assess sustained attention in individuals with ADHD, tested on 3 children and adolescents. Chandrasena et al. (2022) presented an app for ADHD analysis and detection using questionnaires and gaming activities to identify symptoms like hyperactivity and inattention, tested on 23 children and adolescents and 37 adults.

The research studies on non-commercial, non-video game ADHD mobile apps tested on children, as detailed in Table 7, provide valuable insights into various treatment modalities and their effectiveness. For instance, the study by Berrezueta-Guzman, Montalvo, and Krusche (2023) developed a mobile app integrated with Firebase to enable therapists to remotely monitor

Table 6. Summary of non-commercial video game ADHD tested on mixed age groups.

Ref.	Treatment Modality	Treatment Technique	Gamification Element	Medical Endorsement
Swarts et al. (2018)	Clinical diagnostic aid	Coordination Spatial attention Spatial reasoning	Points Time pressure	Not reported
Delgado-Gómez et al. (2020)	Cognitive training	Focused attention Sustained attention	Levels	1 trained psychiatrist
Sujar et al. (2022)	Cognitive training	Sustained attention	Imposed choice.	Not reported
Chandrasena et al. (2022)	Clinical diagnostic aid	Auditory Memorial Logical exercise Selective attention Survey/display information Visual perception	Acknowledgement Points Statistics Storytelling Time pressure	Not reported

Table 7. Summary of non-commercial non-video games ADHD mobile apps tested on children.

Ref.	Treatment modality	Treatment technique	Gamification element	Medical endorsement
Berrezueta-Guzman, Montalvo, and Krusche (2023)	Behavioural	Executive functions Strategy concentration Sustained attention	Progression	6 therapists
Doan et al. (2020)	Behavioural	Executive functions Survey/display information	Economy Objectives Points Statistics	Not reported
Pramana et al. (2014)	CBT	Executive functions	Acknowledgement Points Economy	Therapists tested the platform and offered feedback to improve usability.
Yerys et al. (2019)	Cognitive training	Cognitive Visual perception	Objectives Levels	Not reported
Young et al. (2014)	Clinical diagnostic aid	Coordination	Statistics	Not reported
Sonne et al. (2016)	Time management skills	Focused Attention Memorial	Acknowledgement Sensation Objectives	Three medical researchers developed the app.
Schuck et al. (2016)	Social skill	Cognitive Executive functions	Progression	Not reported
Loubriel et al. (2019)	Behavioural	Executive functions	Narrative	Not reported

children with ADHD during occupational therapy sessions; it was tested on 32 children over 16 weeks, highlighting the potential for remote interventions. In addition, Doan et al. (2020) introduced CoolCraig, a smartwatch and smartphone app designed to support the co-regulation of behaviours and emotions in children with ADHD, tested with 24 children and their caregivers over eight months. Other noteworthy studies include Pramana et al. (2014), focused on a CBT-based mobile app to improve executive functions in children, allowing therapists to monitor progress and administer rewards, incorporating usability feedback. Similarly, Yerys et al. (2019) tested Project EVO, an interactive digital treatment aimed at enhancing cognitive control through gameplay, involving 19 children with ASD and ADHD symptoms. Young et al. (2014) evaluated a mobile app utilising the AX-CPT paradigm to assess attention and impulsivity, involving 11 participants and using accelerometer and gyroscope data to measure physical activity. Similarly, Sonne et al. (2016) developed an app to help children efficiently perform morning and bedtime routines, involving 13 children and featuring modules defining tasks for both children and parents. Schuck et al. (2016) created a web-based app for classroom behaviour management incorporating a token economy system, tested on 12 children. Furthermore, Loubriel et al. (2019) assessed a mobile app with 23 children that included 36 videos of interpersonal interactions, followed by questions to gauge comprehension, social inference skills, and the ability to predict socially appropriate behaviours.

Table 8 provides a summary of studies that have focused on the use of ADHD mobile apps for adults. One such study was conducted by Knouse et al. (2022) developed a self-help application rooted in Cognitive Behavioral Therapy (CBT) principles, aimed to assist individuals in symptom management while fostering a sense of social connection and support from peers undergoing similar challenges. The authors conducted a thorough evaluation with a substantial sample size of 241 adults. In a similar vein, Sobolev et al. (2021) scrutinised their application tailored for the assessment and remote diagnosis of impulsivity in 116 adults. The application integrated self-reports, ecological momentary assessments (EMAs), and active behavioural tasks as primary modules. Similarly, Jang et al. (2021) introduced the Todaki chatbot, designed to deliver CBT and self-management support to individuals with panic disorder. The chatbot addressed self-diagnosis of

Table 8. Summary of non-commercial non-video games ADHD mobile apps tested on adults.

Ref.	Treatment modality	Treatment technique	Gamification element	Medical endorsement
Knouse et al. (2022)	CBT	Executive functions	Statistics Acknowledgement Objectives	It does not specify the number or type of medical specialists involved
Sobolev et al. (2021)	clinical diagnostic aid	Cognitive	Statistics Points	Not reported
Jang et al. (2021)	Cognitive training	Cognitive Strategy concentration	Statistics	Not reported
Păsărelu, Kertesz, and Dobrean (2023)	parent training	Cognitive	Statistics	Not reported

Table 9. Summary of non-commercial non-video games ADHD mobile apps tested on adolescents.

Ref.	Treatment modality	Treatment technique	Gamification element	Medical endorsement
Weintraub et al. (2022)	Parent training.	Cognitive	Statistics	Not reported

various mental disorders associated with decreased attention, psychoeducation on attention deficit problems, and brief CBT sessions equipped with tools to enhance compliance. The evaluation of this chatbot involved 46 adults. Finally, Păsărelu, Kertesz, and Dobrean (2023) explored an application tailored for parental psychological distress management in a study with 21 adults. Rooted in the behavioural parent training protocol, the mobile app encompassed five sections: psychoeducation, activities, diary, mood monitoring, and user profile.

Regarding the non-video game research papers listed in Table 9, it is noteworthy the study conducted by Weintraub et al. (2022) incorporated adolescents in their assessment, with a sample size of 24 subjects. The mobile app developed allowed patients and their parents to review therapy content, engage in the practice of treatment skills, and systematically monitor symptoms along with functional status.

Lastly, Table 10 presents the study by Păsărelu, Kertesz, and Dobrean (2023), which developed the WHAAM app for monitoring ADHD behaviours through a network involving teachers, parents, and clinicians. This app was tested across various age groups, including children, demonstrating its effectiveness in educational and home environments.

In the following section, commercial mobile apps designed to manage ADHD were reviewed.

3.2. Commercial mobile apps for ADHD management

Commercial mobile apps for ADHD management refer to those available for purchase or download through platforms like Google Play and the Apple App Store. These apps, developed by commercial entities, aim to address various aspects of ADHD, including cognitive performance monitoring, time management, social skill improvement, and therapeutic interventions. In this study, the search was limited to commercial apps available in these stores, excluding those with associated scientific publications, except EndeavorRx. Since this was initially mentioned in the research as Akl-T01 and was subsequently marketed under the name EndeavorRx. All commercial apps identified were downloaded and tested individually to gain a comprehensive understanding of their treatment modalities, techniques, and gamification features. Table 11 presents the commercial apps that are not classified as video games, with an additional column detailing the number of ratings from the App Store.

Table 10. Summary of non-commercial non-video games ADHD mobile apps tested on mixed age groups.

Ref.	Treatment modality	Treatment technique	Gamification element	Medical endorsement
Spachos et al. (2015)	Behavioural	Executive functions	Progression	Not reported

Table 11 identifies a single app, *ADHD Test (Adult)*, designed exclusively for adults. It is a calendar app tailored for individuals with ADHD. Two apps categorised for both adolescents and adults, *Theraview-Track ADHD Meds* and *ADHD Behavior Toolbox*, offer self-assessment tools, virtual appointments, medication treatment, and progress tracking.

Additional apps span different age groups. *ADHD Organizer, Planner: Focus* helps users track habits and skills through activity trackers and reminders, while *PiCal: Visual ADHD Day Planner* offers features for managing medication, with a parent-controlled mode for children. *Insumo: ADHD Daily Planner* serves as a diary with mood tracking and statistical analysis. *ADHD Quiz* addresses over 30 specific ADHD-related behaviours, allowing communication between parents and schools. *ADHD Journal* helps users develop coping skills through interactive content, featuring a gamified to-do list and community support. *Numo ADHD: Organizer & Planner* includes a rapid ADHD screening test based on the ASRS-V1.1, while *Done-ADHD Diagnosis & Treatment* offers habit tracking tools.

Table 12 presents commercial non-video game mobile apps available exclusively in the Google Play Store, with an additional column detailing the number of downloads for each app.

Table 12 highlights commercial ADHD mobile apps available in the Google Play Store, with a focus on children, adolescents, and adults. For example, *ADHD Test* provides a self-report scale for adults to screen for ADHD, while apps like *ADHD – Causes, Diagnosis, and Treatment* and *ADHD Attention Deficit Hype* offer educational resources about ADHD, though these are no longer available. Additionally, *ADHD Disease* presents various treatment options, and *My ADHD* includes diagnostic tests like ASRS 1.1 for adults and SNAP-IV for children.

For adolescents and adults, apps like *Shimmer: ADHD Coaching* partner users with ADHD coaches to

Table 11. Summary of commercial non-video game ADHD mobile apps found on app store.

Mobile app name	Treatment modality	Treatment technique	Gamification element	Ratings
ADHD Organizer, Planner: Focus	Organisation	Memorial	Progression Objectives	1.1k
ADHD Test (Adult)	Clinical diagnostic aid	Survey/ Information display	Statistics	857
Numo ADHD: Organizer & Planner	Time management skills	Strategy concentration Focused attention Executive functions	Points Levels Cooperation Progression	530
PiCal: Visual ADHD Day Planner	Organisation	Memorial	Objectives Statistics Sensation	246
Done-ADHD Diagnosis & Treatment	Organisation	Memorial Focused attention	Time Pressure Objectives Statistics	199
Theraview-Track ADHD Meds	Organisation	Memorial	Sensation Statistics	89
Insumo: ADHD Daily Planner	Organisation	Memorial	Progression Objectives	16
ADHD Quiz	Clinical diagnostic aid	Survey/Information display	Statistics	6
ADHD Journal	Social skills	Memorial	Statistics	1
ADHD Behavior Toolbox	Behavioural	Strategy concentration Selective attention Focused attention Sustained attention	Cooperation	1

Table 12. Summary of commercial non-video game ADHD Mobile apps found on google play store.

Mobile app name	Treatment modality	Treatment technique	Gamification element	Downloads
ADHD Test	Clinical diagnostic aid	Survey/Information display	Statistics	+50;000
Shimmer: ADHD coaching	Organisation	Auditory Cognitive Visual perception Executive functions Sustained attention	Objectives Cooperation	+1;000
ADHD Monitor	Biofeedback	Strategy concentration Coordination	Statistics	+100,000
ADHD – causes, diagnosis, and treatment	Organisation	Survey/Information display	Statistics	+500,000
ADHD Attention deficit hype	Organisation	Survey/Information display	Statistics	+10,000
ADHD disease	Organisation	Survey/ Information display	Statistics	+100;000
My ADHD	Clinical diagnostic aid	Survey/ Information display	Statistics	+50;000
ADHD Lifehacks For Adults	Organisation	Survey/ Information display	Statistics	+10;000
ADHD Cognitive Research	Cognitive training	Cognitive	Statistics	+10;000
RoutineFlow: Routine & ADHD	Time management skills	Strategic concentration	Acknowledgment	+100,000

help them set and achieve goals through personalised routines. *ADHD Cognitive Research* allows users to participate in scientific studies on ADHD, and *RoutineFlow: Routine & ADHD* serves as a planner to help users organise their daily schedules.

Two apps are designed exclusively for adults: *ADHD Monitor*, which continuously monitors ADHD symptoms via a smartwatch, and *ADHD Lifehacks For Adults*, which offers professional advice tailored for adults managing ADHD.

Table 13 presents a list of ADHD-related video games available on the Google Play Store and App Store. This table also includes information on the availability of each app across different stores, as well as download and rating statistics, providing a quantitative measure of their popularity and reception.

In alignment with the patterns observed in the preceding two tables, Table 13 highlights the prevalence of applications targeting a broad demographic, including children, adolescents, and adults. Examples include *Magic Land ADHD Learning Game*, which features video games to improve concentration, and *ADHD Concentration Games*, which offers three stages to help users enhance their attention. *ADHD Treatment – Brain Training* focuses on neurocognitive therapy, while *Stress Reliever Fidgets ADHD* simulates fidget toys to reduce stress.

Some apps are specifically designed for children. For example, in *Jumpy Car ADHD*, players help a young boy with ADHD navigate through obstacles to reach his goal, and *EndeavorRx* has been approved by the FDA as the first game-based therapeutic, aimed at improving attention function in children.

Overall, Tables 11–13 summarise the wide range of mobile apps available to support ADHD management, from those promoting concentration to others focusing

Table 13. Summary of commercial video game ADHD mobile apps found on google play store and app store.

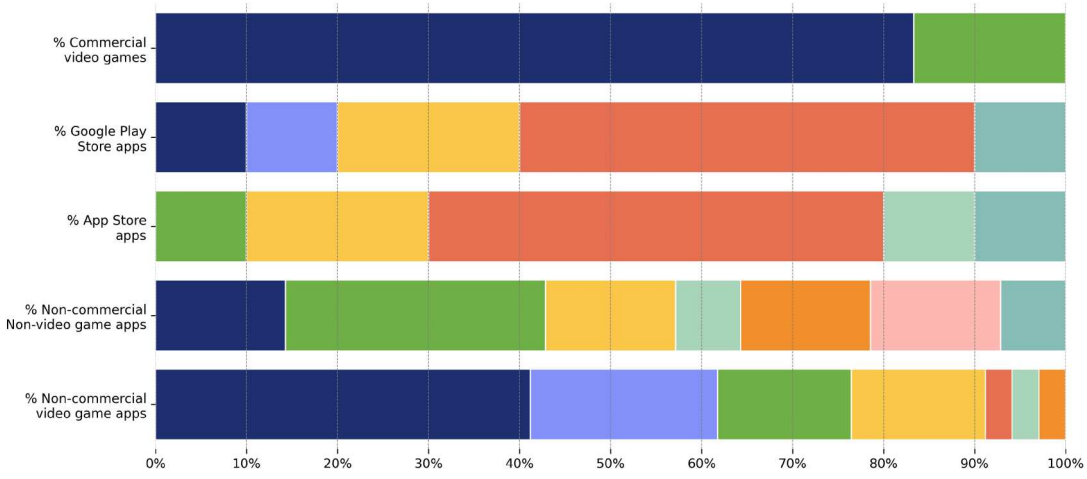
Mobile app name	Treatment modality	Treatment technique	Gamification element	Download/ Ratings	Store
ADHD concentration games	Cognitive training	Strategy concentration	Objectives	+500,000/–	Google Play Store
ADHD Treatment- Brain Training	Cognitive training	Executive functions Focused attention	Progression	–/18	App Store
Magic Land ADHD Learning Game	Cognitive training	Executive functions Focused attention Logical exercise	Levels	–/8	App Store
Jumpy Car ADHD	Cognitive training	Strategy concentration Coordination Visual perception	Levels Progression	+10,000/–	Google Play Store
Stress Reliever Fidgets ADHD	Behavioural	Executive functions Spatial reasoning	Sensation	+50,000/–	Google Play Store
EndeavorRx (EndeavorRx® – ADHD; EndeavorRx® – Kid)	Cognitive training	Memorial Visual perception Strategy concentration Spatial attention	Acknowledgment Storytelling Levels	+5k/749	Google Play Store App Store

on social skills and therapeutic interventions. In the following section, we discuss these findings in relation to the research questions.

4. Discussion

4.1. RQ1. What treatment modalities are employed in mobile apps that manage ADHD?

Previous reviews, such as the one by Stefanidi et al. (2023), provided broad overviews of HCI literature across various subdomains. Building on this foundation, our review specifically examined ADHD-related apps and the different strategies they employed for treatment. In our analysis, we identified a variety of treatment modalities used in these apps. Figure 3 presents the distribution of these ADHD treatment modalities across different mobile app categories. A notable finding is the absence of biofeedback in commercial video games, likely due to the high costs associated with its integration. Conversely, biofeedback is employed in 23.33% of non-commercial video games, where research has consistently shown its potential to alleviate ADHD



	Cognitive Training	Biofeedback	Behavioral	Clinical Diagnostic Aid	Organization	Social Skill	CBT	Parent Training	Time Management Skills
% Non-commercial video game apps	41.18%	20.59%	14.71%	14.71%	2.94%	2.94%	2.94%	0.00%	0.00%
% Non-commercial Non-video game apps	14.29%	0.00%	28.57%	14.29%	0.00%	7.14%	14.29%	14.29%	7.14%
% App Store apps	0.00%	0.00%	10.00%	20.00%	50.00%	10.00%	0.00%	0.00%	10.00%
% Google Play Store apps	10.00%	10.00%	0.00%	20.00%	50.00%	0.00%	0.00%	0.00%	10.00%
% Commercial video games	83.33%	0.00%	16.67%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Figure 3. Distribution of treatment modalities across ADHD mobile apps.

symptoms. For example, non-commercial ADHD mobile apps, such as those developed by Alchalcabi, Eddin, and Shirmohammadi (2017) and Shenjie et al. (2014), incorporate biofeedback using game-based systems or EEG-driven interfaces to improve sustained attention and cognitive performance. These apps demonstrate how biofeedback can be effectively utilised in research-focused environments, even though its presence is limited in commercially available products. Studies by Skalski, Pochwatko, and Balas (2021) (HEG biofeedback) and Sho'ouri (2022) (EOG biofeedback) have both demonstrated improvements in cognitive functions and reductions in ADHD symptoms through biofeedback. Similarly, a systematic review by Rodrigues, Tucci, and de Barros Viana (2022) reinforces the cognitive benefits of biofeedback in ADHD treatment. These findings suggest that integrating biofeedback into commercial video games apps could enhance their therapeutic value. In non-video game mobile apps, non-commercial apps offer a wider range of interventions, including clinical diagnostic aids, CBT, and parental skill development. In contrast, commercial apps tend to focus more on organisational tools and clinical diagnostic aids. The limited presence of CBT and parental coaching in commercial apps suggests a potential area for improvement. While market considerations may influence commercial mobile apps, striking a balance between cost-effectiveness and comprehensive solutions for individuals with ADHD is crucial. For instance, Cognitive training is prominent in commercial apps, with 83.33% employing it, possibly driven by market demands. Hence, incorporating a broader range of evidence-based treatment modalities can enhance therapeutic value and contribute to improved outcomes for individuals with ADHD.

Meanwhile, the global distribution of treatment modalities in ADHD mobile apps in Figure 4, reveals that parent training is underrepresented Parent training can significantly improve parental strategies and self-efficacy, which are crucial for managing ADHD. Rimestad, O'Toole, and Hougaard (2020) highlighted that parent training programmes can significantly improve parental strategies, self-efficacy, and therapeutic alliance. Also, Sugaya et al. (2022) demonstrated that behavioural parent training, when combined with methylphenidate, is effective and safe for young children with ADHD. Furthermore, Döpfner et al. (2020) found that web-assisted self-help interventions for parents can be a viable alternative, effectively supporting parents in routine care conditions. Therefore, incorporating these components into apps could help parents better support their children's development and behaviour.

Similarly, cognitive-behavioral therapy (CBT) is underutilised, representing only 4.05% of treatment modalities, despite its proven effectiveness in reducing ADHD symptoms according to Pan et al. (2019). Additionally, Young, Moghaddam, and Tickle (2020) found that CBT is effective in improving attention and

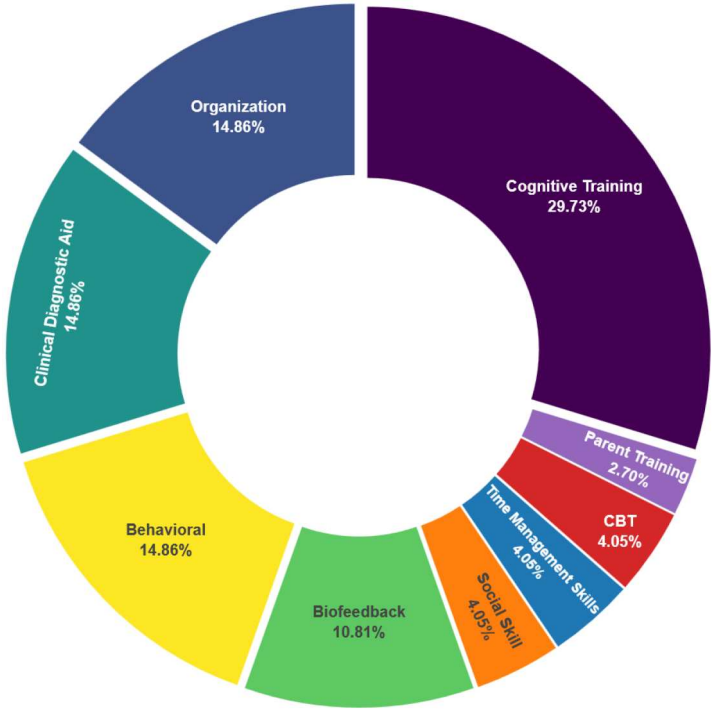


Figure 4. Global distribution of treatment modalities in ADHD mobile apps.

reducing impulsivity in adults with ADHD. Furthermore, Anastopoulos et al. (2021) demonstrated that CBT significantly benefits college students with ADHD by enhancing their self-regulation and addressing emotional difficulties. Integrating CBT into mobile apps could enhance self-regulation and emotional management for users, particularly adults and students with ADHD.

Time management and social skills training are also underrepresented, each making up 4.05% of the total. LaCount et al. (2018) found that structured interventions significantly enhance academic outcomes and reduce ADHD symptoms. Similarly, Desrochers, Tuson, and Magee (2019) highlighted the need for better digital tools tailored for adults with ADHD to aid in time management. On the other hand, social skills training is vital for improving peer interactions and reducing social problems. Storebø et al. (2019) and Willis et al. (2019) demonstrated that structured social skills programmes significantly enhance social competence in children and adolescents with ADHD. Including these interventions in apps could provide a more holistic approach to addressing ADHD-related challenges.

Cognitive training, which accounts for 29.73% of the total modalities, is the most prevalent treatment approach. However, its efficacy as a standalone treatment remains debated. Sonuga-Barke and Cortese (2018) concluded that cognitive training alone does not suffice as a primary ADHD treatment due to insufficient evidence from blinded outcome studies. They suggest that cognitive training might be better suited as an early intervention to address working memory deficits. More research is needed to validate cognitive training as a standalone therapy.

4.2. RQ2. What treatment techniques are commonly utilised by ADHD mobile apps?

Previous research, such as that of Sonuga-Barke and Cortese (2018) has recognised the potential of cognitive training to address specific deficits, such as working memory in people with ADHD, although they stress that it should not be considered as the only intervention. On the other hand, Spiel and Gerling (2021) criticise that many games and apps developed for neurodivergent populations follow a traditional medical approach that focuses on correcting perceived deficits rather than promoting more inclusive and self-determined experiences. In our analysis, presented in Table 14, we observed that cognitive techniques are employed in 13.66% of the apps reviewed, reflecting their significant presence in the treatment of ADHD. However, we also found that other techniques, such as auditory processing (2.48%) and spatial reasoning (4.35%), are underrepresented. This finding suggests that, although cognitive techniques are frequently used, there is a lack of diversity in intervention strategies that would support a more comprehensive and balanced approach, as proposed by, Spiel and Gerling (2021) in proposing an application design that addresses the variety of needs of neurodivergent individuals. Therefore, collaboration with experts in the field of ADHD and cognitive development, along with thorough research and user feedback, can inform the mobile app development process and guide decisions regarding the inclusion of specific techniques. Moreover, developers should explore the benefits of combining multiple techniques within a single app, thereby adopting a holistic approach that simultaneously addresses various cognitive domains. This approach has the potential to offer more comprehensive support and enhance the overall effectiveness of the app.

Table 14. Distribution of treatment techniques across ADHD mobile apps.

Technique	%
Cognitive	13.66%
Executive functions	11.80%
Strategy Concentration	9.94%
Memorial	9.32%
Focused Attention	8.07%
Sustained attention	8.07%
Coordination	6.83%
Visual perception	6.83%
survey/display information	6.21%
Spatial attention	4.35%
Spatial Reasoning	4.35%
Logical Exercise	3.11%
Anticipation	2.48%
Auditory	2.48%
Selective Attention	2.48%

From an overall perspective, the mobile app of Schena et al. (2023) supports the greatest number of treatment techniques across all mobile app types, which can be explained by the fact that it was reportedly developed in a meticulously scientific environment. It is a non-commercial video game mobile app relying on six clearly identified treatment techniques, cognitive, coordination, visual perception, spatial attention, logical exercise, and executive functions. On the other hand, Sonne et al. (2016) and Schuck et al. (2016) support the greatest number of treatment techniques in the non-commercial non-video game mobile apps category, employing two techniques each, focused attention, memorial and cognitive, executive functions, respectively. Shimer: ADHD coaching (Google Play Store app) and *ADHD Behavior Toolbox* (App Store app), featured the largest number of treatment techniques in their respective categories. Specifically, Shimer: ADHD coaching showcased five techniques (auditory,

cognitive, visual perception, executive functions and sustained attention), and *ADHD Behavior Toolbox* featured four techniques (strategy concentration, selective attention, focused attention and sustained attention).

We also assessed mobile app preference based on either the number of times a mobile app has been downloaded from the app store (in the case of Google Play Store apps) or the better rated mobile apps (App Store apps). As regards App Store non-video game mobile apps, 63.5% of them cater to children, adolescents, and adults alike, with *PiCal: Visual ADHD Day Planner* being the best rated in this category. In contrast, 70% of the App Store mobile apps are specifically designed for children, adolescents, and adults, with *ADHD Organizer, Planner: Focus* with the highest number of ratings. Only one mobile app is targeted at adults only and has 44 ratings. As regards Google Play Store non-video game mobile apps, 50% of them are tailored to meet the needs of children, adolescents, and adults with ADHD. Among this category, the most frequently downloaded mobile app is *ADHD – causes, diagnosis, and treatmen*t. In contrast, 30% of the Google mobile apps are specifically developed for adolescents and adults, with the most downloaded option being *Routine-Flow: Routine & ADHD*. Mobile apps designed exclusively for adults constitute 20% of the total mobile apps retrieved from Google Play Store, with *ADHD Monitor* being the most downloaded app.

In terms of video game mobile apps, 64.7% of the reviewed mobile apps are specifically developed for children, with Lumosity, Polygrams – Tangram Puzzles, Breathe, Think, Do with Sesame, and *Jumpy Car ADHD* being the most frequently downloaded options on Google Play Store. Furthermore, among the mobile apps intended for children, adolescents, and adults alike, which constitute 23.5% of the total, the most popular video games are Spot it: Find the Difference and *ADHD concentration games*. Among the non-commercial mobile apps, 51% were specifically designed for children, while 19% were aimed at both children and adolescents. In contrast, only 14% of the mobile apps were designed for adults only. No mobile apps were explicitly mentioned as having been tested on children, adolescents, and/or adults in this category.

4.3. RQ3 Which ADHD mobile apps are endorsed by healthcare providers, therapists, and/or physicians?

Our findings indicate that only 23.9% of non-commercial apps collaborate with healthcare institutions, suggesting a lack of integration with clinical experts. This is consistent with the observations of Powell, Parker, and Harpin (2018) and Păsărelu, Andersson, and Dobrean (2020), who noted that many ADHD management technologies lack robust evidence due to a lack of validation by healthcare professionals, limiting their applicability in clinical settings. Cibrian et al. (2022) also highlight that, although emerging technologies such as wearables and virtual reality show great potential to support self-regulation in children with ADHD, most of these solutions are still in the early stages of development and have not been validated in clinical studies. In our review, we observed that commercial apps, such as *Shimer: ADHD* coaching and *EndeavorRx*, which do have the support of experts and official certifications, tend to have greater credibility and acceptance. Notably, *EndeavorRx* stands as the pioneering mobile app to receive FDA approval for the treatment of some ADHD symptoms (FDA Prmits Marketing). It is designed to be used as a part of a therapeutic regimen that includes clinician-directed therapy, medication, and educational programmes to comprehensively address ADHD symptoms. Access to in-game treatment necessitates a prescription or an order from a qualified healthcare provider.

4.4. RQ4 What are the primary gamification elements incorporated in ADHD mobile apps?

Our findings indicate that the most commonly used gamification elements in ADHD apps are Levels (15.75%), Statistics (13.70%), Objectives (10.96%) and Progression (10.96%), reflecting a focus on tracking progress and motivation through measurable achievements. However, there is an absence of elements such as Chance, Novelty and Reputation, which could limit the diversity of experiences within the applications reviewed. This finding may be related to that mentioned by Peñuelas-Calvo et al. (2022), who indicated that video games designed for the treatment of ADHD tend to use mainly gamification and cognitive training to promote performance improvements but highlight that the use of other less common elements could complement the positive effects observed in these interventions. Comparing these results, it appears that incorporating a greater diversity of gamification elements could help make the apps more engaging and possibly increase their impact on ADHD symptom management.

In non-commercial video game apps, performance-related gamification elements – such as levels, points, progression, and acknowledgment – constitute 44.87% of the total, with Levels (19.23%) being the most prominent. This reflects a focus on driving user engagement through achievement tracking. Personal gamification

elements make up 23.08% of the total, with Sensation (14.1%) being particularly significant, showing an effort to engage users' sensory experiences. However, Ecological elements such as Chance, Rarity, and Time Pressure are used sparingly, accounting for 15.38%, suggesting that developers prioritise engagement over creating a realistic, high-pressure environment. Fictional elements, including Narrative and Storytelling, represent 14.10%, adding depth to the user experience but not as a central focus. The absence of strong Social elements (less than 2.56%) suggests that these apps could benefit from incorporating more features that encourage social interaction and collaboration.

In non-commercial non-video game apps, Statistics (26.67%) is the most prominent gamification element, reflecting a strong focus on data-driven feedback. Other key elements include Points and Progression (both at 13.33%), Acknowledgment (10%), and Levels (3.33%), which together represent the focus on performance tracking and rewarding behaviour. Sensation and Objectives, categorised under personal gamification, make up 20% of the elements, indicating an effort to engage users personally. However, Narrative (3.33%) and Economy (10%) are underutilised, limiting the apps' ability to offer immersive experiences. The absence of Social gamification elements further reduces the potential to foster cooperative interactions and community support among users.

In commercial video game apps, performance-related elements lead, comprising 66.67% of the total, with Levels (33.33%) and Progression (22.22%) being particularly prevalent. This emphasis on goal-oriented engagement highlights developers' focus on structured progress. Acknowledgment (11.11%) and Personal elements like Sensation and Objectives (both at 11.11%) are also present, reflecting efforts to cater to individual user preferences. Storytelling, a key part of the Fictional dimension, is present in 11.11% of apps, but its limited use indicates missed opportunities to deepen user engagement through narrative. The absence of Social and Ecological elements suggests that these apps could benefit from incorporating more varied strategies to promote interaction and environmental engagement, which may improve user outcomes.

In commercial non-video game apps, the Performance dimension leads, accounting for 55% of gamification elements in the Apple App Store and 81.82% in the Google Play Store. Statistics is especially prominent in Google Play Store apps at 72.73%, while Apple apps incorporate a broader range of elements, including Objectives (20%), Cooperation (10%), and Sensation (10%). Additionally, Google Play Store apps feature Objectives and Cooperation (both at 9.09%), suggesting an attempt to introduce goal-setting and some social interaction. However, the absence of Fictional elements, such as Storytelling, across both stores indicates a missed opportunity to create more immersive, narrative-driven experiences that could further engage users managing ADHD.

4.5. Challenges and trends

The growing body of research on ADHD and the use of technology in its treatment has highlighted several trends and challenges. Our findings concur with those of Baykal, Van Mechelen, and Eriksson (2020) and Börjesson et al. (2015), reinforcing the importance of involving children with diverse developmental conditions in the design process and adopting standardised evaluation criteria. Despite these recommendations, many ADHD apps still fall short in inclusivity and usability, underscoring the ongoing need for user-centered improvements.

However, the time lag between publications and their availability in virtual app stores raises some questions about the practical application and marketing of these mobile apps. *SmartCAT* and *ADHD Trainer*, for example, were published in 2014 but were not commercially available until 2020 and 2017, respectively. This delay can be attributed to several factors, including the need for further development, rigorous testing, and obtaining regulatory approval. It also highlights the challenges of translating research and development into practical mobile apps ready for public use. This finding aligns with the insights from Cibrian, Hayes, and Lakes (2020), who discuss the significant hurdles in moving from research to real-world application, highlighting the gap between development and practical adoption in daily settings. Further supporting this point, Sofian, Hashim, and Ahmad (2018) also emphasise the technical and logistical challenges in mobile app development, including platform fragmentation and performance optimisation, which can hinder the successful deployment of research-based applications.

Mobile apps such as *Peak*, *Inflow*, and *doBrain* were published and made available in digital stores in the same year. This suggests a more agile process, possibly indicative of technological advances, greater efficiency in mobile app development, or a greater emphasis on timely commercialisation. It would be interesting to delve deeper into the factors that facilitated this simultaneous release and availability, as well as the implications for users and the mobile app market. The case of *ADHD Coping Card* is also worth discussing, the mobile app has been available on App Store since 2021, despite being published in the literature in 2023.

Table 15. Non-commercial mobile apps for ADHD available for public use.

Mobile app name	Platform
SmartCAT (Pramana et al. 2014)	Apple
ADHD Trainer (Ruiz-Manrique, Tajima-Pozo, and Montañes-Rada 2014)	Android
Peak (Savulich et al. 2019)	Apple Android
Inflow ADHD (Knouse et al. 2022)	Apple Android
DoBrain (Ha et al. 2022)	Apple Android
ADHD Coping Card (Păsărelu, Kertesz, and Dobrean 2023)	Apple
AkI-T0 – EndeavorRx (Kollins et al. 2020; Stamatis, Mercaldi, and Kollins 2023)	

This raises questions about the reasons for the time gap and the motivations for releasing the mobile app to the public earlier. One could speculate that the developers felt it was useful to make the mobile app available to users earlier, perhaps to meet an immediate need or gather real-world feedback before finalising the research and publishing the results. However, further research and more information from the developers would be needed to fully understand the reasoning behind this timing. As such, further exploration of the reasons behind these timelines and their implications may provide valuable information about the evolving landscape of ADHD mobile app development and its impact on people with ADHD.

Moreover, a discernible upward trend is evident in the evolution of mobile apps designed for ADHD management. Several mobile apps, originally conceived as research projects, are now accessible for commercial use, as detailed in Table 15.

Furthermore, our review has identified applications that leverage wearable technology for their operational features. This refers to electronic devices that are incorporated directly into clothing or worn on the body to provide advanced functionalities and, in many cases, monitoring various biological or performance metrics. As shown in Table 16, the most widespread wearable on the market is the BCI headset, with Emotiv Epoc at the top of the list. However, there are also alternative brands such as Muse, NeuroSky MindWave, and Mendi. As for the use of cameras, in the literature analyzed, the use of cameras integrated into the device or webcams prevails, although it is acknowledged that there are cameras specialised in eye tracking such as Tobii Eye Tracker (Tobii Eye Tracker 5) and infrared cameras such as Boson Plus. Radiofrequency communication, on the other hand, is facilitated by devices such as RFDuino, among others. Finally, the use of the Kinect device and the integration of smartphone sensors, including gyroscope and accelerometer, represent additional approaches within this panorama.

Table 16. Wearable technology in non-commercial ADHD mobile apps.

Wearable type	Number of papers
BCI Headsets	3 (Alchalcabi, Eddin, and Shirmohammadi 2017; Shenjie et al. 2014; Thomas, Vinod, and Guan 2013b)
Camera	3 (Liu et al. 2022; Park, Lee, and Lee 2021; Perochon et al. 2023)
Radio Frequency (RF) communication	2 (De La Guía, Lozano, and Penichet 2015; Sonne and Jensen 2016)
Phone sensors	1 (Young et al. 2014)

Furthermore, we observed a significant absence of clear information within the mobile apps regarding the handling of patient data, especially in video game mobile apps. It is crucial for developers to explicitly state how patient data is managed and the security measures in place to protect privacy and safeguard patient information. While the discussion of security and privacy falls beyond this work's scope, this aspect warrants attention for the sake of transparency and user trust.

Baykal, Van Mechelen, and Eriksson (2020), Börjesson et al. (2015), Spiel and Gerling (2021) further emphasise the shift from the medical model of disability to participatory design, integrating neurodivergent perspectives to improve methodological clarity and inclusiveness in technology research. These participatory approaches are critical for developing mobile apps that truly meet the needs and preferences of children with ADHD, fostering better engagement and outcomes. Additionally, the current study underscores the importance of medical endorsements who plays a crucial role in enhancing the credibility and acceptance of ADHD mobile apps among users, caregivers, and healthcare professionals. For instance, Kollins et al. (2020) demonstrated that mobile apps endorsed by reputable medical institutions, such as Duke University Health System and Johns Hopkins Medical Center, were more likely to be trusted and utilised effectively by users.

Furthermore, the inclusion of gamification elements has been shown to significantly improve user engagement and adherence to treatment protocols. Hoffmann et al. (2020) demonstrated that gamification in stress management mobile apps can positively influence patients' motivation and engagement, thereby promoting the learning of stress management techniques. Elements such as points, levels, and progression make therapeutic activities more engaging and enjoyable, increasing the likelihood of sustained use. Toda et al. (2019) emphasised that gamification elements enhance educational environments by making tasks more appealing and interactive, a principle that can be extended to ADHD mobile apps. Building on these

findings, future work could focus on incorporating a broader range of gamification techniques, such as novelty and social connection, to further enhance the therapeutic experience and user engagement in ADHD apps. While current apps frequently rely on performance-related elements like levels, progression, and statistics, integrating less utilised elements – such as chance, novelty, and social features like cooperation and competition – could diversify and enrich the user experience. Social interaction through cooperative tasks or competitive scenarios could encourage sustained engagement, while elements of novelty might stimulate curiosity and adaptability. By aligning these advanced gamification strategies with evidence-based treatment techniques, future ADHD mobile aps can address symptom management while fostering a more holistic and motivating therapeutic approach.

Therefore, in the development of mobile apps designed to manage ADHD, several critical challenges need to be addressed:

- Defining the target population and determining appropriate gamification elements: It is imperative to customise the mobile app to meet the unique needs and characteristics of individuals with ADHD, ensuring that the selected gamification elements are suitable and effective in enhancing engagement and therapeutic outcomes.
- Establishing communication and collaboration with specialists: This entails incorporating features within the mobile app that allow users to consult or seek guidance from healthcare professionals. Additionally, securing medical endorsement for the app's development and functionalities ensures credibility and expertise in the field.
- Exploring the integration of biofeedback mechanisms in commercial applications: By incorporating biofeedback technologies, the mobile app can provide users with real-time information on physiological or cognitive measures. This facilitates self-regulation and enhances the effectiveness of intervention strategies.
- Prioritising security and privacy of patient data: Due to the sensitive nature of health-related information, robust security measures must be implemented, adhering to relevant privacy regulations to safeguard patient data.
- Encouraging the availability of mobile apps with scientific publications and accessibility in online stores: Emphasising both scientific validation and availability in online stores ensures that evidence-based interventions reach a wider audience, promoting their adoption and impact in clinical settings and daily life.
- Incorporating psychometric properties within mobile apps: By integrating validated assessments and measurement tools, mobile apps can gather pertinent data to monitor progress, assess symptom severity, and provide personalised feedback to users. This inclusion of psychometric properties enhances the clinical utility of the mobile app and contributes to evidence-based practice.

5. Limitations

Although this review provides a comprehensive analysis, it is essential to recognise several significant limitations.

- This review focused exclusively on articles that design or create a mobile app of their own, excluding those that only test a pre-existing app.
- The review focused on mobile apps that primarily employ a smartphone or tablet-type interface, excluding those that rely exclusively on web pages, SMS, or other forms of user interaction.
- The review focused on video game and non-video game applications specifically designed for individuals with ADHD. Consequently, general applications that offer beneficial features for ADHD management, but were not specifically designed for ADHD, were omitted.
- In the case of commercial mobile apps, the selection criteria included only those with more than 1,000 downloads in the Google Play Store and at least one rating in the App Store.
- The review did not delve into patient data security and privacy measures.
- The analysis of the technology utilised in the mobile apps was not addressed, thereby excluding them from the scope of the review embedded technologies and wearable devices.
- The findings are limited in their applicability to specific linguistic and cultural contexts due to the exclusion of non-English language mobile apps.
- Mobile apps outside of the Apple App Store and Google Play Store were not reviewed.
- A comprehensive or systematic analysis of the medical endorsement that the mobile apps are intended to provide was not performed.

Addressing these limitations in future research is crucial to expanding the knowledge and effectiveness of applications designed for managing ADHD. Including embedded technologies and wearable devices could provide a more comprehensive view of the available technological options. Additionally, considering applications in other languages and diverse cultural

contexts will enhance the global relevance of the findings. Delving deeper into the analysis of security and privacy measures will strengthen users' trust in these applications. Moreover, exploring alternative distribution platforms could reveal innovative solutions do not present in the major mobile app markets. Evaluating the effectiveness of pre-existing applications will offer a solid evidence base for their utility, helping to create a more comprehensive and robust framework for the development and evaluation of ADHD management applications. Finally, a comprehensive and systematic analysis of the medical endorsement provided by these mobile apps, including quantitative and qualitative assessments, will help to understand how these mobile apps are integrated into medical treatment regimens. This will create a more comprehensive and robust framework for the development and evaluation of ADHD management mobile apps.

6. Conclusion

This scoping review aimed to investigate the availability of ADHD support mobile apps across both scientific literature and the most well-known virtual app stores (App Store and Google Play Store). For clarity purposes, the reviewed mobile apps were categorised as either commercial or non-commercial and further differentiated as video games or non-video games. The study identified a wide range of mental health mobile apps aimed at people with ADHD, as well as their parents and caregivers. The review specifically comprises 35 mobile apps retrieved from the app stores and 37 reported in the literature. We comprehensively examined various aspects of these mobile apps, including their characteristics, empirical evidence supporting their use, content, design features, treatment approaches, and gamification elements. During the analysis of these applications, it became evident that the participation of medical specialists in the field of ADHD is frequently omitted. Moreover, when such participation is mentioned, the specific number of specialists involved, and the nature of their contributions are not specified. This underscores the imperative need to ensure their active collaboration or supervision in this area. Additionally, we found two mobile apps requiring permission or a prescription for full access, indicating limited availability (*ADHD Cognitive Research* and *EndeavorRx*).

Notable differences exist between commercial and non-commercial mobile apps, with non-commercial mobile apps emphasising therapeutic interventions and parental support. In contrast, commercial mobile apps prioritise organisational tools and clinical diagnostic support. Developers should consider striking a balance between cost-effectiveness and comprehensive solutions, incorporating a broader range of evidence-based treatment modalities to improve outcomes for individuals with ADHD. The development of mobile apps designed for people with ADHD holds great promise for providing comprehensive support and improving treatment outcomes. Given the common incidence of deficits in executive function and sustained attention among people with ADHD, it is imperative to consider the diverse range of cognitive profiles among them. App developers should strive to incorporate techniques that cater to a broader spectrum, such as auditory processing, selective attention, spatial reasoning, and anticipatory skills. As for gamification, we found a wide range of gamification elements across the various types of mobile apps (i.e. commercial, non-commercial, video games, and non-video games). Performance-related gamification elements, such as Levels, Progression, and Points, predominate in both non-commercial and commercial ADHD mobile apps. This reflects a strong focus on motivating users by tracking and acknowledging their progress. Elements related to the Ecological, Social, and Fictional dimensions are often absent, limiting the potential for providing a holistic and engaging user experience. Therefore, a suggestion for future research is to delve into the reasons behind these trends and their impact on user engagement and experience, thus contributing to the development of effective and engaging ADHD mobile apps tailored to individual needs.

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