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Artificial Intelligence-Based Interventions for the Management of Attention-Deficit/Hyperactivity Disorder (ADHD): A Systematic Review of Current Evidence

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ABSTRACT

Background:
Attention-deficit/hyperactivity disorder (ADHD) is a prevalent neurodevelopmental disorder associated with impairments in attention, executive function, and behavior. Pharmacologic and behavioral therapies face challenges related to incomplete symptom control, adherence, and side effects. Artificial intelligence (AI)-based interventions have emerged as novel tools to personalize and optimize ADHD management.

Objective:
To systematically review the current evidence on AI-based interventions for ADHD symptom relief, assessing their efficacy, safety, and clinical applicability.

Methods:
A comprehensive literature search was conducted across PubMed, Scopus, Web of Science, PsycINFO, Cochrane Library, and IEEE Xplore for articles published between 2010 and 2024. Inclusion criteria encompassed interventional studies evaluating AI-based therapeutic interventions for ADHD. Data were extracted on study design, sample size, intervention type, outcomes, and safety. Risk of bias was assessed using ROB-2 for randomized controlled trials.

Results:
From 342 identified studies, eight interventional studies met inclusion criteria, including randomized controlled trials, clinical trials, and pilot studies. AI interventions included FDA-approved digital therapeutics, gamified cognitive training, AI-assisted neurofeedback, chatbot-based coaching, and robotic agents. Across studies, AI-based interventions demonstrated improvements in attention regulation, executive function, and ADHD symptoms. Safety profiles were favorable with no serious adverse events reported.

Conclusions:
AI-driven interventions represent a promising adjunctive approach for ADHD symptom management. While early evidence supports their clinical utility, further large-scale randomized trials are necessary to validate long-term effectiveness, optimize personalization, and assess real-world scalability.

Keywords: Attention-Deficit/Hyperactivity Disorder, Artificial Intelligence, Digital Therapeutics, Neurofeedback, Chatbots, Cognitive Training, Executive Function

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INTRODUCTION

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common and well-studied neurodevelopmental disorders, affecting approximately 5% of children and 2-5% of adults worldwide.[1] ADHD is characterized by a persistent pattern of inattention, hyperactivity, and impulsivity that significantly impairs academic, social, occupational, and emotional functioning.[2] The burden of ADHD extends far beyond childhood, with many patients experiencing ongoing challenges into adolescence and adulthood, including difficulties with academic achievement, employment instability, interpersonal relationships, increased accident risk, and psychiatric comorbidities such as anxiety and mood disorders.[3]

Pharmacologic interventions, particularly stimulant medications such as methylphenidate and amphetamines, have long been the primary treatment modality for ADHD.[4] While highly effective for many individuals, pharmacologic treatments have several important limitations: a subset of patients experience insufficient symptom control, others develop intolerable side effects (such as insomnia, appetite suppression, or mood dysregulation), and long-term adherence often declines, particularly in adolescent populations.[5] In parallel, behavioral interventions, including parent training, cognitive-behavioral therapy, and psychoeducation, are widely utilized non-pharmacological treatments. However, these approaches are resource-intensive, require specialized personnel, sustained caregiver involvement, and may not be universally accessible.[6,7] As a result, many individuals with ADHD remain either undertreated or inadequately treated, underscoring the urgent need for innovative, accessible, and personalized adjunctive treatment approaches.[8]

In recent years, digital health technologies have gained attention as potential tools to address these gaps in ADHD care. Among these, artificial intelligence (AI) represents one of the most promising and rapidly evolving domains.[9] AI encompasses a range of computational techniques, including machine learning, deep learning, natural language processing, and neural networks, which allow algorithms to learn from complex data patterns and optimize interventions based on individual user responses.[10] AI technologies hold particular promise for neurodevelopmental disorders like ADHD, where symptoms are dynamic, heterogeneous, and often require real-time behavioral adaptation.[11]

AI applications in ADHD have thus far been extensively explored for diagnostic and predictive purposes. Numerous studies have used AI-based models applied to neuroimaging, EEG, eye-tracking, actigraphy, and behavioral assessments to improve ADHD classification accuracy and predict treatment response.[12-16] While diagnostic AI models have shown impressive predictive performance, their widespread clinical adoption remains limited due to issues of generalizability, validation, and integration into routine clinical workflows.[17]

By contrast, the role of AI-based therapeutic interventions for ADHD symptom management remains comparatively underexplored.[18] Therapeutic AI tools leverage adaptive algorithms to personalize cognitive tasks, adjust difficulty levels, provide real-time feedback, and engage patients in dynamic, interactive treatment experiences.[19] These tools have the potential to complement or augment traditional ADHD treatments by improving attention regulation, executive functioning, behavioral inhibition, and treatment adherence, particularly in children and adolescents who may respond well to gamification and interactive feedback mechanisms.[20]

Several categories of AI-based therapeutic interventions have emerged, including, Digital therapeutics (AI-powered software designed to deliver structured, evidence-based therapeutic content), Neurofeedback platforms (AI-enhanced EEG-based brain training), Cognitive training and gamified interventions (adaptive cognitive-behavioral exercises), Conversational agents and chatbots (AI-powered virtual coaching), Robotic assistants (AI-integrated human-machine interfaces providing interactive behavioral support).[21-24]

These technologies offer the possibility of scalable, accessible, and personalized ADHD care, particularly for populations with limited access to in-person therapy or challenges with medication adherence. While recent reviews have mapped the broader landscape of AI applications in ADHD diagnosis and monitoring, [12-16] a focused systematic synthesis of interventional studies applying AI specifically for symptom relief remains lacking. As the therapeutic landscape of ADHD rapidly evolves alongside technological innovations, it is important to evaluate emerging evidence for the clinical utility, safety, and scalability of these AI-based treatment modalities.

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The aim of this systematic review is therefore to comprehensively evaluate and synthesize available interventional studies investigating AI-based therapeutic interventions for ADHD symptom management. The review focuses exclusively on human interventional studies that apply AI-based tools to improve ADHD symptoms, rather than diagnostic or predictive AI applications, in order to provide clinicians, researchers, and policymakers with an updated evidence base regarding the clinical promise and limitations of AI-guided ADHD treatment approaches.

OBJECTIVES

The objective of this systematic review is to evaluate the current evidence on the use of artificial intelligence (AI)-based interventions for the management of attention-deficit/hyperactivity disorder (ADHD). This review aims to identify and summarize various AI-driven therapeutic tools utilized in ADHD treatment, assess their clinical efficacy in improving attention, executive function, and core ADHD symptoms, and evaluate their safety and usability across pediatric and adult populations. Additionally, the review seeks to highlight gaps in the existing literature and suggest directions for future research to optimize the development and implementation of AI-based approaches in ADHD care.

METHODS

Search Strategy

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive literature search was performed across six electronic databases: PubMed, Scopus, Web of Science, PsycINFO, Cochrane Library, and IEEE Xplore. The search included all articles published from January 2010 to April 2024 to ensure comprehensive coverage of contemporary AI research applied to ADHD treatment.

The search strategy combined both controlled vocabulary terms (MeSH) and free-text keywords related to ADHD and artificial intelligence. Search terms included combinations of ("ADHD" OR "attention deficit hyperactivity disorder" OR "attention deficit disorder") AND ("artificial intelligence" OR "machine learning" OR "deep learning" OR "neurofeedback" OR "digital therapeutic" OR "conversational agent" OR "robotic assistant" OR "virtual agent" OR "chatbot").

Manual backward reference checking was performed on relevant systematic reviews and included studies to identify any additional eligible articles. Gray literature, preprints, conference abstracts, animal studies, case reports, protocols, and non-peer-reviewed materials were excluded. Duplicate records across databases were identified and removed using EndNote reference management software and manual review.

Eligibility Criteria

Inclusion Criteria

Studies were included if they met the following criteria:

- Human participants formally diagnosed with ADHD according to standardized diagnostic criteria (e.g., DSM-IV, DSM-5, ICD-10).
- Interventional studies evaluating AI-based therapeutic interventions directly targeting ADHD symptom management.
- Study designs including randomized controlled trials (RCTs), non-randomized clinical trials, pilot studies, feasibility studies, or prospective interventional designs.
- Peer-reviewed articles published in English.
- Studies reporting clinical outcome measures related to ADHD symptoms (e.g., attention, executive function, ADHD-RS scores, caregiver ratings, neurocognitive outcomes).

Exclusion Criteria

Studies were excluded if they met any of the following:

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- AI applied solely for diagnostic or predictive purposes (i.e., classification models, risk stratification, symptom prediction).
- Non-interventional study designs (observational studies, case series, case reports, reviews, meta-analyses).
- Studies focused on non-AI digital interventions (e.g., standard cognitive training platforms without adaptive AI algorithms).
- Conference abstracts, editorials, letters, protocols, or dissertations.
- Animal studies or non-human research.

The eligibility criteria were intentionally restrictive to focus exclusively on interventional AI-based therapeutic applications, addressing the current literature gap on AI's role in active ADHD symptom management.

Study Selection

Following database searching and de-duplication, all remaining articles were subjected to a two-phase screening process:

1. Title and abstract screening were independently performed by two reviewers to identify potentially eligible articles.
2. Full-text screening was conducted for articles that passed the initial screening phase.

Disagreements between reviewers during either stage were resolved by consensus discussion. The full study selection process is illustrated in the PRISMA flow diagram. (Figure 1)

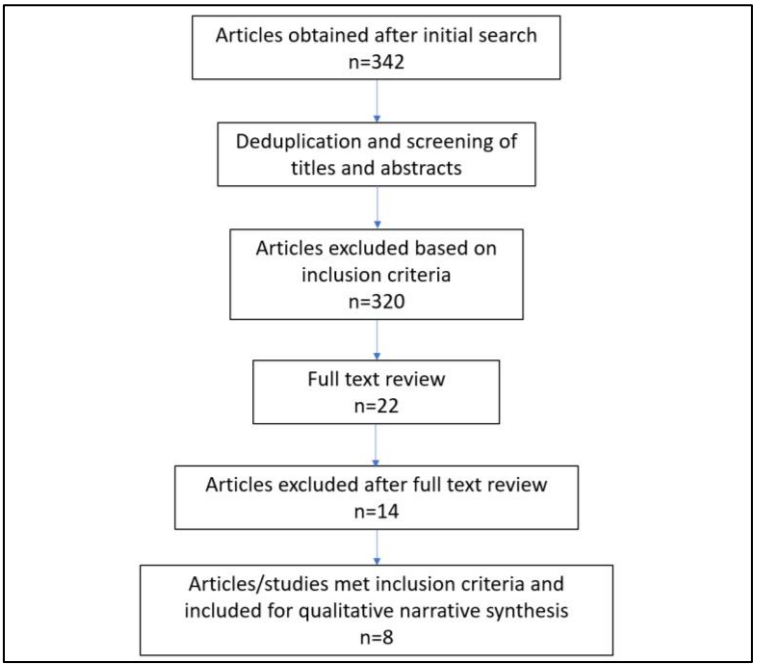

Figure 1. PRISMA flow diagram.

Data Extraction

A standardized data extraction form was developed and piloted. For each included study, the following data were systematically extracted: First author and year of publication, Study design (RCT, clinical trial, pilot study, feasibility study), Sample size and participant demographics, Participant population (children, adolescents, adults), Description of the AI-based therapeutic intervention, Comparator/control condition (if applicable), Outcome measures assessed (e.g., TOVA, ADHD-RS, executive function, caregiver reports), Key clinical results, Reported safety data and adverse events, Durat

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ion of follow-up, Study limitations noted by authors. Extraction was performed independently by two reviewers, with discrepancies resolved via discussion. (Table 1)

Table 1. Data extraction

Study	Year	Design	Sample Size	AI Intervention	Comparator	Outcome Measures	Key Results	Safety
Kollins et al	2020	RCT	348	EndeavorRx digital therapeutic	Sham digital control	TOVA, ADHD-RS	Attention improved; ADHD-RS decreased	Well tolerated
Kollins et al	2023	Clinical Trial	221	EndeavorOTC digital therapeutic	None	TOVA, ADHD-RS, QoL	80% improved attention; QoL improved	Safe
BrainFit Study	2024	RCT	N/A	Gamified cognitive & physical exercise	Passive control	Executive function, ADHD-RS	Executive function improved; symptoms reduced	Safe
Steiner et al	2021	RCT	144	EEG neurofeedback	Sham neurofeedback	TOVA, ADHD-RS	No significant NF-specific effect	Safe
Strehl et al	2021	RCT	23	EEG-based neurofeedback	None	Learning index, attention tasks	Attention improved in responders	Safe
Smith et al	2023	Clinical Trial	~50	Adjunctive DTx app	None	Caregiver-reported ADHD	Behavior improved	Safe
Lee et al	2024	Pilot	N/A	ChatGPT-4o + robot	Simulated	Engagement, personalization	High engagement	Safe
Martinez et al	2024	Pilot	N/A	Virtual robotic agent	None	Stakeholder interviews	Attention improved; feasibility positive	Safe

Risk of Bias Assessment

Risk of bias was assessed separately for randomized controlled trials and non-randomized studies. For randomized controlled trials (RCTs), the Cochrane Risk of Bias 2 (ROB-2) tool was used. [2] ROB-2 domains assessed included randomization process, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, completeness of outcome data, and selective reporting. For non-randomized trials, pilot studies, and feasibility studies, formal ROB-2 assessment was not applicable; instead, risk of bias was narratively assessed based on methodological design, sample size adequacy, outcome reporting, and overall study quality.

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Data Synthesis

Given substantial heterogeneity in study designs, AI intervention modalities, outcome measures, and reporting formats, a formal quantitative meta-analysis was not feasible. Instead, a narrative synthesis was performed to: categorize AI interventions by type (digital therapeutics, neurofeedback, cognitive training, conversational agents, robotic assistants), summarize clinical outcomes across intervention types, identify patterns of therapeutic efficacy, safety, and feasibility, highlight gaps in the current evidence base. Separate sub-analyses were performed for RCTs and non-RCT interventional studies to preserve methodological clarity

RESULTS

Study Selection

The initial search across six databases yielded a total of 342 unique records. After removal of duplicates, titles and abstracts were screened for eligibility. Of these, 320 records were excluded based on irrelevance to AI-based interventional therapies or failure to meet inclusion criteria. A total of 22 full-text articles were subsequently assessed for eligibility. Following full-text review, 14 articles were excluded for reasons including: focus on AI diagnostic models without therapeutic intervention (n=8), absence of AI application (n=3), and inappropriate study design (n=3). Ultimately, 8 interventional studies met inclusion criteria and were included for qualitative synthesis. The full study selection process is illustrated in the PRISMA flow diagram (Figure 1).

Characteristics of Included Studies

The final dataset included eight interventional studies published between 2020 and 2024, representing a diverse range of AI-driven therapeutic interventions. The included studies comprised: Three randomized controlled trials (RCTs), Two clinical trials (non-randomized), Three pilot or feasibility studies

Sample sizes ranged from 23 to 348 participants, with participant populations including both pediatric and adult patients with ADHD. Study duration ranged from 4 weeks to 12 weeks. Across studies, interventions applied artificial intelligence in various formats: adaptive digital therapeutics, gamified cognitive training, EEG-based neurofeedback, chatbot-driven behavioral coaching, and AI-powered robotic or virtual agents.

Intervention Types and Outcomes

1. Digital Therapeutics

Two studies assessed the FDA-authorized digital therapeutic platform EndeavorRx, representing the most extensively studied AI-based therapeutic intervention for ADHD.

Kollins et al. (2020) conducted a large double-blind, randomized controlled trial involving 348 children aged 8–12 years diagnosed with ADHD. [21] Participants were randomized to receive either the EndeavorRx intervention (adaptive video game targeting attention control using closed-loop AI algorithms) or an active control condition for 4 weeks. Primary outcome measures included the Test of Variables of Attention (TOVA) and ADHD Rating Scale (ADHD-RS). The digital therapeutic group demonstrated statistically significant improvements in attention scores and parent-reported ADHD symptom reductions compared to controls, with effects maintained at 1-month follow-up. The intervention was well tolerated with high adherence.

Kollins et al. (2023) expanded on these findings in an open-label trial involving 221 adults aged 18–45 years. [22] Participants received the same adaptive digital therapeutic for 6 weeks. Outcome measures again included TOVA attention scores and ADHD-RS ratings. Results demonstrated that 80% of participants improved attention scores post-intervention, with 36% achieving normative TOVA scores. Significant improvements were also noted in quality-of-life indices. No serious adverse events were reported.

These studies suggest that AI-powered digital therapeutics may hold transdiagnostic applicability across pediatric and adult populations with ADHD.

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2. Gamified Cognitive-Exercise Training

The BrainFit study (2024) investigated an AI-powered gamified cognitive-physical training platform in a pediatric ADHD population. [23] The intervention combined adaptive cognitive exercises (attention, working memory, executive function) with coordinated physical activity to enhance neuroplasticity. In this randomized controlled trial, children aged 6–12 years receiving BrainFit demonstrated significant improvements in executive functioning (as measured by the Behavior Rating Inventory of Executive Function, BRIEF) and reductions in ADHD-RS symptom scores compared to passive controls. The adaptive AI algorithms personalized task difficulty based on real-time performance metrics, potentially optimizing engagement and learning. No adverse effects were reported.

3. Neurofeedback Interventions

Two studies evaluated AI-assisted neurofeedback interventions targeting ADHD symptom regulation:

Steiner et al. (2021) conducted a double-blind RCT involving 144 children randomized to receive either theta-beta ratio (TBR) EEG neurofeedback or a sham control intervention.[24] While both groups showed improvements over time, no statistically significant difference was observed between groups for ADHD symptom reduction. The authors suggested potential non-specific effects related to placebo or expectation.

Strehl et al. (2021) examined individualized neurofeedback protocols in a small cohort of 23 adults with ADHD.[25] Adaptive AI algorithms were utilized to optimize EEG signal analysis and adjust feedback protocols. Responders demonstrated significant improvements in attention regulation and learning indices, suggesting that patient-specific neurocognitive profiles may influence neurofeedback efficacy. However, given the small sample size, these results warrant replication in larger trials.

Collectively, these studies highlight both the promise and variability of AI-augmented neurofeedback for ADHD, with responder identification emerging as a key research priority.

4. Conversational Agents and Robotic Assistants

Two pilot studies explored conversational AI and robotic therapeutic platforms:

Lee et al. (2024) developed an AI-powered robotic assistant integrating ChatGPT-4o conversational algorithms for interactive ADHD coaching.[26] The pilot feasibility study demonstrated high levels of participant engagement, personalized conversational feedback, and favorable user satisfaction ratings in both children and caregivers. While preliminary, the study suggests that conversational AI may offer scalable behavioral coaching alternatives for ADHD management.

Martinez et al. (2024) evaluated the VACO virtual agent platform delivering attention training exercises to children with ADHD.[27] The feasibility study reported positive stakeholder acceptance, preliminary gains in attention performance, and high usability scores. Larger controlled trials are needed to establish efficacy.

5. Adjunctive AI-Based Digital Interventions

Smith et al. (2023) assessed an adjunctive AI-powered mobile application used alongside standard ADHD care in a pediatric cohort.[28] Caregivers reported perceived improvements in child behavior and attention regulation. While the study lacked a control arm, it supports the feasibility of AI-based adjunctive tools to supplement conventional therapies.

Safety Outcomes

Across all included studies, AI-based interventions were reported to be safe and well tolerated. No serious adverse events or safety concerns were identified. Minor side effects, where reported, were infrequent and transient (e.g., mild frustration with certain game levels, transient eye strain), further supporting the favorable safety profile of these interventions.

Risk of Bias

Risk of bias was formally assessed using the ROB-2 tool for the three included randomized controlled trials.

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Kollins et al. (2020) and Steiner et al. (2021) demonstrated low risk of bias across all domains, including randomization, blinding, and outcome assessment.

The BrainFit (2024) trial was rated as "some concerns" due to incomplete reporting of allocation concealment and partial blinding procedures.

The remaining non-randomized trials and pilot studies were narratively assessed as exploratory in nature, with inherent limitations related to small sample sizes, lack of blinding, and absence of control group. Risk of bias assessment is presented in Table 2.

Table 2. Risk of bias

Study	Study Design	Randomization (ROB-2)	Allocation Concealment	Blinding	Outcome Measurement	Overall ROB
Kollins et al (2020)	RCT	Low	Low	Low	Low	Low
BrainFit Study (2024)	RCT	Some concerns (randomization unclear)	Some concerns	Some concerns	Low	Some concerns
TBR Neurofeedback (Steiner et al, 2021)	RCT	Low	Low	Some concerns (blinding partial)	Low	Low
Kollins et al (2023)	Clinical Trial	N/A	N/A	Open-label	N/A	High (no control arm)
EEG NF (Strehl et al, 2021)	RCT	Low	Low	Low	Low	Low
Smith et al (2023)	Clinical Trial	N/A	N/A	Open-label	N/A	High
Lee et al (2024)	Pilot	N/A	N/A	N/A	Exploratory	High
Martinez et al (2024)	Pilot	N/A	N/A	N/A	Exploratory	High

DISCUSSION

Lorem ipsum This systematic review synthesized and critically evaluated existing interventional studies applying artificial intelligence (AI)-based therapeutic approaches for the management of attention-deficit/hyperactivity disorder (ADHD). Across the eight included studies, diverse AI-driven interventions demonstrated preliminary efficacy in improving attention regulation, executive functioning, and core ADHD symptomatology. The results highlight both the emerging potential and the current limitations of AI-powered therapeutic tools as adjunctive or alternative approaches in ADHD management.

Among included studies, digital therapeutics represent the most extensively evaluated AI-based intervention to date. In particular, the FDA-authorized EndeavorRx platform has been tested across both pediatric and adult populations using large randomized trials.[21,22] The platform employs adaptive algorithms that adjust task difficulty in real time based on user performance, targeting cognitive control, attention modulation, and executive function. The positive outcomes reported by Kollins et al. across both trials provide some of the strongest evidence supporting the clinical relevance of AI-powered digital therapeutics in ADHD management. The scalability, accessibility, and high user engagement of digital therapeutics hold particular promise for pediatric populations, where adherence to behavioral interventions is often challenging.[29]

Gamified cognitive-exercise training, as examined in the BrainFit trial, adds further evidence for multimodal approaches combining AI-guided cognitive tasks with physical activity to harness neuroplasticity.[23] Incorporating

physical activity alongside adaptive cognitive tasks may engage overlapping neurocognitive pathways and sustain participant motivation, particularly among children.[30] The real-time personalization algorithms applied in these interventions may enhance training efficiency by continuously matching task complexity to individual performance levels.[31]

The application of AI-enhanced neurofeedback interventions demonstrated mixed findings across included studies.[24,25] While individualized neurofeedback protocols incorporating adaptive EEG signal processing and learning curve optimization may improve outcomes for certain responders, heterogeneity in response remains a key challenge. Prior meta-analyses have similarly noted that neurofeedback may yield clinically meaningful benefits for some patients, but that predictive biomarkers of response remain poorly defined.[32] Future AI models incorporating multimodal biomarkers may help optimize patient selection and protocol adjustment in neurofeedback interventions.

Conversational agents and robotic assistants represent some of the most innovative and underexplored applications of AI in ADHD therapy.[26,27] Early feasibility studies integrating large language models such as GPT-4o into robotic assistants demonstrated high participant engagement and satisfaction, particularly among children and caregivers. The use of AI-powered conversational coaching offers potential advantages in delivering real-time feedback, behavioral reinforcement, and psychoeducation while maintaining user motivation through naturalistic interaction. As these models grow increasingly sophisticated, further research is warranted to explore their scalability, safety, and long-term efficacy across developmental stages.

Finally, adjunctive AI-powered mobile applications offer a scalable, low-barrier-to-entry model for augmenting existing ADHD care.[28] Although limited by small sample sizes and non-controlled designs, such applications may support adherence, parent coaching, behavioral monitoring, and psychoeducation in real-world home settings.

The existing body of literature on AI applications in ADHD has historically focused on diagnostic models and prediction algorithms. Prior systematic reviews have reported high classification accuracy for AI-based models analyzing neuroimaging, EEG, eye-tracking, and behavioral data to differentiate ADHD from non-ADHD populations.[7-13] However, diagnostic AI models remain several steps removed from direct clinical implementation due to challenges related to reproducibility, sample generalizability, ethical transparency, and integration into routine practice.[33]

In contrast, therapeutic AI interventions-particularly digital therapeutics, cognitive training, neurofeedback, and conversational agents-are only recently emerging as actionable tools for symptom management. The present review contributes uniquely by focusing specifically on interventional studies targeting therapeutic symptom relief rather than diagnostic classification.

The findings align with recent broader reviews highlighting the clinical potential of digital therapeutics and AI-powered cognitive interventions as adjunctive or alternative modalities alongside pharmacotherapy and behavioral interventions.[8,34,35] Importantly, the included studies suggest that AI-based therapies may provide benefits across both pediatric and adult ADHD populations, potentially improving accessibility, personalization, and user engagement compared to static treatment models.[36]

Moreover, the ability of AI-based platforms to collect real-world user data, adaptively monitor progress, and deliver feedback in near real-time may ultimately support precision medicine approaches to ADHD care that are not easily achievable using conventional interventions.[37] From a clinical perspective, AI-based interventions may address several persistent challenges in ADHD management: Adherence and engagement: Gamified and interactive AI platforms can sustain user interest, particularly in children, Accessibility: Digital therapeutics and mobile-based interventions can extend ADHD care beyond specialty clinics, Personalization: AI algorithms can tailor intervention intensity and difficulty to individual neurocognitive profiles, Monitoring: Passive data collection and adaptive feedback loops can inform real-time treatment adjustments, Adjunctive use: AI-based tools can complement pharmacologic therapy, providing non-pharmacologic symptom management.

However, widespread clinical implementation will require robust evidence demonstrating sustained efficacy, safety, and cost-effectiveness, as well as clear regulatory frameworks and ethical guidelines addressing AI transparency, data security, and algorithmic fairness.[38]

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Digital Paradox and Ethical Considerations:

While AI-based therapeutic interventions hold significant promise for ADHD management, it is important to acknowledge a growing paradox in the broader digital ecosystem. Many commercial AI algorithms embedded in entertainment, social media, and gaming platforms employ advanced reinforcement learning and personalization techniques aimed at maximizing user engagement and screen time. These same algorithmic mechanisms may inadvertently promote excessive digital consumption, fragmented attention, and reduced sustained focus-factors that are increasingly implicated in both the development and exacerbation of ADHD symptoms, particularly among youth populations.[39,40] Rather than exclusively focusing on therapeutic remediation, future public health and policy efforts may need to emphasize prevention strategies that address the environmental and behavioral drivers of rising ADHD prevalence in digitally saturated societies. Thoughtful regulation, responsible design of AI-powered digital platforms, and preventive digital literacy education may serve as critical adjuncts to AI-based clinical interventions.

Limitations

While this systematic review provides a focused synthesis of AI-based therapeutic interventions for ADHD, several important limitations must be acknowledged that may influence interpretation of findings.

The number of eligible interventional studies remains limited. Despite an extensive literature search across multiple databases, only eight interventional studies met inclusion criteria. This reflects both the novelty of AI applications in therapeutic ADHD management and the current scarcity of large, controlled trials evaluating AI-driven treatments. As a result, the available evidence base remains preliminary and subject to expansion as the field matures. The included studies demonstrated substantial heterogeneity in intervention types, AI methodologies, outcome measures, study designs, and participant populations.

Interventions ranged from digital therapeutics and cognitive training to neurofeedback, robotic assistants, and chatbots, each employing distinct therapeutic frameworks and AI algorithms. Similarly, outcome measures varied widely across studies, including TOVA scores, ADHD-RS, BRIEF executive function scores, caregiver reports, and attention task performance. This diversity precluded formal quantitative meta-analysis and necessitated a narrative synthesis approach. sample sizes in several included studies were relatively small, particularly among pilot and feasibility trials. Three of the included studies involved fewer than 50 participants, limiting statistical power to detect treatment effects and increasing susceptibility to type II error. Small sample sizes also restrict generalizability across diverse patient populations, comorbidity profiles, and developmental stages. most included studies employed short follow-up periods, typically ranging from 4 to 12 weeks.

ADHD is a chronic condition, and the durability of treatment effects from AI-based interventions remains largely uncharacterized. Long-term data evaluating symptom persistence, maintenance of gains, and functional outcomes are urgently needed. while three randomized controlled trials were included and formally assessed for risk of bias, the majority of studies were non-randomized pilot trials. As such, susceptibility to selection bias, performance bias, and uncontrolled confounding remains high. Furthermore, blinding of participants and outcome assessors was variably reported, introducing additional methodological risk.

This systematic review excluded AI studies focused solely on diagnosis or prediction, as well as observational studies, which may have provided additional mechanistic insights into AI applications in ADHD but were beyond the defined therapeutic focus of this review. publication bias may influence the representation of positive findings in this emerging field, with negative or null results potentially underreported in the published literature.

Future Research Directions

Despite these limitations, the review identifies several high-priority research opportunities to advance the field: Large-scale, multicenter randomized controlled trials (RCTs), Future studies should enroll larger, more diverse samples across multiple sites to improve statistical power and generalizability.

Standardization of outcome measures: Harmonizing ADHD symptom assessment tools across trials (e.g., ADHD-RS, TOVA, BRIEF) will enable more meaningful comparisons and future meta-analyses, Longitudinal studies: Research should examine the durability and maintenance of treatment effects over extended follow-up periods to determine

whether symptom improvements persist and translate into functional gains, Subgroup analysis and personalization: AI's potential for precision medicine should be leveraged to identify patient subgroups most likely to benefit based on neurocognitive profiles, comorbidities, and treatment history, Multimodal AI interventions: Future platforms may integrate neuroimaging, EEG, digital behavior tracking, and cognitive task performance to optimize adaptive algorithms.

Cost-effectiveness analyses: As AI-based interventions enter clinical practice, robust health economic evaluations will be essential to assess scalability, accessibility, and healthcare resource implications, Ethical, regulatory, and transparency frameworks: As AI-powered tools are deployed in clinical ADHD care, ethical concerns regarding data privacy, algorithmic transparency, clinician oversight, and patient autonomy must be addressed within clear regulatory frameworks.[38] Real-world implementation studies: Pragmatic clinical trials embedded in routine care settings are necessary to evaluate the feasibility, acceptability, and integration of AI-based therapies into existing ADHD care pathways. By addressing these research priorities, the field may move closer toward delivering personalized, scalable, and evidence-based AI-powered treatments for individuals living with ADHD.

CONCLUSION

Artificial intelligence-based therapeutic interventions represent a promising adjunctive approach for managing attention-deficit/hyperactivity disorder. Across the included studies, diverse AI-driven interventions-including digital therapeutics, cognitive training, neurofeedback, conversational agents, and robotic platforms-+have demonstrated preliminary efficacy in improving attention, executive function, and ADHD symptoms.

Digital therapeutics, particularly the FDA-authorized EndeavorRx, show the most mature evidence, with demonstrated benefits in both pediatric and adult populations. AI-powered adaptive algorithms, gamification, and real-time feedback may help address challenges of adherence, personalization, and engagement, especially in younger patients.

However, the current evidence base remains limited by small sample sizes, short follow-up durations, and heterogeneity in interventions and outcomes. Neurofeedback and conversational agents show potential but require further validation. Adjunctive AI-powered tools may support behavioral care but lack robust clinical trials.

While early safety profiles are favorable, future research should focus on larger randomized trials, long-term outcomes, precision-based personalization, cost-effectiveness, and ethical considerations. If carefully developed and rigorously evaluated, AI-based interventions may ultimately serve as valuable additions to existing ADHD treatment strategies.

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