🌐 What are the implications and impacts of current digital health interventions for children and adolescents with diagnoses ADHD?

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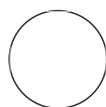
ABSTRACT

Attention deficit hyperactivity disorder (ADHD) has become increasingly relevant in the wake of a technology centred and stimulation rich society. ADHD is a neurodevelopment condition which has a multifaceted effect on behaviour, work performance and sleep. Most cases of ADHD are diagnosed at a young age. The treatment for ADHD is typically either medication or various modes of therapy, however many of these aim to only ameliorate the symptoms and not the underlying condition. In the evolving landscape of ADHD treatment, digital health interventions (DHIs) have received notable interest for their potential to address the diverse range of symptoms exhibited by children and adolescents with ADHD, and to deliver this remotely. This review aims to examine the evidence and literature to identify patterns

amongst interventions which might indicate features which facilitate success. Our findings show that DHIs hold promise in improving attention, executive functions, and

ADHD symptoms. A number of insights relating to outcome measures were uncovered, highlighting the need for standardised outcome measures which align with

the diverse ADHD care ecosystem, and offer a more accurate representation of treatment outcomes. Whilst we faced challenged in meta-analysis of the studies, reviews such as this play a crucial role in advancing the digital health space, and elucidating the need for validation and evidence for interventions. As is concluded by

this review, clinicians, innovators and researchers all have a role to play in improving the standards of evidence, in the hopes of providing safer, more user-centric and accessible interventions.

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Review question

Have digital health interventions been effective in management and treatment of diagnosed adolescent ADHD? If so, what features or functions have resulted in this success, and what would an ideal digital intervention look like?

Background

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder which affects children and adolescents all over the world. ADHD frequently results in significant functional deficits in a variety of areas, including academic performance, social relationships, and general quality of life (Pandian et al., 2021). ADHD is characterised by persistent patterns of inattention, hyperactivity, and impulsivity (Oh et al., 2023). According to estimations, 6-8% of children and adolescents worldwide may have ADHD, which is a continually rising prevalence (Salari et al., 2023). A significant burden is placed on affected people, their families, and society as a whole by the disorder's chronic nature and rising prevalence.

Traditionally, the management of ADHD has involved a combination of pharmacological interventions, behavioural therapy, and psychosocial support. While these approaches have shown to be effective in reducing ADHD symptoms and improving functional outcomes, they are certainly not without limitations (Lim et al., 2020). Pharmacological treatments, such as stimulant medications (e.g., methylphenidate, amphetamines), are often considered a first-line intervention for ADHD and aim to address the low dopamine, hypothesised to be the cause of symptoms of ADHD (Pandian et al., 2021). However, concerns about long-term effects, potential side effects, generalisability and issues related to medication adherence have raised questions about the optimal use of medication as a sole treatment modality. Non-pharmacological interventions, including behavioural therapy and psychosocial interventions, require significant time commitments, specialized expertise, and may not be readily accessible or affordable for all individuals with ADHD.

Digital health has been in increasingly relevant and promising sector since its meteoric rise following the COVID-19 pandemic, and it has shown immense promise in the treatment and management of neurodevelopmental disorders (Lakes et al., 2022). Digital interventions for ADHD encompass a wide range of approaches, including applications, gamified computer-based programs, wearable devices and virtual reality simulations. These vast interventions do not aim to completely negate current treatments, but can supplement and augment existing strategies, with the ultimate aim of providing a more personalised, interactive and engaging solution. Additionally, digital tools allow for progression and symptoms of ADHD to be closely monitored, thus providing more accurate outcome measures. Despite the promise and transformative potential of digital health interventions for ADHD, there are a number of challenges which remain unaddressed, many of which this review aims to

examine. For example, the measures of outcomes of these interventions require careful examination, and whilst some studies have shown positive effects on ADHD symptom reduction, executive functioning, and academic performance, the evidence base is still evolving, and the overall effectiveness of digital interventions remains to be established. Furthermore, there are concerns related to the equity of access to digital interventions, as individuals from low-income backgrounds or marginalized communities may face barriers in terms of technology access, digital literacy, and financial resources. The involvement of parents and caregivers in the implementation and management of digital health interventions for ADHD is another crucial aspect which must be considered. Parental engagement and support play a vital role in the success of interventions targeting children and adolescents. Understanding the perspectives, experiences, and challenges faced by parents in utilizing digital interventions is critical to ensure their effectiveness and acceptance.

The overarching objective of this systematic review is to thoroughly analyse the implications and effects of existing digital health interventions for ADHD-affected adolescents and children. With an emphasis on outcomes, equity issues, parental participation, and other pertinent aspects, we look to identify the strengths, limits, and potential knowledge gaps by evaluating the available literature. The results of this study will help to advance the understanding of the possible advantages and difficulties of using digital therapies to manage ADHD, directing subsequent research and influencing clinical practice and policy development.

Searches

For the purposes of this review the Preferred Reporting Items of the Systematic Reviews and Meta-analysis (PRISMA) guidelines and the Cochrane Handbook of Systematic Reviews of Interventions will be followed. An electronic search of scientific published databases will be used to perform this systematic review. Medline, Embase, Web of Science and Google Scholar will be used and searched (from 2014 up to present).

Searches will not be limited by document type or publication status/language/date however in order to maintain relevance and accuracy, efforts will be made to include articles which are current with regards to the information and the data they contain.

Searches will be narrowed through keywork searches using the following: ADHD, digital, computer, intervention, adolescent, children, attention, application, trial, gamified, health, treat, manage.

Defined search expressions include: "computer intervention ADHD children/adolescents", "digital intervention adhd children/adolescents", "game intervention ADHD children/adolescents", "digital health ADHD children/adolescents".

Types of studies to be included

This review will include studies which present evidence for effectiveness (and implementation) of digital health tools for treatment of adolescent ADHD. This will include randomised control trials, clinical trials and pilot studies, all with the intent of evaluating effectiveness of interventions

Studies which involve the use of medications will be included, so long as the medication is not the primary intervention being studied.

Case reports, editorials or reviews will not be considered eligible.

Participants/population

Participants can include

- Those with diagnosed ADHD, under the ages of 18, as defined by standardised and generally accepted diagnostic criteria (e.g., DSM-5, ICD-11).
- Those who care for a child (<18 yo) with diagnosed ADHD.

Studies in which participants were on ADHD medication in conjunction with/or without a digital intervention will be included.

Setting

This review will include studies conducted in in various settings, including but not limited to home, school, or clinical environments.

Intervention(s)

This review will focus on digital health interventions specifically designed to address ADHD symptoms in children and adolescents. This can encompass computer programmes, mobile applications, wearable devices, digital therapeutics, virtual and augmented reality, telehealth, reminders and video games/gamified programs.

Interventions which target behaviour change, attention retention, academic performance impulsivity and other notable aspects of ADHD will be included.

Any studies focused on pharmacological interventions and/or internet (digital) addiction will be excluded for the purposes of this review.

Comparators or control

Any study with a control arm using either alternative interventions, sham interventions, or no interventions will be included. Some (pilot) studies, in which there is no control arm or comparators may be included in order to determine measures of efficacy.

Whilst not all studies are use the same control method, studies will be analysed as a cohort, and further grouped based on a number of criteria (outlined in Sub-group analysis) to elucidate best practices with regards to experimentation.

Context

This review is being conducted as part of the Research Project module of the UCL MSc Digital Health and Entrepreneurship. The subject matter has been chosen as a matter of personal interest from the lead researcher.

Outcome measures

Studies which take the following measures as demonstrators of intervention outcome will be included:
- Cognition/Attention
- Behaviour Management/Self-Regulation
- Academic/Organizational Skills
- Motor Behaviours/physical activity
- Clinical care quality improvement
- Social/Emotional Skills
- Medication adherence
- Life/Vocational Skills

This review will not exclude studies with varying scales or methods for gathering outcome measures, and will certainly discuss the potential limitations associated with unstandardised measures.

Secondary outcomes

The following measures will also be observed and considered:
- Usability
- Parental feedback
- User ratings
- Engagement

However studies which do not measure these outcomes will still be included.

Data extraction

1   Studies collected throughout the search process will be processed through Microsoft Excel and Rayyan (a free web based systematic review software), whereby any duplicates will be removed, and studies will be sorted to either be included or excluded based on the previously defined criteria.

2   Data will be extracted by hand and will be programmed into Microsoft Excel for synthesis. Data point and variables extracted from studies will the following:

2.1   **Study characteristics**: authors, year of publication, country, study design, sample size, study period, setting, patient recruitment.

2.2   **Patient characteristics**: number of patients randomised into each arm, age, gender, and status of condition; medication, coexisting neurodevelopmental issues (e.g. autism spectrum disorder, etc).

2.3   **Intervention and control groups**: intervention name, domain, administration route and duration of administration.

2.4   **Outcomes**: outcome name, type (binary/continuous), measure, and time points.

3   Two independent reviewers will perform data extraction, and any discrepancies will be resolved through consensus.

Risk of bias assessment

4   The quality and risk of bias of included studies will be assessed using appropriate tools, such as-

4.1 Cochrane Risk of Bias tool (v1) for RCTs (Higgins et al., 2011).

4.2 Newcastle-Ottawa scale for non-randomized designs.

Strategy for data synthesis

5 For continuous outcomes effect size measures for continuous outcomes depend on the consistency
of the measurement tool and scale. Standardized Mean Difference (SMD) will be used for data combination. Effect sizes include a 95% confidence interval. Data with a consistent direction of effect are included.

6 For studies with binary Outcomes a Risk Ratio (RR) will be used. Effect sizes are presented with a 95% confidence interval.

7 This review will use a random-effects model due to the high probability of heterogeneity in the RCTs
and other studies that will be included in this review.

Analysis of subgroups or subsets

8 Sub-group analysis will be carried out, and studies will be pooled and grouped based on the following factors:
- Studies Active controls (e.g. other active intervention)
- Studies with no intervention in the control group
- ADHD on medication
- ADHD not on medication
- >12 years of age
- 8-12 years of age
- Intervention domain
- Intervention setting
- Study duration

9 Sub group analysis will pool studies who's interventions are in the same domain, and thus outcomes

will be compared.