Adult Attention Deficit Hyperactivity Disorder: Reviewing a Psychological Approach to Treatment and Considerations for Measuring Sustained Attention as Part of a Screening Process.

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Chapter 1

Effectiveness of Mindfulness-based Cognitive Therapy for Adults with Attention Deficit Hyperactivity Disorder: A Systematic Review and Meta-analysis

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Abstract

Psychological approaches can be considered for treatment for ADHD in adults, often as an adjunct to prescribed medications. There is evidence for the effectiveness of Cognitive Behavioural Therapy (CBT) in this patient group, however less is known about Third-wave approaches in this area. This study aims to determine if Mindfulness-based Cognitive Therapy (MBCT) is an effective treatment for adults with ADHD based on systematic review of current evidence. Consistent with PRISMA guidance, this review carried out a meta-analysis to evaluate studies that had investigated ADHD symptoms after completing MBCT. Three randomised controlled trials met criteria to be included in this review. The meta-analysis used a random-effects model ($p=0.006$; $I^2=80\%$), which indicated a reduction in ADHD symptoms in the MBCT group compared to the control group at the end of treatment (MD=-6.10, 95% CI: -10.40 to -1.79). Findings from this review suggest that MBCT could be used to reduce symptoms in adults with ADHD. In future research it would be beneficial to build understanding about specific mechanisms within mindfulness-based approaches and their role in improving symptoms of ADHD.

Keywords: ADHD, Adults, Mindfulness, MBCT.

Introduction

Treatment of ADHD in adults

Attention Deficit Hyperactivity Disorder (ADHD) is characterised by inattentiveness, impulsiveness and hyperactivity (American Psychiatric Association, 2013). Although primarily diagnosed in childhood, in 2020, it was estimated that estimated that 2.58% of the global population of adults had ADHD (Song et al., 2021).

Guidance around treating the symptoms of ADHD in adults indicates that medication can be effective (NICE, 2018). As with most medication prescriptions, guidance also highlights the importance of monitoring physical health as well as the impact of ADHD medication on co-existing mental health conditions. NICE (2018) also outlines that non-pharmacological interventions, including psychological interventions, may be considered as an alternative to medication in adults in the case that the medication isn't effective, the individual is unable to adhere to the medication, or the individual declines this treatment. In some cases, namely where medication is effective, but some symptoms persist, non-pharmacological interventions are recommended alongside pharmacological interventions.

Beachy et al. (2022) highlight the importance of considering the contextual factors of a person's life when providing treatment for ADHD, and the need to provide treatment that is effective in meeting the full needs of an individual. This is relevant given the prevalence of ADHD and other co-existing conditions (Fayyad et al., 2017). This is consistent with guidance from NICE (2018), which indicates the need for a treatment plan that is person-centred, that fully considers the needs of the individual accessing care.

In terms of specific psychological interventions, NICE (2018) guidance also recommends interventions with a cognitive behavioural therapy (CBT) approach. A Cochrane systematic review by Lopez et al. (2018) also suggested that CBT is an effective treatment strategy for ADHD symptoms, and that a combination of medication and CBT may be beneficial (although the evidence was described as low quality). This outcome was similar to that of a more recent meta-analysis from Li &

Zhang, (2024), which suggested that the combination of CBT and medication reduced symptoms of ADHD more than the use of medication alone.

Mindfulness-based approaches for ADHD in adults

Mindfulness-based Cognitive Therapy (MBCT) was developed in the 1990s primarily as a relapse prevention treatment for people who had been treated for depression (Segel, 2002). MBCT is rooted in cognitive behavioural therapy principles - for example, that a person's feelings are related to their behaviours and the thoughts they have (Chiesa & Malinowski, 2011). MBCT is an approach that is commonly considered "Third wave" CBT (Dimidjian et al., 2016).

Evidence suggests the potential for mindfulness based treatment options for ADHD, due to the benefits on cognitive functions. Chiesa et al. (2011) reviewed evidence to suggest that Mindfulness Meditation Practice develops cognitive functions, including executive function, memory and attention. This review also talked about the difference in which different aspects of mindfulness practice may be linked to the development of cognitive functions in specific domains, namely linking the impact of a person's ability to bring awareness to internal and external stimuli with attentional ability. This was broadly consistent with findings reviewed by Lodha & Gupta, (2022), which suggested that open monitoring techniques were beneficial to generating enhanced cognitive functioning, more "predominant effects" were found in this domain resulting from focussed attention practise. Evidence has also suggested that mindfulness approaches are most beneficial to specifically the inhibition tapping part of cognitive functioning (Gallant, 2016). Although these above reviews recommend further high-quality research, the cognitive domains addressed by mindfulness practice have similarities to what would be attributed to that seen in individuals with ADHD, strengthening the hypothesis that mindfulness-based treatment options may be beneficial in this patient group. For example, Wielgosz et al. (2019) suggested that Mindfulness Meditation could be beneficial for people with ADHD, due to the emphasis on developing attentional capacity.

Although these findings may have implications for individuals with ADHD, several gaps remain. These reviews included studies primarily of individuals who were not experiencing ADHD. Oliva et al. (2021) stated that mindfulness-based interventions

could be considered as part of an individual's treatment formulation to complement a main approach to treatment, but that there was not enough existing evidence to recommend mindfulness-based interventions as a stand-alone treatment intervention for ADHD symptoms.

In terms of the specific mechanisms of MBCT that target the symptoms of ADHD, the evidence base is underdeveloped. Geurts et al. (2021) found evidence to suggest that self-compassion was potentially a mediating factor in improving symptoms of ADHD along with self-reported inhibition. The authors did question the sensitivity of the inhibition measure, stating that a behavioural measure might provide more accuracy. With regards to inhibition, (Schoenberg et al., 2014) also suggested that amplitudes of error related potentials in brain imaging in response to a NoGo test was correlated with a reduction in hyperactivity and impulsivity symptoms and increased acting with awareness following MBCT intervention. This has implications for the potential role of awareness -based components of MBCT contributing to reducing levels of impulsivity in ADHD.

Although neuroimaging studies have identified structural changes in the brain in response to engagement in mindfulness practice, Tang et al. (2015) suggests that this evidence would benefit from an understanding of the implications of these changes on a person's cognitive and social improvements to ensure more meaningful knowledge of these processes.

There is variability in the types of Mindfulness-based interventions that are applied in research and clinical settings. Zhou et al. (2020) reviewed studies in which participants had completed a Mindfulness-based training that took place over a period less than 8 weeks. Results were mixed in terms of improving cognitive functioning, but the study did highlight the benefits of this therapeutic approach on mental health outcomes. Zhou et al. (2020) attributed the inconsistency across their review paper to be potentially linked to the variety of materials and measures used in the studies and their interventions. This was echoed by Fullen et al. (2020) who emphasised the need for review of standardisation across Mindfulness-based approaches for Adults with ADHD.

Rationale and Aims

To date, no meta-analysis has been conducted to determine the impact of MBCT as a standalone intervention in adults with ADHD. This current systematic review and meta-analysis will synthesise data from studies that have explicitly evaluated MBCT rather than Mindfulness-based approaches more generally. This paper will aim to examine the effectiveness of MBCT in treating ADHD symptoms in adults based on existing evidence.

Research Question

To determine through use of a narrative synthesis and meta-analysis if MBCT is an effective treatment for adults with ADHD.

Methods

Study registration and reporting guidelines

This meta-analysis and review was conducted in accordance with Preferred Reporting Items of Systematic reviews and Meta-analyses (PRISMA) guidelines (Page et al., 2021). This study was registered on the International Prospective register for Systematic Reviews (registration number: CRD42024597740).

Search strategy and protocol

Search strategies used MeSH and text terms based on keywords of ADHD, MBCT, and Randomised Controlled Trials (RCT). Parts of the strategies were adapted based on search terms used to review interventions for ADHD in a Cochrane review by Lopez et al. (2018).

As this current study reviews RCTs, validated RCT search filters from the Scottish Intercollegiate Guidelines Network (SIGN) were integrated into the strategies used for each database, excluding PsycINFO, which used a filter from the Canadian Agency for Drugs and Technologies in Health (CADTH).

In terms of bibliographic databases, the reviewer searched Medline, Embase, CINAHL and PsycINFO using the search strategies adjusted for database specific syntax. Due to risk of publication bias in the reporting of RCTs, the reviewer also searched two medical registers: ClinincalTrials.gov and World Health Organisation: International Clinical trials Registry Platform. Citation searches were completed using the included studies to identify any additional studies that met criteria for inclusion in the review.

The search strategies for each database can be found in Appendix 1.2. The search strategies were sent to a research librarian for feedback and suggestions were integrated into the final strategies.

Screening and study selection criteria

Inclusion and exclusion criteria were established using PICOS framework (Tacconelli, 2010) as detailed below. Studies were included in the review if they met the following criteria:

- Population: Recruited participants who were 18 years old or older and had a diagnosis of ADHD.
- Intervention: The intervention being investigated was MBCT
- Comparator: The control criteria made use of either a waiting list or treatment as usual
- Outcome: ADHD related symptoms were the primary outcome
- Study Design: The study design was a randomised controlled trial.

Studies were excluded from the review if they displayed the following criteria:

- Population: Recruited participants had a learning or intellectual disability
- Intervention: The intervention was indicated to not take a specific MBCT approach, for example “Mindfulness” or “Mindfulness Training”
- Comparator: The study had no control group
- Outcome: The primary outcome was unrelated to ADHD symptoms, for example, depression or anxiety.
- Study Design: The study did not have a randomised control design.

Following searches, duplicate studies were removed, and studies screened independently (by primary researcher, and peer reviewer) to exclude studies that did not meet inclusion criteria based on title and abstract. The full text of the remaining studies were then screened by the same reviewers independently to exclude any studies that did not meet criteria. If the primary researcher and peer reviewer disagreed on whether a study met criteria, then there was a consensus discussion with the research supervisor. This process was completed using Covidence software.

Outcome Measures

The primary outcome analysed in this review was the level of ADHD symptoms reported. This review carried out secondary analysis on other outcome data where enough authors had consistently measured the same outcome.

Data Extraction and Quality Assessment

Adapted from Li & Zhang, (2024), this present study extracted and presented data on author, year of study, design, intervention delivery method (e.g. group or individual therapy), details of control condition, sample size, country, gender, assessment scales,

and follow up time (where applicable). Outcome measure data was extracted from the mean post intervention scores from each group.

Quality appraisal of the selected studies was conducted using the Cochrane Risk of Bias assessment tool (Higgins et al., 2011).

Data Synthesis

A narrative synthesis was conducted to describe the selected studies by presenting the details of the interventions that were used in each study, including intervention length, delivery method and any adaptations that were made to the original cited intervention protocol. Descriptive information on the study's population, for example, co-occurring pharmacological input was also synthesised.

Statistical data analysis as part of a meta-analysis was completed and presented using RevMan 5.3 as set out by Li & Zhang, (2024). The effect size was indicated by determining the Standard Mean Difference (SMD) between the mean post intervention score extracted from the intervention group and the control group (using 95% confidence interval). A greater value produced indicated a greater change in the outcome being measured.

Heterogeneity was assessed using Cochrane I^2, where an I^2 value of 50% or higher would indicate heterogeneity (Higgins & Thompson, 2002). This information was used to inform the type of effects model used in the analysis.

Results

Screening overview

The literature search using the described search strategies was completed on the 4th of October 2024. A total of 37 records were identified from bibliographic databases (Medline, Embase, PsycINFO, and CINAHL) and clinical registers (World Health Organisation: International Clinical Trials Registry Platform and NIH: ClinicalTrials.gov) and imported into Covidence for screening process. At this point Covidence excluded duplicate records (n=13). Due to the length of time since the initial search was completed, the search was re-run on the 1st of July 2025, and returned no additional studies.

Based on title and abstract, a further 16 records did not meet inclusion criteria for the following reasons: inappropriate study type (n=5), population of children not adults (n=5), incorrect intervention (n=5) and incorrect condition (n=1). The full text of the remaining six articles were reviewed, one of which was excluded due to being a study protocol, a further two studies were excluded as they were duplicate reports of the included studies. This process meant that a final three RCTs were included for meta-analysis (Gu et al., 2018; Hepark et al., 2019; Janssen et al., 2019). No further papers were identified from citation searches. This screening process is detailed in Figure 1.

Figure 1

PRISMA Flowchart Illustrating Selection Process

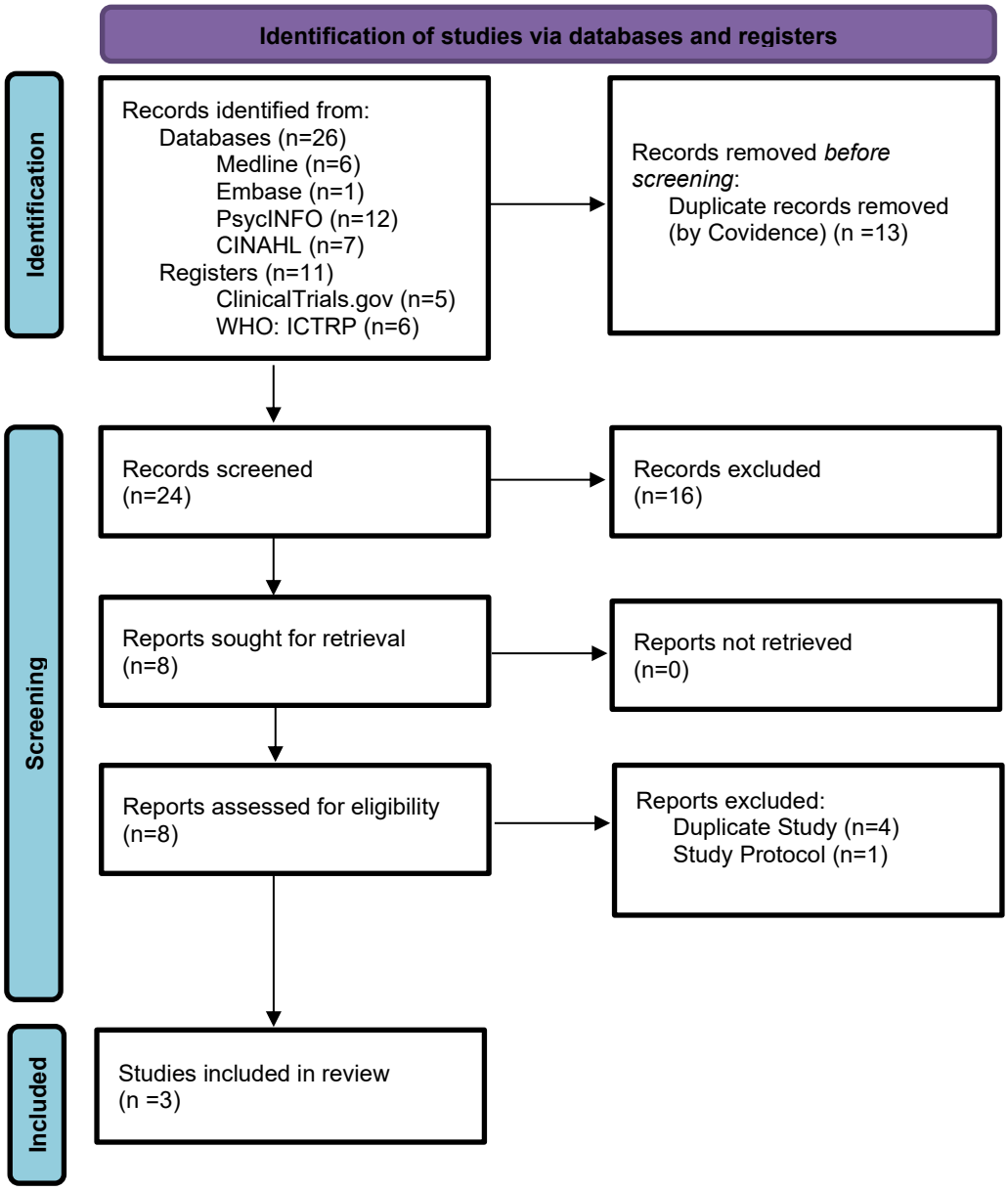


Table 1

Characteristics of Included Studies

				Experimental group				Control group						Assessment Scales	
Study	Country	Design	Intervention Details	Mean Age (SD)	Sample size	Gender F/M	Medication Use (%)	Type	Mean Age (SD)	Sample size	Gender F/M	Medication Use (%)	Follow up time	Primary	Secondary
Gu et al. (2018)	China	RCT	MBCT 6 weekly individual sessions (1 hour)	20.21 (1.03)	28	12/16	20 (71.43)	WL	20.38 (1.02)	26	12/14	20 (76.92)	3 months	CAARS-S:SV	BAI; BDI-2; Academic performance; MAAS; ANT
Hepark et al. (2019)	Netherlands	RCT	MBCT 12 weekly group sessions (time not specified)	36.5 (10)	55	34/21	33 (60)	WL	35.2 (9)	48	22/26	26 (54.17)	None	CAARS-INV:SV*	CAARS-S:SV*; BRIEF-ASR; BDI-2; STAI; OQ 45.2; KIMS
Janssen et al. (2019)	Netherlands	RCT	MBCT 8 weekly 2.5 hour group sessions	39.7 (11.1)	60	32/28	36 (60)	TAU	39.7 (11.1)	60	32/28	29 (48.33)	3 and 6 months	CAARS-INV:SV	CAARS-S:SV; BRIEF-A; FFMQ-SF; SCS-SF; MHC-SF; OQ 45.2

Footnote: RCT=Randomised Controlled Trial, MBCT=Mindfulness-based Cognitive Therapy, WL=Waiting list, TAU=Treatment as usual, CAARS-S:SV=Conners Adult ADHD Rating Scale – Self-Report: Screening Version, CAARS-INV:SV=Conners Adult ADHD Rating Scale – Investigator Rated: Screening Version, BAI=Beck Anxiety Inventory, BDI-2=Beck Depression Inventory 2nd Edition, MAAS=Mindful Attention and Awareness Scale, ANT=Attentional Network Test, BRIEF-ASR=Behaviour Rating Inventory of Executive Function – Adult Self-Report version, STAI=State-Trait Anxiety Inventory, OQ 45.2=Outcome Questionnaire, KIMS=Kentucky Inventory of Mindfulness Skills, BRIEF-A=Behaviour Rating Inventory of Executive Function – Adult, FFMQ-SF=Five Facet Mindfulness Questionnaire – Short Form, SCS-SF=Self-Compassion Scale – Short Form, MHC-SF=Mental Health Continuum – Short Form.

*Hepark et al. (2019) did not specify which self-report versions of the CAARS-S were used in their study, however they did specify that the scales they used had 30 items, which is the case for the screening versions of both the investigator and self-report measures of the CAARS-S.

Study characteristics and narrative synthesis

As seen in Table 1, the three RCTs that met criteria took place in either China or the Netherlands from 2018 to 2019. A total of 277 participants were included at this stage, with an average age of 34.35 years. Table 1 shows the demographics of participants at the stage of allocation to the group, apart from Gu et al. (2018) as two people dropped out after allocation but prior to commencement of intervention, and their demographic information was therefore not reported.

All three studies indicated that content of their interventions was adapted from an original protocol for relapse prevention intervention in adults with depression (Gu et al., 2018 and Hepark et al., 2019 both cited Segal et al., 2002; Janssen et al., 2019 cited Segal et al., 2012). Gu et al. (2018) didn't specify the way in which the content had been adapted, but did detail the main session themes for the intervention they used. Both Hepark et al. (2019) and Janssen et al. (2019) specified that they had replaced the psycho-education of depression with psycho-education about ADHD, and included information on mindful listening and speaking, citing their use of the Mindful Awareness Practises for ADHD programme (MAPs; Zylowska et al., 2008). Janssen et al. (2019) also stated that modifications to their intervention were made following their pilot study (Janssen et al., 2020).

The format in which MBCT was delivered varied across the three selected studies. Gu et al. (2018) delivered the intervention on an individual basis over six sessions lasting one hour each, whereas the other two studies opted for a group format. Hepark et al. (2019) delivered 12 group sessions but did not specify the length of these sessions. Janssen et al. (2019) ran 12 group sessions, with each session lasting for two and a half hours. Each study intervention was delivered on a weekly basis, and prescribed 30 minutes daily home-practice, the delivery of which again varied between each study. In Gu et al. (2018), participants were given CDs and workbooks to assist them with this. This was also the case in Hepark et al. (2019), but authors stated that the exercise duration progressively increased. Janssen et al. (2019) stated that they instructed participants to practise 6 days a week using guided exercises. Although the studies themselves don't provide this level of detail about the home practice, MAP (Zylowska et al., 2008) as used by Hepark et al. (2019) and Janssen et al. (2019) detailed that

home practice consists of formal meditation exercises and mindful awareness in daily living exercises. This information was not fully detailed in the same way in protocols used by Gu at al., (2018).

Two studies (Gu et al., 2018 and Hepark et al., 2019) referred to their control groups as waiting list groups. Hepark et al. (2019) indicated that the stage at which participants were invited to take part in the study followed around three months of pharmacotherapy and a psycho-education program, participants were not permitted to take part in any other group intervention during the study period and were also required to keep their medication stable. Gu et al. (2018) similarly required participants receiving pharmacotherapy to have remained at a stable dose of medication for at least one month prior to enrolment in the study. Janssen et al. (2019), referred to the control group as accessing Treatment as Usual (TAU). The authors defined this as participants having the freedom to access treatment without influence of the research team, as they normally would outside of the study, and that participants were asked additional questions so the authors could monitor the level of input. All three of the studies included in this review collected data to describe the number of participants accessing medication for their ADHD (see Table 1). All studies indicated that participants in the control groups were offered the opportunity to take part in the MBCT intervention following completion of the study period.

Risk of bias

Quality of the three studies included in the meta-analysis was appraised using the Cochrane Risk of Bias assessment tool, as shown in Figure 2. In two of the studies, the process by which randomisation occurred was not indicated. Hepark et al. (2019) did specify that participants were assigned to each condition within the study using a website that was specifically developed for their study by an independent researcher, but no further detail was given around this process. In a similar vein, Gu et al. (2019) only stated that participants were randomly assigned to conditions, and information was not given to indicate the stage at which allocation sequence was no longer concealed to participants.

Due to the requirement for participation in an intervention outwith usual treatment or inaction due to being on a waiting list, participants across all studies would be aware

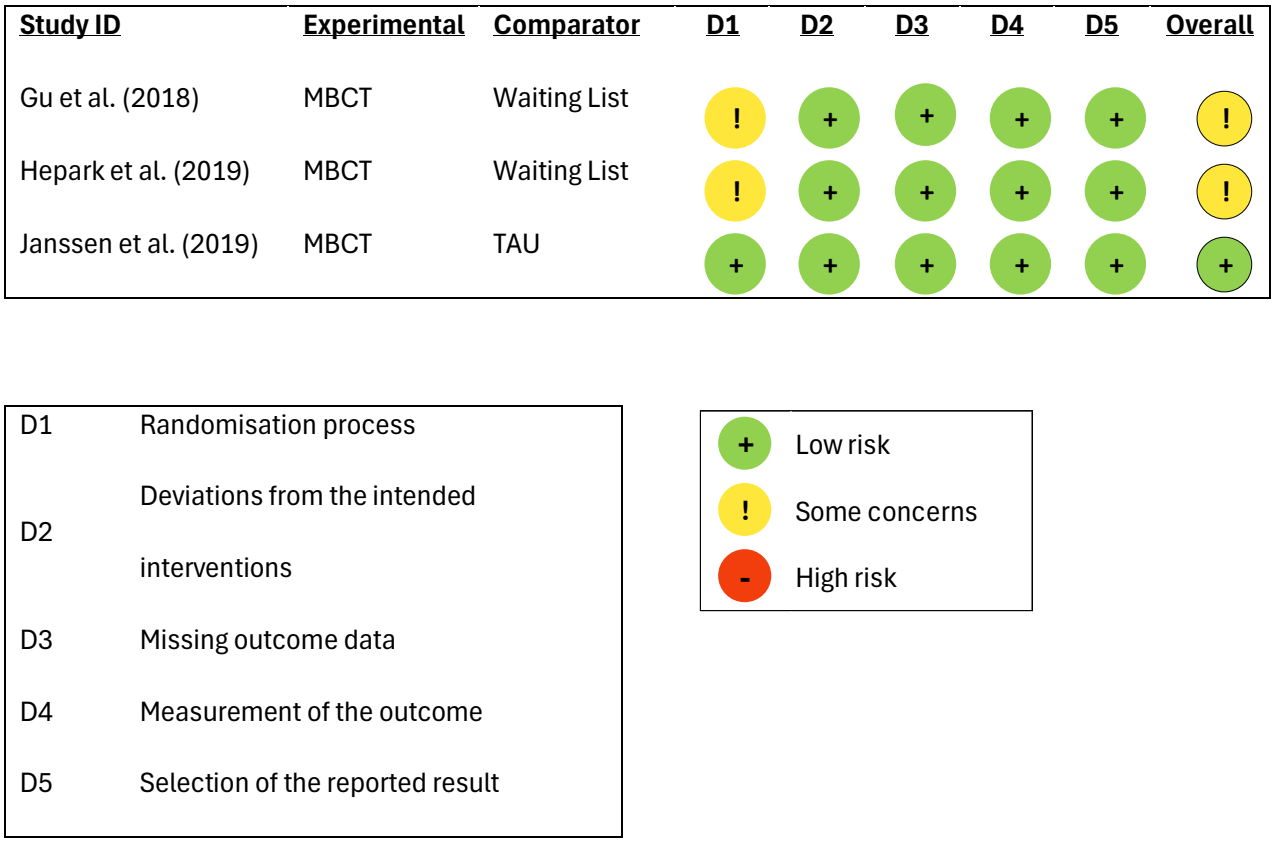
that they have been placed within the intervention as they would have attended MBCT sessions. All studies also indicated that while participants had dropped out of intervention group, the intervention was indicated to continue as normal for other participants. All studies carried out intention to treat analyses on the outcome data produced in response to the missing data.

Gu et al. (2018) and Janssen et al. (2019) both specified that the interviewers assessing the participant outcome measures at each time point were blind to the group in which that participant has been placed in. In Janssen et al. (2019) blind raters were also used to review a random sample of video-taped interviews. Hepark et al. (2019) indicated that in their study these assessments were single blinded, which would usually infer that the participant doesn't have knowledge of the group they are placed in, but the interviewer does. Given that the participants are likely to know if they were part of the intervention group in the latter part of the study, it's unclear here if the authors mean to indicate that the interviewers are blinded to the participant's condition, as it seems unlikely that the participant wouldn't have this knowledge.

For each study, outcome measures were analysed and reported as detailed in methodology indicating low risk of bias in reporting the selected result. Given the issues with the randomisation process not being clearly set out, the information gathered from Gu et al. (2018) and Hepark et al. (2019) indicated some level of concern in terms of overall risk of bias.

Figure 2

Quality Appraisal Results



Reporting of attrition data

Reporting of attrition data varied across each study. Post intervention data was available from all participants who took part in the intervention in Gu et al. (2018) (intervention: n=28, control: n=26). Hepark et al. (2019) reported post intervention data from 42 participants in the control condition, citing that one participant had been excluded at the pre-test stage, and five at the post-test stage following lost or incomplete data. In the intervention condition, post-test data was either not received (n=8) or incomplete (n=4). The authors also cited that there were participants that did not begin (n=4) or did not complete (n=5) intervention; data from 41 participants were included in their intervention condition analyses, suggesting crossover between those who did not complete the intervention nor the post-test questionnaires. In the Janssen et al. (2019) control condition, four participants withdrew from the study, and

one did not return post-test questionnaires, therefore data was reported for 55 participants. In the intervention condition, two participants did not complete pre-test measures, and seven did not complete the intervention stage. The authors report that only 51 participants completed the intervention stage, however they have included data from 52 participants in the analysis from this condition. Data from 244 participants were included in the meta-analysis, 121 of which were in the intervention group and 123 were in the control group.

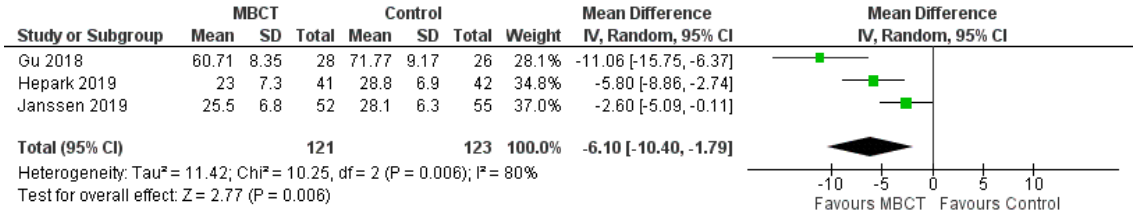
Primary outcome measures

Three RCT studies were included in the meta-analysis. All of which used a version of CAARS to evaluate ADHD symptoms in the participants as primary outcome measures at each stage of their data collection. Gu et al. (2018) used a self-report version (CAARS-S:SV) as primary outcome measure. The remaining other two studies used investigator versions (CAARS-INV:SV). These latter two studies also used as the CAARS-S:SV as a secondary outcome measure. For this reason, results from symptoms that have been self-reported using the CAARS-S:SV were included in the meta-analysis of primary outcomes. If there was not this level of consistency between the measure type in the papers it may have been appropriate to reconsider the meta-analytic approach to this review. Although the analysis could be carried out in the case where there is consistency in measures across two papers, a more in-depth narrative approach may have been required to display a fuller picture of the information that the data provides across all three papers.

This meta-analysis used a random-effects model ($p=0.006$; $I^2=80\%$), which indicated a greater reduction in of ADHD symptoms in the MBCT group compared to the control group at the end of treatment (MD=-6.10, 95% CI: -10.40 to -1.79), as shown in the forest plot in Figure 3.

Figure 3

Primary Analysis: ADHD Symptoms



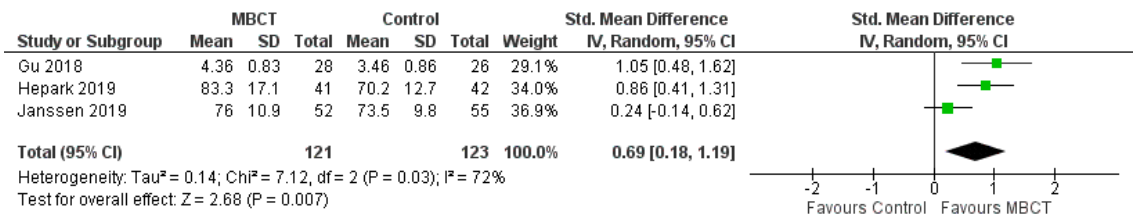
Secondary outcome measures

Each study completed a range of outcome measures as secondary measurements, due to the small study number it was challenging to draw meaningful data for analysis of secondary measures, as there was limited consistency across the outcomes that data was collected for. The only secondary outcome for which data was gathered consistently across all three studies was mindfulness skills and each study used a different measure to collect this. Gu et al (2018) used the Mindful Attention and Awareness Scale (MAAS) (Brown & Ryan, 2003), Hepark et al. (2019) used the Kentucky Inventory of Mindfulness Skills (KIMS) (Baer et al., 2004), and Janssen et al. (2019) used the Five Facet Mindfulness Questionnaire - Short Form (FFMQ-SF) (Bohlmeijer et al., 2011).

Results from a random-effects model (p=0.03; I^2=72%) indicated an increase in Mindfulness skills in the MBCT group compared to the control group at the end of treatment (SMD=0.69, 95% CI: 0.18 to 1.19), the forest plot of this result is detailed in Figure 4.

Figure 4

Secondary Analysis: Mindfulness Skills



Discussion

Main Findings

This narrative synthesis and meta-analysis aimed to examine the effectiveness of MBCT for adult ADHD. This study is the first to look specifically at MBCT intervention in this patient group rather than mindfulness-based programs more generally. Results from this meta-analysis of three eligible studies show promising indications that MBCT is more effective in reducing ADHD symptoms compared to waiting list or treatment as usual. Results from an analysis of secondary outcomes suggested that mindfulness skills also improved for the participants accessing MBCT compared to those in the control group. This perhaps affirms that the intervention's emphasis on mindfulness and bringing awareness to the present remains a critical element of the intervention.

Although the subject of this meta-analysis is novel, the evidence that it presents is consistent with findings from reviews in other cognitive approaches, namely CBT as indicated by Li & Zhang (2024) and Lopez et al. (2018). These two reviews also cited the potential value of CBT alongside medication for ADHD in order to achieve positive outcomes in this patient group, which was not specifically assessed in the papers reviewed in this current study.

A previous meta-analysis of Mindfulness-based Therapies more generally (Cairncross & Miller, 2020) included a larger number of studies (ten), and although also noted a drop in ADHD symptoms, produced a smaller effect size that sits outwith the confidence interval of this present meta-analysis. Results from the present study were also consistent with findings from a systematic review conducted by Lee et al. (2017), which considered mindfulness-based training programmes for adult ADHD more broadly (including MBCT). A more recent study by Zhou et al. (2020) that looked at components of executive function (common areas of deficits in people with ADHD) rather than symptoms of ADHD as outcome measures, reported mixed results in terms of effectiveness of short-term mindfulness-based training approaches, which does not fully align with this current study's results.

It remains important to consider that MBCT differs from other mindfulness practices due to its foundations within a CBT-based framework. Chiesa & Malinowski (2011)

maintain that the concept of addressing thoughts (even if this is just to accept them) differs from traditional mindfulness meditations due to these more cognitive based elements. Although there may be the sense of "controlling" attention within MBCT interventions, these authors indicate that the attitude around this should remain one of non-judgemental compassion towards thoughts. Lutz et al. (2008) have described this as less about concentration but rather a focus on building "mental stability". These components perhaps may help to bring about a shift in the way that individuals respond to and view the internal mechanisms of their ADHD, promoting acceptance of a wandering mind. This is in a similar vein to research from Geurts et al. (2021) that suggests that self-compassion is a mediating variable in the success of MBCT for adults with ADHD.

As the mechanisms of MBCT that could potentially be driving change in ADHD symptoms remain undefined, it could also be possible that improving psychological wellbeing, for example depressive mood – which can be positively impacted by Mindfulness-based interventions (Poissant et al., 2020), can improve symptoms that have a likeness to ADHD symptoms. This perhaps is to be expected, as MBCT has an evidence base for treatment of depression, although the studies in this review have adapted this intervention for ADHD, it may be the case that the mechanism for action for depression remains. However it is of note that in the two studies that measured depression in this review, the clinically relevant effect sizes were small. Overall, this further emphasises the importance of closer examination of the components of MBCT that seem to be delivering promising early results.

Findings from this current study specifically using MBCT rather than a more general mindfulness-based approach potentially makes the case for the value of maintaining specificity and consistency in this patient group. This is consistent with suggestions from Zhou et al. (2020) that noted the variety of materials and measures used across research in this area. This is perhaps also relevant given the importance of maintaining a specific structured approach for individuals who often struggle with attention related cognitive deficits.

A query remains generally about the use of an intervention programme that was developed for such a specific presenting problem: relapse prevention in depression

(Segel, 2002). The rationale for the use of this intervention with ADHD is perhaps lacking in the papers that were included in the study. If future research is to continue, a robust rationale for adapting this intervention for individuals with ADHD will be required to hold up under scrutiny.

Strengths and limitations

There are strengths and limitations to this systematic review and meta-analysis, that should be considered when interpreting the results. All three trials are of reasonable size and quality. Other than randomisation there was low risk of bias across all other domains. The evidence detailed in this study is perhaps limited by the low number of recent studies that met criteria to be included. It is of note that the three studies included are all at least five years old at the time of writing, suggesting an absence of ongoing research with these specific parameters.

In this meta-analysis the outcome data was extracted from the mean post intervention groups scores in each study, rather than from the adjusted effect sizes. This has implications for the accuracy of the results and so is a limitation of this study. The decision to conduct the analysis using this method was made based on the required time constraints placed on this study. The studies that were included in this meta-analysis have reported adjusted effect sizes and also the methods by which they made these adjustments for baseline symptoms.

The variation in the way each study was structured perhaps raises some questions around the reliability of the meta-analysis result, there were a low number of studies and the length of intervention, and method of delivery was not consistent across all studies. It would be interesting to for future research consider the impact of these different elements and determine dose-dependent effects, however this would require a large number of studies in this area to be completed so that this review could be repeated to answer these questions.

A strength of this study is that there was specificity in the intervention being examined, which Fullen et al. (2020) identified as a need to ensure fidelity within the evidence base. The selection criteria specified that studies must have an RCT design in order to be included. This allowed studies to be robust in terms of available results,

but due to the pre-existing evidence, this limited the number of studies that were eligible, and the possible secondary analyses that could have been carried out. This current study perhaps is useful in highlighting the current early stage that this research is at, by drawing attention to the limited number of studies available for review.

A limitation of this review is that attempts were not made to seek clarity from authors during quality appraisal. Therefore anomalies around participants completion rates in Janssen et al. (2019) and ambiguity around single blinding process described by Hepark et al. (2019) lacked clarification.

There was reasonable consistency across the control groups in the included studies in terms of their existing treatment plans, however there would have been variability between participants in the ADHD medication that they were receiving at the time of the study. It was helpful that the authors disclosed the proportion of participants who were accessing medication for their ADHD and while there would be additional ethical requirements for research that requests that participants alter their established medications, it was difficult to assess the full impact of the intervention given the likely positive impact of medication in reducing ADHD symptoms.

Future research

This study suggests that MBCT may have benefits in improving the symptoms of people with ADHD. While CBT is becoming more established as a treatment for ADHD, particularly alongside medication (Li & Zhang, 2024), the benefits of third-wave CBT approaches with mindfulness components is perhaps an area for further research.

The current evidence base indicates that mindfulness-based approaches have value in the treatment of mental health conditions. Notably mindfulness has been recommended as treatment for first episode psychosis and insomnia (NHS Education for Scotland, 2014) and MBCT remains recommended as a treatment for depression, namely for individuals that are at a greater risk of relapse (NICE, 2022).

In order to develop standards and guidance to establish a consistent evidence base it would be beneficial for future research practices to clearly describe the features of their intervention that constitute mindfulness, which might allow for more

consistency when reviewing and replicating literature on this topic in future. There remains variation across mindfulness-based approaches that are used for treatment of ADHD in adults (Fullen et al., 2020), and as evidenced by this present study, the adaptations made to intervention protocols aren't always detailed in full. This is important to address in order to allow for replication of research and progression of the evidence base.

It would be beneficial for research into mindfulness-based interventions to consider adopting a consistent MBCT intervention protocol. This current study provides evidence for use of the MAPs (Zylowska et al., 2008). While significant resource is required to develop a manualised psychological approach from scratch, it may also be useful to consider the use of an intervention specifically designed for ADHD in adults, (rather than adapted from an intervention for depression). Regardless of intervention, this remains a relevant consideration as a strong evidence base for a clearly defined intervention would allow greater opportunity for clinical governance in delivering this psychological care.

This perhaps indicates that completing a future study that groups participants who access ADHD medication separately from those who don't, would allow researchers to determine the impact of MBCT on these two groups separately.

It would be beneficial if future research were able to build upon the evidence provided by these papers by choosing to emulate similar follow up time points as that were used by Janssen et al. (2019) (3 months and 6 months) when considering the longitudinal impact of MBCT.

The promising evidence produced by this study paves the way for future research to consider the implementation of MBCT in adults with ADHD. The next steps for this would therefore be the development of a study that examines the acceptability and effectiveness of this intervention in real world clinical settings.

Conclusion

Evidence presented in this meta-analysis suggests that MBCT could be used to reduce symptoms in adults with ADHD. Further research would be valuable to consider the value of combining ADHD medication and MBCT interventions as a part of treatment plan. Secondary analysis indicated an improvement in Mindfulness skills. Given existing literature around the impact of mindfulness more broadly on attention domains, determining if the link between improvement in mindfulness skills and ADHD symptoms is mediated by a specific mechanism would be a welcome contribution to this evidence base.

Declarations

Conflicting interests: The authors declare there are no conflicting interests.

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References

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Arlington, VA: American Psychiatric Publishing.

Baer, R. A., Smith, G. T., & Allen, K. B. (2004). Assessment of Mindfulness by Self-Report: The Kentucky Inventory of Mindfulness Skills. *Assessment*, *11*(3), 191–206. https://doi.org/10.1177/1073191104268029

Beachy, B. R., Bauman, D. E., & Baker, M. D. (2022). Attention Deficit Hyperactivity Disorder: Third-Wave Behavior Therapy Conceptualization. In W. O'Donohue & A. Masuda (Eds), *Behavior Therapy: First, Second, and Third Waves* (pp. 649–671). Springer International Publishing. https://doi.org/10.1007/978-3-031-11677-3_28

Bohlmeijer, E., ten Klooster, P. M., Fledderus, M., Veehof, M., & Baer, R. (2011). Psychometric Properties of the Five Facet Mindfulness Questionnaire in Depressed Adults and Development of a Short Form. *Assessment*, *18*(3), 308–320. https://doi.org/10.1177/1073191111408231

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, *84*(4), 822–848. https://doi.org/10.1037/0022-3514.84.4.822

Cairncross, M., & Miller, C. J. (2020). The Effectiveness of Mindfulness-Based Therapies for ADHD: A Meta-Analytic Review. *Journal of Attention Disorders*, *24*(5), 627–643. https://doi.org/10.1177/1087054715625301

Chiesa, A., Calati, R., & Serretti, A. (2011). Does mindfulness training improve cognitive abilities? A systematic review of neuropsychological findings. *Clinical Psychology Review*, *31*(3), 449–464. https://doi.org/10.1016/j.cpr.2010.11.003

Chiesa, A., & Malinowski, P. (2011). Mindfulness-based approaches: Are they all the same? *Journal of Clinical Psychology*, *67*(4), 404–424. https://doi.org/10.1002/jclp.20776

Dimidjian, S., Arch, J. J., Schneider, R. L., Desormeau, P., Felder, J. N., & Segal, Z. V. (2016). Considering Meta-Analysis, Meaning, and Metaphor: A Systematic Review and Critical Examination of "Third Wave" Cognitive and Behavioral Therapies. *Behavior Therapy*, *47*(6), 886–905. https://doi.org/10.1016/j.beth.2016.07.002

Fayyad, J., Sampson, N. A., Hwang, I., Adamowski, T., Aguilar-Gaxiola, S., Al-Hamzawi, A., Andrade, L. H. S. G., Borges, G., de Girolamo, G., Florescu, S., Gureje, O., Haro, J. M., Hu, C., Karam, E. G., Lee, S., Navarro-Mateu, F., O'Neill, S., Pennell, B.-E., Piazza, M., … on behalf of the WHO World Mental Health Survey Collaborators. (2017). The descriptive epidemiology of DSM-IV Adult ADHD in the World Health Organization World Mental Health Surveys. *ADHD Attention Deficit and Hyperactivity Disorders*, *9*(1), 47–65. https://doi.org/10.1007/s12402-016-0208-3

Fullen, T., Jones, S. L., Emerson, L. M., & Adamou, M. (2020). Psychological Treatments in Adult ADHD: A Systematic Review. *Journal of Psychopathology and Behavioral Assessment*, *42*(3), 500–518. https://doi.org/10.1007/s10862-020-09794-8

Gallant, S. N. (2016). Mindfulness meditation practice and executive functioning: Breaking down the benefit. *Consciousness and Cognition*, *40*, 116–130. https://doi.org/10.1016/j.concog.2016.01.005

Geurts, D. E. M., Schellekens, M. P. J., Janssen, L., & Speckens, A. E. M. (2021). Mechanisms of Change in Mindfulness-Based Cognitive Therapy in Adults With ADHD. *Journal of Attention Disorders*, *25*(9), 1331–1342. https://doi.org/10.1177/1087054719896865

Gu, Y., Xu, G., & Zhu, Y. (2018). A Randomized Controlled Trial of Mindfulness-Based Cognitive Therapy for College Students With ADHD. *Journal of Attention Disorders*, *22*(4), 388–399. https://doi.org/10.1177/1087054716686183

Hepark, S., Janssen, L., de Vries, A., Schoenberg, P. L. A., Donders, R., Kan, C. C., & Speckens, A. E. M. (2019). The Efficacy of Adapted MBCT on Core Symptoms and Executive Functioning in Adults With ADHD: A Preliminary Randomized Controlled Trial. *Journal of Attention Disorders*, *23*(4), 351–362. https://doi.org/10.1177/1087054715613587

Higgins, J. P. T., Altman, D. G., Gotzsche, P. C., Juni, P., Moher, D., Oxman, A. D., Savovic, J., Schulz, K. F., Weeks, L., Sterne, J. A. C., Cochrane Bias Methods Group, & Cochrane Statistical Methods Group. (2011). The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ*, *343*(oct18 2), d5928–d5928. https://doi.org/10.1136/bmj.d5928

Higgins, J. P. T., & Thompson, S. G. (2002). Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine*, *21*(11), 1539–1558. https://doi.org/10.1002/sim.1186

Janssen, L., Kan, C. C., Carpentier, P. J., Sizoo, B., Hepark, S., Schellekens, M. P. J., Donders, A. R. T., Buitelaar, J. K., & Speckens, A. E. M. (2019). Mindfulness-based cognitive therapy v. treatment as usual in adults with ADHD: A multicentre, single-blind, randomised controlled trial. *Psychological Medicine*, *49*(1), 55–65. https://doi.org/10.1017/S0033291718000429

Janssen, L., de Vries, A. M., Hepark, S., & Speckens, A. E. M. (2020). The Feasibility, Effectiveness, and Process of Change of Mindfulness-Based Cognitive Therapy for Adults With ADHD: A Mixed-Method Pilot Study. Journal of Attention Disorders, 24(6), 928–942. https://doi.org/10.1177/1087054717727350

Lee, C. S. C., Ma, M.-T., Ho, H.-Y., Tsang, K.-K., Zheng, Y.-Y., & Wu, Z.-Y. (2017). The Effectiveness of Mindfulness-Based Intervention in Attention on Individuals with ADHD: A Systematic Review. *Hong Kong Journal of Occupational Therapy*, *30*(1), 33–41. https://doi.org/10.1016/j.hkjot.2017.05.001

Li, Y., & Zhang, L. (2024). Efficacy of Cognitive Behavioral Therapy Combined with Pharmacotherapy Versus Pharmacotherapy Alone in Adult ADHD: A Systematic Review and Meta-Analysis. *Journal of Attention Disorders*, *28*(3), 279–292. https://doi.org/10.1177/10870547231214969

Lodha, S., & Gupta, R. (2022). Mindfulness, Attentional Networks, and Executive Functioning: A Review of Interventions and Long-Term Meditation Practice. *Journal of Cognitive Enhancement*, *6*(4), 531–548. https://doi.org/10.1007/s41465-022-00254-7

Lopez, P. L., Torrente, F. M., Ciapponi, A., Lischinsky, A. G., Cetkovich-Bakmas, M., Rojas, J. I., Romano, M., & Manes, F. F. (2018). *Cognitive-behavioural interventions for attention deficit hyperactivity disorder (ADHD) in adults—Lopez, PL - 2018 | Cochrane Library*. https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD010840.pub2/full?highlightAbstract=adhd%7Cpsychological%7Ccbt%7Cpsycholog%7Cadult%7Cinterventio n%7Cintervent

Lutz, A., Slagter, H. A., Dunne, J. D., & Davidson, R. J. (2008). Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences*, *12*(4), 163–169. https://doi.org/10.1016/j.tics.2008.01.005

National Institute for Health and Care Excellence. Attention deficit hyperactivity disorder: diagnosis and management (2019 September 13). [NICE guideline No. 87], 2018. Available at: https://www.nice.org.uk/guidance/ng87. Accessed May 29th, 2025.

National Institute for Health and Care Excellence. Depression in adults: treatment and management (2022 September 29). [NICE guideline No. 222], 2022. Available at: https://www.nice.org.uk/guidance/ng222. Accessed May 29th, 2025.

NHS Education for Scotland. Matrix - A guide to delivering evidence based psychological therapies in Scotland; Adult Mental Health 2014. https://www.nes.scot.nhs.uk/media/2ocnzsta/matrix_-_adultmentalhealthtables.pdf Accessed May 29th, 2025.

Oliva, F., Malandrone, F., di Girolamo, G., Mirabella, S., Colombi, N., Carletto, S., & Ostacoli, L. (2021). The efficacy of mindfulness-based interventions in attention-deficit/hyperactivity disorder beyond core symptoms: A systematic review, meta-analysis, and meta-regression. *Journal of Affective Disorders*, *292*, 475–486. https://doi.org/10.1016/j.jad.2021.05.068

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71

Poissant, H., Moreno, A., Potvin, S., & Mendrek, A. (2020). A Meta-analysis of Mindfulness-Based Interventions in Adults with Attention-Deficit Hyperactivity Disorder: Impact on ADHD Symptoms, Depression, and Executive Functioning. *Mindfulness*, *11*(12), 2669–2681. https://doi.org/10.1007/s12671-020-01458-8

Schoenberg, P. L. A., Hepark, S., Kan, C. C., Barendregt, H. P., Buitelaar, J. K., & Speckens, A. E. M. (2014). Effects of mindfulness-based cognitive therapy on neurophysiological correlates of performance monitoring in adult attention-deficit/hyperactivity disorder. *Clinical Neurophysiology*, *125*(7), 1407–1416. https://doi.org/10.1016/j.clinph.2013.11.031

Segal, Z. V., Williams, J. M. G., & Teasdale, J. D. (2002). Mindfulness-based cognitive therapy for depression: A new approach to preventing relapse. The Guilford Press.

Segal, Z., Williams, M., & Teasdale, J. (2012). Mindfulness-based cognitive therapy for depression. Guilford press.

Song, P., Zha, M., Yang, Q., Zhang, Y., Li, X., & Rudan, I. (2021). The prevalence of adult attention-deficit hyperactivity disorder: A global systematic review and meta-analysis. *Journal of Global Health*, *11*, 04009. https://doi.org/10.7189/jogh.11.04009

Tacconelli, E. (2010). Systematic reviews: CRD's guidance for undertaking reviews in health care. The Lancet Infectious Diseases, 10(4), 226.

Tang, Y.-Y., Hölzel, B. K., & Posner, M. I. (2015). The neuroscience of mindfulness meditation. *Nature Reviews Neuroscience*, *16*(4), 213–225. https://doi.org/10.1038/nrn3916

Wielgosz, J., Goldberg, S. B., Kral, T. R. A., Dunne, J. D., & Davidson, R. J. (2019). Mindfulness Meditation and Psychopathology. *Annual Review of Clinical Psychology*, *15*(Volume 15, 2019), 285–316. https://doi.org/10.1146/annurev-clinpsy-021815-093423

Zhou, H., Liu, H., & Deng, Y. (2020). Effects of short-term mindfulness-based training on executive function: Divergent but promising. *Clinical Psychology & Psychotherapy*, *27*(5), 672–685. https://doi.org/10.1002/cpp.2453

Zylowska, L., Ackerman, D. L., Yang, M. H., Futrell, J. L., Horton, N. L., Hale, T. S., Pataki, C., & Smalley, S. L. (2008). Mindfulness Meditation Training in Adults and Adolescents With ADHD: A Feasibility Study. *Journal of Attention Disorders*, *11*(6), 737–746. https://doi.org/10.1177/1087054707308502

Chapter 2

Measuring Sustained Attention in Adults with Attention Deficit Hyperactivity Disorder

Prepared in accordance with the author requirements for Journal of Attention Disorders

Submission Guidelines: Journal of Attention Disorders: Sage Journals

Plain Language Summary

Title: Measuring Sustained Attention in Adults with Attention Deficit Hyperactivity Disorder.

Background: Attention Deficit Hyperactivity Disorder (ADHD) tends to be diagnosed in childhood, however in recent years there has been an increase in referrals across services by adults seeking assessment for ADHD (Smith et al., 2024). These assessments can take a long time to complete, and people referred are facing significant waiting times. Screening of ADHD does currently happen as a first step but can be reliant on a person's self-judgement, which might not be accurate. If a more accurate screening process takes place, this may speed up the process for those referred. Cognitive assessment measures can be used to build an understanding of a person's cognitive functioning in domains relevant to ADHD. Additional objective evidence of an individual's cognitive functioning would be potentially useful at the screening stage of assessment to ensure that individuals with a high likelihood of meeting ADHD criteria proceed beyond the screening stage.

Aims and Questions: This study aimed to examine the relationship between a person's sustained attention and self-reported ADHD symptoms. This study also considered how sustained attention presents in people who have been diagnosed with ADHD compared to those who have not. This research also considered the feasibility of completing this study, including the acceptability of the Sustained Attention Response Task (SART) as a method by which sustained attention was measured).

Methods: Participants were university students who were contacted via their course administrators with requests to take part. Participants were included in the research providing they were aged 18-29, and had no history of psychosis, brain injury or no current severe mental health disorder. 12 participants were split into three groups: those with ADHD, those without ADHD, and those who suspect they may have ADHD. Participants met with the researcher to complete the SART and a self-report measure.

Findings: The SART measure was deemed to be feasible and acceptable for use in research. There was a positive relationship observed between sustained attention and self-reported ADHD symptoms in people who were not taking medication for their ADHD, also. Due to the small number of participants that took part, this study suggests that a pilot study may be beneficial to further evaluate the SART for potential use as a screening measure for ADHD.

References:

Smith, M. C. F., Mukherjee, R. A. S., Müller-Sedgwick, U., Hank, D., Carpenter, P., & Adamou, M. (2024). UK adult ADHD services in crisis. *BJPsych Bulletin*, *48*(1), 1–5. https://doi.org/10.1192/bjb.2023.88

Young, S., Asherson, P., Lloyd, T., Absoud, M., Arif, M., Colley, W. A., Cortese, S., Cubbin, S., Doyle, N., Morua, S. D., Ferreira-Lay, P., Gudjonsson, G., Ivens, V., Jarvis, C., Lewis, A., Mason, P., Newlove-Delgado, T., Pitts, M., Read, H., … Skirrow, C. (2021). Failure of Healthcare Provision for Attention-Deficit/Hyperactivity Disorder in the United Kingdom: A Consensus Statement. *Frontiers in Psychiatry*, *12*. https://doi.org/10.3389/fpsyt.2021.649399

Word count: 475

Abstract

The number of adults seeking assessment for ADHD in the UK has risen in recent years, creating lengthy waiting lists. Clinician resource required to complete a full assessment is significant, a robust but efficient screening process would be beneficial to ensure that those who are likely to meet criteria for ADHD proceed to assessment stage. This study aims to determine the feasibility and acceptability of using the Sustained Attention Response Task (SART) and consider the relationship between SART error scores and self-reported ADHD symptoms as measured by the Adult ADHD Self-report Scale (ASRS). This study used a cross sectional between-subjects design to evaluate how SART error rates (indicative of sustained attentions deficits) varied across people who have ADHD, people who suspect they have ADHD and people who have no suspicion that they have ADHD. A correlation was also run to determine the relationship between ASRS scores and SART errors. There was no statistically significant difference in SART scores observed across the 3 groups, nor was a relationship observed between SART errors and ASRS scores in the full sample. A strong positive correlation however was observed between SART errors and total ASRS scores when the data was filtered to only include participants who weren't taking ADHD medication, $r(8)=0.71$, $p<0.05$. This study presents preliminary evidence for the potential use of a computerised test such as the SART, as a method to screen for ADHD in adults. This current study indicates feasibility and acceptability and presents considerations for future research in the form of a potential pilot study to evaluate use of the SART in clinical settings.

Keywords: ADHD, Adults, Sustained Attention, Screening, Assessment.

Introduction

About ADHD

Attention Deficit Hyperactivity Disorder (ADHD) is characterised by inattentiveness, hyperactivity and impulsivity (American Psychiatric Association, 2013). Although primarily diagnosed in childhood, receiving a diagnosis of ADHD in adulthood has become increasingly common globally. Song et al. (2021) estimated that 2.58% of the global population of adults in 2020 had ADHD.

In terms of neurobiology, heterogeneity presents challenges in identifying a clear understanding of functional and structural components of ADHD. Da Silva et al. (2023) summarised that ADHD is characterised by disruption in several neurotransmission processes. In particular, as a result of ADHD, disorder in dopamine receptors impacts cognitive, emotional and attentional processes, dysregulation in the noradrenergic system affects working memory and alertness and disruption to serotonin neurotransmitters presents difficulties in mood and emotional regulation. Knowledge of how these symptoms present in ADHD can be valuable in determining a person's level of functioning. A person's working memory, sustained attention and response speed has shown the most success in indicating whether or not a person had ADHD (Nikolas et al., 2019).

Prevalence of adults being referred to services for assessment and treatment of ADHD has increased in recent years and issues in accessing this care seem to have been exacerbated following the COVID-19 pandemic (Young et al., 2021). Due to the specialist nature of ADHD assessment, there is ever growing demand being placed on ADHD specialist services for assessment and treatment of the condition (Smith et al., 2024). This can have a costly impact for services and individuals, some NHS England services commission independent providers using public funding (Smith et al., 2024) to provide access to appropriate care. Some individuals will seek services directly, which in these instances means low-income families are less likely to be in a position to access appropriate care (Young et al., 2021).

Significant barriers remain around receiving an accurate diagnosis of ADHD in adulthood. Canela et al. (2017) hypothesise that this may be due in part to

compensatory strategies that people with ADHD have developed to cope, including the use of rigid structures or being overly punctual. This may result in challenges in accurately diagnosing individuals where ADHD has not interfered in daily functioning. This study also suggests that the individuals themselves may not be aware of placing themselves in occupational environments which minimise their difficulties.

There is also commonality in the nuanced presentations of ADHD and presentations of comorbidities, which can make it challenging to differentiate between symptoms (Long & Coats, 2022). This research highlighted that a delay of diagnosis impacts negatively on a person's self-esteem with individuals citing thoughts around feeling stupid or a failure when comparing themselves to their peers (Long & Coats, 2022). The potential impact of these negative core beliefs run the risk of predisposing individuals to develop common comorbidities such as anxiety and depression.

Assessment of ADHD

Current recommendations require diagnosis of ADHD in adulthood to be made by an appropriately qualified and trained health professional (National Institute for Health and Care Excellence (NICE), 2018). Diagnostic criteria specifies that impairments related to inattention, hyperactivity and impulsiveness must have begun during childhood and persisted into adulthood, that the impairments cannot be explained by any other condition, and that the impairments are associated with at least moderate to severe impairment in social, psychological, educational, or occupational functioning (American Psychiatric Association, 2013).

Guidance from NICE (2018) states that ADHD diagnosis should be given only following a comprehensive assessment of a person's current psychosocial functioning and observed mental state, and a full psychiatric and developmental history. As a structure for assessment, mental health clinicians make use of the diagnostic interview - the DIVA 2.0 has been found to produce reliable diagnoses when compared to the Conners' Adult ADHD Diagnostic Interview for DSM IV (CAADID) (Ramos-Quiroga et al., 2016). Although observational data and rating scales can inform assessment, guidelines indicate that a diagnosis cannot be based on this information alone (NICE, 2018). Suggestions have been made to consider options like objective or computerised

measures as part of the ADHD assessment process to improve efficiency in response to current waiting list challenges Smith et al. (2024).

Clinical time required from relevant specialist professionals to carry out Adult ADHD assessment places a significant demand on services, with patients experiencing lengthy waiting lists. A more robust screening process would possibly be valuable to filter the cases which require further specialist assessment for ADHD.

Screening for ADHD

Potvin et al. (2016) discussed the importance of both subjective and objective measures in screening for ADHD for a full understanding of an individual's cognitive functioning. Existing literature has stated the value of self-report measures in informing the diagnostic process, however has also highlighted the risk of ADHD self-report measures returning high rates of false positives (Lovett & Harrison, 2021). Ramsay (2017) summarised the value of multiple screening measures, and their importance of guiding further assessment but emphasised that they should be used with caution and cited the example that a person's scores may be elevated due to symptoms of a mood episode.

The Adult ADHD Self-Report Scale (ASRS) (Kessler et al., 2005) is commonly used and recommended as a screening measure to guide further evaluation (Hines et al., 2012), and has high diagnostic accuracy (Brevik et al., 2020). However, recent evidence suggests limited sensitivity and a risk of false negatives in university students (Lovett et al., 2021), adults with co-morbid alcohol issues (Luderer et al., 2019) and people with major depressive disorder (Dunlop et al., 2018). Evidence has been suggested for the Screen for Cognitive Impairment in Psychiatry (SCIP) in detecting symptoms of ADHD, however more research is required to determine whether it can be used to discriminate between ADHD and other co-morbidities (Tourjman et al., 2019). Additional objective evidence of an individual's cognitive functioning would be beneficial as part of the screening process, and may have implications for the reliability and validity of data gathered at screening.

Cognitive assessment

Previous studies have considered the use of cognitive assessment to gain a better understanding of the neuropsychological impairments of an adult with ADHD. Theiling

& Petermann (2016) used the WAIS-IV to establish the neuropsychological profile of adults with ADHD and found results to suggest that people with ADHD are more likely to have reduced scores on tests of working memory and processing speed. This is consistent with findings from Leib et al. (2021), who also found variation across participants with ADHD in processing speed and working memory using the WAIS-IV. This study also speculated that testing under distraction-free conditions may generate outcomes on processing speed that are not a true representation of a person's day to day functioning.

Nasiri et al. (2023) summarised a range of cognitive assessment batteries that can be used in a variety of settings and cover a range of attentional deficits. A general measure of attention used for assessment of ADHD, is the Test of Attentional Performance (TAP), which was used by Stibbe et al. (2020) to determine gender differences in cognitive difficulties in ADHD, the tests covers a range of functions often impaired in people with ADHD: working memory, alertness and attention, as well as response inhibition and behavioural control.

A person's ability for sustained attention relates primarily to their ability to remain focussed on a task over time (Esterman & Rothlein, 2019), and there is evidence of deficits of sustained attention in adults with ADHD (Marchetta et al., 2008). Tucha et al. (2017) indicated that the use of "Go/No-go" measures in research may be beneficial to building an evidence base around sustained attention deficits in adults. Previous research has indicated that Continuous Performance Tests (CPTs), show promising evidence for discriminating between core ADHD symptoms and other comorbid mental health presentations (Rosso et al., 2023). A recent thesis by Kirivanova (2024) looked at the relationship between neurotypical individuals' scores on the ASRS and a CPT, but found no statistically significant relationship. Robertson et al. (1997) developed the Sustained Attention Response Task (SART) which is considered a "Go/No-go" task and suggested that commission errors represent lapses in sustained attention. There is a reduced evidence base relating to sustained attention in comparison to other attentional processes (Esterman & Rothlein, 2019), which provides rationale for a closer look at the use of the SART as a measure of performance on sustained attention tasks.

There is evidence to suggest that cognitive functioning across test batteries can be similar between those diagnosed with ADHD and those who do not meet full diagnostic criteria (Guo et al., 2021). Relevant to this, some neuropsychological assessment measures have also been scrutinised for poor success in discriminating between the potential reasons why individuals have impaired neuropsychological functioning, for example ADHD versus psychiatric symptoms (Holst & Thorell, 2017).

There is enough evidence in the role of cognitive assessment and neuropsychological testing in evaluating ADHD-related cognitive deficits in people with ADHD to warrant further investigation. As discussed in previous sections, significant time and staff resource is required to assess a person for ADHD, and given the limited sensitivity in current screening processes, a more robust accurate screening process that included a brief neuropsychological or cognitive test would perhaps be beneficial to ensure that individuals with a high likelihood of meeting criteria proceed beyond screening stage.

It therefore seems there is scope to consider a screening process that is efficient in terms of staff resource, especially if there is an accessible method that facilitates the collection of objective evidence to improve the reliability of the screening stage of assessment. There is currently relatively limited evidence for the role of cognitive assessment in specifically screening for ADHD, which indicates the need for exploratory research.

Rationale and aims

The current high demand on services to assess ADHD has highlighted the importance of a more robust initial screening process. Self-report measures such as the ASRS provide quick results, but as previously mentioned, are more susceptible to bias and have reduced sensitivity in specific groups. This study considers the role of cognitive assessment as part of a neuropsychological approach to screening for ADHD in adults, and how the cognitive profile of attention deficits relates to outcomes measured by self-report measures. This study therefore aims to build a neuropsychological profile of sustained attention through use of the SART, to develop preliminary evidence for its consideration as part of a screening process for ADHD, in order to increase sensitivity of this screening stage. While the approach taken in this current study will not decisively indicate fully that the SART can be used as part of a clinical screening

pathway, but will instead show directions for future research, by reporting on areas relevant for future replication and piloting.

This study aims to examine the relationship between a person's sustained attention and their self-reported ADHD symptoms as measured by an ADHD screening tool. As stated previously, research in this area has been mixed, however assessing the relationship for any correlation would provide insight of any significant areas of interest when using these methods. The existing body of work on this topic is small and therefore the scope of this current study is limited to a proof of principle approach.

Feasibility frameworks have previously been used in research to determine whether novel approaches could be appropriate for use in further research and in clinical contexts. Kurokawa et al. (2024) used a feasibility approach to consider the use of telepsychiatry to facilitate neurodevelopmental assessments in children, using this to inform future processes. The Medical Research Council (Skivington et al., 2021) indicate the requirement for investigation of feasibility when developing clinical practice. This research will therefore consider the feasibility and acceptability of a study that uses the SART as a measure of sustained attention to compare with self-reported ADHD symptoms.

This study will therefore aim to evaluate the following research questions:

1. Feasibility: Can the research procedures (including recruitment and data collection using the SART) be achieved?
2. Acceptability: Were participants (including people with ADHD) able to take part in the study without experiencing difficulties or distress?
3. What is the relationship, if any, between sustained attention, and self-reported ADHD symptoms as measured by a screening tool?
4. Is there a difference between the sustained attention of participants with ADHD, those with suspected ADHD and those without ADHD?

Methods

Design

This quantitative study uses a cross sectional, between-subjects design. A proof of principle approach has been selected in this case, due to the stage of development of this area of research, to assess the feasibility of a study that compares sustained attention and self-reported symptoms of ADHD, and to capture the relationship between the evidence provided by these two measures.

Participants

Participants were university students, as in (Lovett et al., 2021), attending university in a major Scottish city. To examine the between group differences set out in the research questions, participants were split into three groups: those with a formal diagnosis of ADHD, those who suspect they may have ADHD and may be awaiting diagnosis and those who have no suspicion that they have ADHD. Participants of any gender aged 18-29 years old were eligible to be included. This age range was selected in accordance with scoring guidance and norms from the Conners Adult ADHD Rating Scales (CAARS), which separates groups by age to reflect the change in scoring profiles as people grow older. Participants were excluded if they met the following criteria:

- History or current presentation of psychosis or taking anti-psychotic medication.
- Current severe mental health issue
- Severe traumatic brain injury

This criteria was primarily adapted from Robertson et al. (1997) which had excluded people who have a history of a major psychiatric condition, which also found evidence that the SART was sensitive to the effects of brain injury. Those in the ADHD group who take medication for their ADHD were included in the recruitment, however they were asked to provide detail on the dosage and medication that they take.

A power calculation was not carried out to determine that sample size required as the project was a proof-of-principle study. Guided by previous research aimed at assessing feasibility and proof of principle (Nordby et al., 2021), the study aimed to recruit 10 participants in total. Although the study may not be sufficiently powered especially for

small effect sizes, any statistically significant results will provide indication of areas important for further study.

Recruitment procedures

The study received ethical approval to recruit from students within the School of Health and Wellbeing (SHW) at the university. Recruitment procedures followed University of Glasgow guidance for recruiting participants from students and additional approval from the Dean of Learning of the SHW was sought as part of this. The study advert was therefore disseminated to potential participants via the researcher emailing administration staff within each college, who then emailed the study advert to the enrolled students.

The researcher shared the study advert (Appendix 2.9) to administration staff within each college who, disseminated the study advert to the enrolled students. The advert contained information on the aims of the study, eligibility criteria and a contact email. As in Grotewiel et al. (2023), participants contacted the researcher to schedule a time to meet and participate in the study. Meetings took place in a meeting room on university campus and were scheduled in accordance with researcher and participant availability. These meetings took place between February and May 2025.

The researcher replied via email to any potential participants who got in touch, reiterating the eligibility criteria and asking the participant if they had any questions about the research. At this first contact, the researcher also sent the potential participant the Information sheet, a shortened version of the Information sheet, and the Data Privacy notice for the study (Appendices 2.4, 2.5 and 2.7). If participants confirmed they were happy to take part and met the eligibility criteria they would arrange a time to meet with the researcher. Participants were informed via the information sheet provided that detailed that the tasks were not diagnostic in nature.

As this study was completed as part of a taught university course, it was required to sit within a specific timeline in order to be completed as part of the primary researcher's employment contract. Namely, the recruitment was required to be completed by May 2025. Further to this, the university's ethics requirements were such that the researcher could only contact specific course administrators within the School of

Health and Wellbeing, therefore recruitment took place within the limits of these parameters.

Materials and measures

Demographic and other background information was gathered to ensure participants were placed in correct groups for the study. Information was gathered that was indicative of feasibility and acceptability. The Sustained Attention Response Task (SART) was used to assess the cognitive profile of sustained attention. The Adult ADHD Self-Report Scale (ASRS-v1.1), was selected as a screening tool for ADHD.

Feasibility and acceptability

Feasibility was primarily indicated based on whether the study is able to recruit the desired number of participants, and if the measures collect the required data. Acceptability will be indicated if the participants were able to attend meetings with the researcher and complete the required measures (namely the SART) without ceasing involvement in the task, and without distress. This will be evidenced through researcher observation to determine if participants experienced any kind of distress.

Demographic and background information

Data was collected on participants age, gender and ethnicity. Participants were asked if they have been diagnosed with ADHD, if they suspect that they have ADHD or if they have no reason to believe they have ADHD to ensure they were placed in the correct group. Participants were asked if they are taking medication for ADHD symptoms, and if so, details of the type and daily dosage. Although this is not part of exclusion criteria, this is relevant as this medication may impact performance on other measures. Although there are no studies that directly examine the impact of ADHD medication on performance on the SART in adults, evidence shows that these medications can improve sustained attention in people with ADHD (Advokat, 2010).

Adult ADHD Self-Report Scale

The Adult ADHD Self-Report Scale (ASRS-v1.1) is widely used and accepted as an initial screening tool for ADHD in an adult population. This scale has preliminary support for identifying symptoms of ADHD in young people (Green et al., 2019), and diagnostic accuracy has been indicated in adults for both the short form, and the full 18 item version (Brevik et al., 2020). The ASRS contains 18 statements, and for each statement

participants are asked to rate how often in the last six months they have felt that way in using a five-point Likert scale (Never, Rarely, Sometimes, Often, Very Often). Each of the answer boxes have a threshold of clinical significance, indicated by shaded squares in the answer column. In a clinical context, the selection of four or more shaded squares in response to the first six questions (Part A) indicates the relevance for further assessment of ADHD symptoms. The remaining questions (Part B) provide additional information about a person's presentation relating to ADHD traits that will likely be useful in the context of further assessment.

For the purpose of this research, ASRS scores will be analysed as two different variables. Participant data will be split into two groups based on whether or not they have met the clinical significance threshold in in Part A of the ASRS (selected four or more shaded boxes), representing a categorical variable.

Secondly, the answers for all 18 questions in the questionnaire will each be assigned a numeric value from zero to four corresponding to the Likert scale (Never=0, Rarely=1, Sometimes=2, Often=3, Very Often=4). These values will be summed in order to give a total score out of 72 and will represent the ASRS as a continuous variable for analysis. This ASRS total score has previously been used in methodology from Brevik et al. (2020) to give a measure of ADHD traits, and Kessler et al. (2005) highlight the potential use of this score in monitoring progress during ongoing treatment.

Sustained Attention to Response Task

The SART (Robertson et al., 1997) was used to measure sustained attention, due to its sensitivity to sustained attention deficits. This test measures response inhibition indicative of sustained attention and has been used previously to measure inhibition as an indicator of executive function for a study investigating cognitive functioning (Oosterholt et al., 2012).

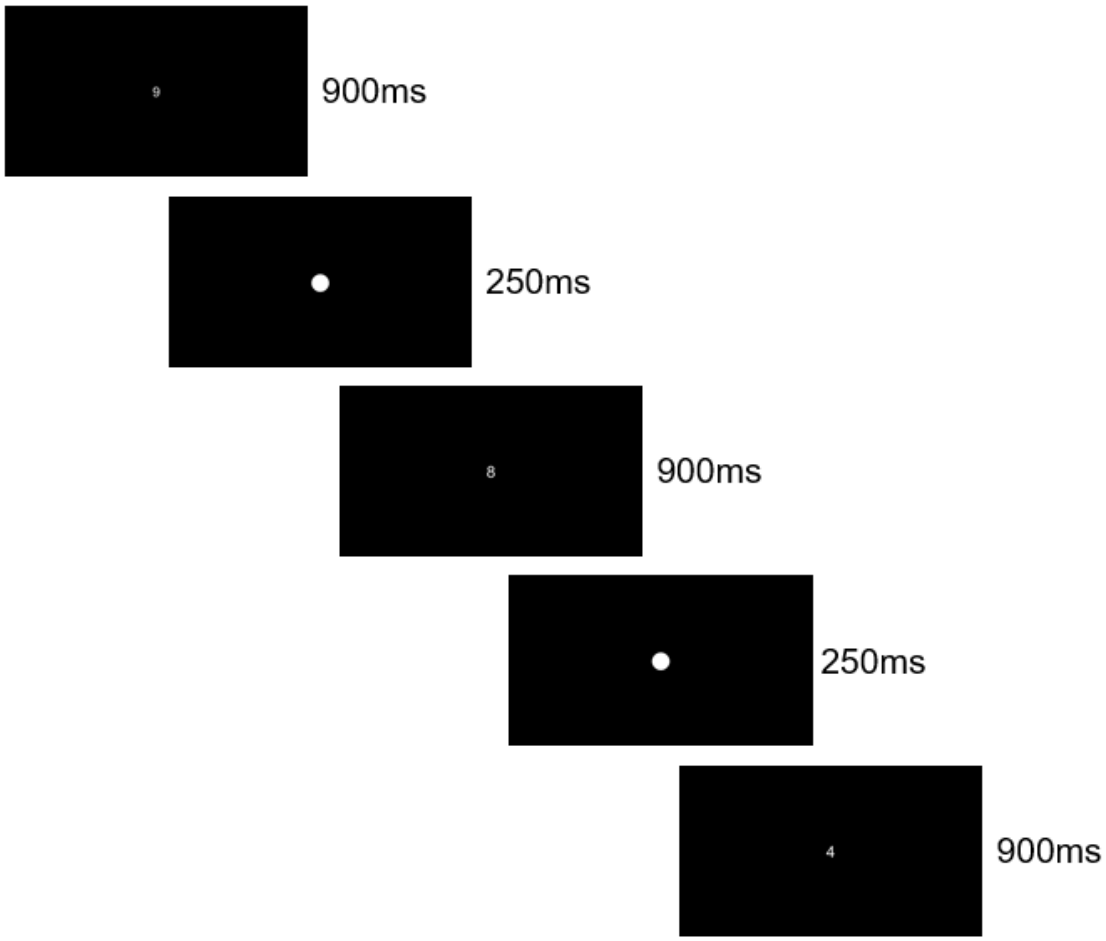
The SART is a Go/No-go test in which participants are shown individual digits and asked to respond (press space bar) for all digits shown apart from the target digit (in this case the number three), where they were required to withhold a response. This present study followed the parameters set out in Robertson et al. (1997), whereby each of the nine digits were shown by the programme 25 times, (resulting in 225 total

iterations of digits being presented), the presentation of the digits was quasi-randomised and pre-fixed.

The digits were presented in a variety of five randomly allocated font sizes and ranged in height from 12mm to 29mm tall. Each digit was presented for 0.25 seconds followed by a 0.9 second “mask” which was a solid white circle 29 mm in diameter. This was a variation on the “mask” used by Robertson et al, (1997), as this present study used an updated version of the SART. The digits, masks and instructions were presented in white text on a plain black background in the centre of the computer screen (as detailed in Figure 5). This study used a Lenovo ThinkPad with a screen size of 14 inches, participants sat at a desk with the laptop, no restrictions were placed on the distance the participants were from the screen.

Figure 5

Presentation of Stimuli in SART



Prior to the test phase of the SART, participants took part in a built-in practise phase, consisting of the presentation of 18 digits, two of which were targets. Participants were instructed to give equal importance to speed and accuracy when completing the task.

The SART programme records the response (whether or not the participant presses the space bar) to each digit presentation. For the purpose of this study, the data that is extracted by the SART will be the number of times a participant does not withhold pressing the space bar when presented with the number three. This will indicate the number of errors that each participant makes on the SART, which will be a maximum score of 25.

Research procedures

At the meeting with the researcher, participants were given paper copies of the information sheet, shortened information sheet, and the data privacy notice. The participants were given another opportunity to ask the researcher questions, and then completed the consent form (Appendix 2.6) if they were happy to take part in the study.

The participants were firstly asked questions relating to their demographic information, followed by completing the ASRS, and then lastly the SART. After these were completed the researcher explained that the testing had been completed, and allowed the participants to ask questions, or share reflections on their experience of completing the measures (primarily due to the cognitively challenging nature of the SART).

Data analysis

Data analysis was conducted using IBM SPSS Statistics 29.0.2.0. As detailed previously, data collected from the ASRS provides two different variables for analysis:

- To evaluate the SART errors using the categorical variable data from the ASRS, an independent samples T-test (or non-parametric alternative) was carried out.
- To assess the relationship between SART errors and self-reported ADHD symptoms as a continuous variable measured by the ASRS, this study completed a Pearson's correlation co-efficient (or a non-parametric alternative) to compare results from the ASRS and the SART across all participants.

To compare data gathered by the SART across three groups (ADHD, Suspected ADHD and Non-ADHD) an ANOVA was carried out (or a non-parametric alternative if required).

Given the proof of principle design adopted by this study, additional exploratory analysis was carried out to determine if any further links or comparisons can be made within the data gathered.

Results

In total, 12 participants (ten female, two male) agreed to take part in the study and met with the researcher to do so. Participants ranged in age from 18 to 29 (mean 25.58, SD 3.34). Further details are shown in Table 2.

Table 2

Descriptive statistics in each group

	No ADHD	Suspected ADHD	ADHD
N	5	5	2
Gender Female/Male	4/1	4/1	2/0
Mean Age (SD)	27.60 (1.67)	24.00 (4.00)	24.50 (3.54)
Medication Use	0	0	2
Positive result for ASRS Part A	0	5	2
Total ASRS score Mean (SD)	26.00 (2.92)	48.20 (11.71)	55.00 (9.90)
SART Errors Mean (SD)	5.80 (4.09)	9.40 (4.72)	3.00 (1.41)

Feasibility and Acceptability

In terms of recruitment the required number of participants were met, and those who took part completed the measures as required. This suggests that this research has feasibility to be further developed. It is important to note that recruitment took three months to complete, and initially 22 people expressed interest in the research, therefore ten people declined to take part following this initial contact, either by lack of response or by responding to say they had changed their mind. Participants who did take part were able to attend meetings with the researcher in a building on the university's campus. Participants acknowledged the challenging nature of the SART, but all understood the instructions, as viewed by the researcher in the room, also there were no anomalies in the raw SART output to suggest otherwise. No participants needed to cease taking part, nor did they show distress or express difficult emotions in response to taking part in the process, suggesting acceptability. The short nature of the SART (less than 20 minutes) also seemed to be viewed positively.

As this is anticipated to be part of a larger process for the piloting of such an approach to screening, Table 3 identifies aspects of this research that have scope to map on to more clinical context for further development either in a research or clinical capacity.

Table 3

Feasibility Implications for Future Research in a Clinical Context

Aspects of current study	**Implications for research under clinical conditions or clinical screening**
Inclusion of human adult participants who do and don't have ADHD.	Inclusion of human adult patients who may or may not have ADHD.
Participants motivated to engage due to an interest or curiosity in ADHD.	Patients motivated to engage due to an interest of curiosity in their own potential ADHD symptoms.
Clear accessible pre-task information in format of information sheets.	Clear accessible written or verbal information, communicated prior to taking part.
Informed consent recorded using form and written signature.	Informed consent recorded either via written signature or verbal consent documented in clinical notes dependent on context.
Computerised task.	Computerised task.
Confidential environment with researcher present.	Confidential environment with clinician or researcher present, or alternatively task that can be accessible to patients online from home. Further thought would be required for this latter procedural change.
Requirement for additional time to interpret results.	Requirement for additional time to interpret results, and discuss outcome of screening measure and feedback to patient if in a clinical context.

Relationship between ASRS and SART

ASRS as a clinical threshold

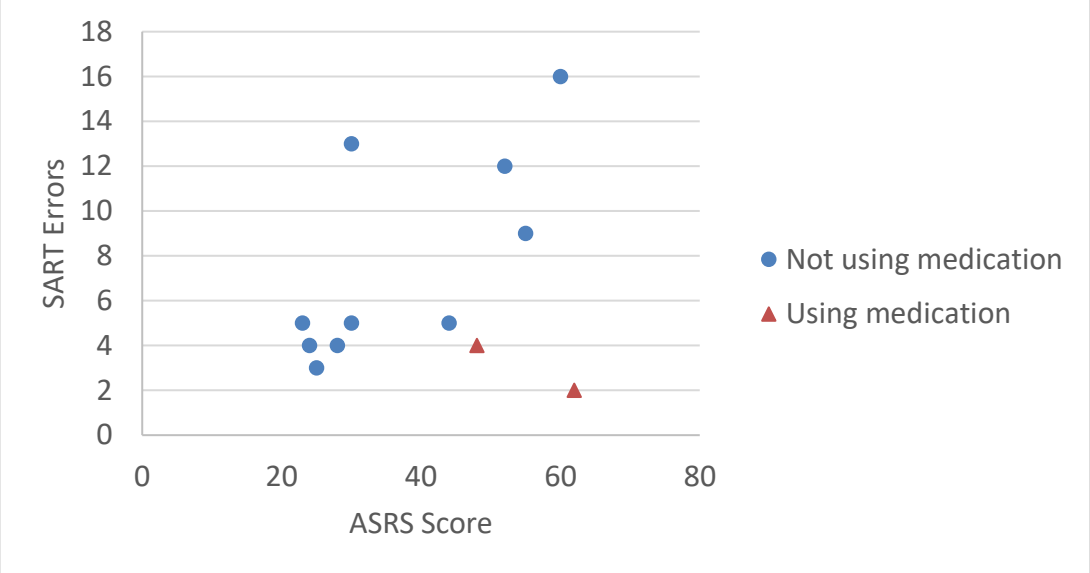
A Shapiro-Wilk test of normality indicated that the data from the number of errors in the SART variable was non-normally distributed ($p<0.05$), therefore a non-parametric test was used. A Mann-Whitney U test was completed to determine whether the number of SART errors differed depending on whether or not a person reached clinical threshold on the ASRS (four or more shaded answers in part A). The results indicated that there was no evidence at the 95% significance threshold for a difference between the number of SART errors in those that reached clinical threshold on the ASRS compared to those who did not ($Z=-0.741$, $p=0.530$).

ASRS as a continuous variable

ASRS scores and SART errors from the full sample of participants are presented in a scatterplot in Figure 6. As stated above, the SART error scores remain non-normally distributed therefore a non-parametric test was carried out to assess the relationship between the SART errors and ASRS total score. Due to the small sample size in this study, a Kendall's tau-b correlation was run to determine the relationship between total ASRS score and the number of errors from the SART. This result was not statistically significant ($p=0.363$), meaning that there was no relationship observed between the SART and the ASRS either as a categorial variable indicating clinical threshold or as a continuous variable that sums the total score in this sample.

Figure 6

Relationship between SART Errors and ASRS scores



SART score across ADHD groups

In order to assess normality, residuals for the SART error variable were calculated across each group. A Shapiro-Wilk test indicated that this data can be assumed as normally distributed and a parametric analysis would be appropriate. A one-way ANOVA was therefore carried out to determine the difference in SART scores across each group which was not statistically significant ($F(2,9)=1.927$, $p=0.201$). These results indicate that there is no difference between the SART error scores across the ADHD, suspected ADHD or non-ADHD groups in this study.

Additional exploratory analysis

Two individuals within the ADHD groups stated that they were taking medication for their ADHD. There is evidence to suggest that medication for ADHD can lead to improved sustained attention in adults with ADHD (Advokat, 2010). The scatterplot in Figure 6 is presented to visualise the pattern in participants who take medication compared to those who don't. It was pertinent to consider that medication may be impacting the outcomes measured in this study, therefore this study carried out a sensitivity analysis which repeated the analyses of the relationship between the ASRS and the SART errors only on those who were not currently taking medication for ADHD (n=10).

From observation of Figure 6, it does appear that the two participants that take medication rated their ADHD symptoms relatively highly using the self-report measure, although this is interesting there is a crucial caveat that these participant numbers are very small so it's difficult to draw definitive conclusions.

A Shapiro-Wilk test of normality indicated that both the SART error data and ASRS continuous variable and were normally distributed. An independent samples t-test was then carried out to evaluate whether there was a difference between the SART errors of in those who reached clinical threshold on the ASRS compared to those who did not. The results indicated that there was no statistically significant difference between SART errors of those who met clinical threshold on the ASRS ($M=9.40$, $SD=4.72$) and those who did not ($M=5.80$, $SD=4.09$), $t(8)=-1.29$, $p=0.23$.

A Pearson's correlation coefficient was also calculated and found that there was a statistically significant strong positive correlation between the ASRS continuous variable and the SART errors, $r(8)=0.71$, $p<0.05$. The strong positive correlation indicates the higher a person's ASRS score was (as a continuous variable), the more errors they made.

Discussion

This is the first study to examine the potential of using the SART as part of the screening process for ADHD in adults. The key results of this study indicate that errors on the SART correlate with the severity of self-reported symptoms of ADHD in individuals who are not taking medication for ADHD. Evidence from this study also suggests that the SART has feasibility and acceptability for use with participants, based on the short time required to administer, the fact it could be administered independently, and that there was no distress indicated by participants who took part.

Statistical findings for this study indicate that there is no difference in sustained attention across the three groups, however results did outline that there was a correlation between sustained attention and self-reported ADHD symptoms, when participants using medication were excluded. As discussed throughout this study, in order to draw specific conclusions about this measure's role in a clinical setting, a larger, fully powered sample would be required. This study provides scope for the SART measure to be used in further research relating to ADHD as part of this process.

While this study found a relationship between the SART errors and the ASRS as a continuous variable, there was no statistically significant result for the ASRS as a categorical variable. As previously indicated the categorical variable on the ASRS would indicate clinical significance, whereas the continuous data is representative of information used to create a fuller picture of ADHD traits. A larger, sufficiently powered study may be able to give more conclusive evidence around whether the categorical ASRS score would reveal differences in cognitive functioning between groups. There may also be variability in the severity of ADHD symptoms, or compensatory strategies that develop in people with ADHD (Canela et al., 2017), especially in a university-recruited sample. It is also important to consider that the ASRS as a self-report measure is at risk of bias based on a person's wellbeing and current situation (Brevik et al., 2020).

The correlation found in this present study between that SART and ASRS data contrasts with evidence presented by Kirivanova (2024) who compared error data from a different Go/No-go task (CPT) to the same corresponding continuous variable

data from the ASRS in a larger sample but did not find a significant relationship. This perhaps strengthens the argument specifically for use of the SART as a measure to indicate ADHD symptoms. There are also methodological differences that could explain the differences in findings. Of note, Kirivanova (2024) included a non-ADHD sample in their study, however didn't disclose the way in which they ensured people who had ADHD were excluded (participants were students at university recruited for academic credits). It was therefore difficult to guarantee that participants with ADHD (who may have been using medication) were not included, which could have skewed results.

The importance of considering use of ADHD medication in research with individuals with ADHD is highlighted by this study. This study which found a statistically significant correlation between SART errors and ADHD symptoms as a continuous variable, only after excluding participants taking medication. This is in line with the fact that ADHD medication improves sustained attention in adults with ADHD (Advokat, 2010). There are also other ways to account for effects of medication. For example, Machida et al. (2022) managed this potential effect when they asked children in their study to cease medication use prior to 24 hours before being tested using the SART. Machida et al. (2022) found that the number of errors on the SART were able to classify which children did and didn't have a diagnosis of ADHD.

This current study also provided evidence to indicate that the SART is feasible for use in future research and offers consideration for testing with a clinical perspective in mind. The short time required for the test to be completed (less than 20 minutes including the practice stage), the possibility of completing the test independently of clinician involvement and the fact that it is inexpensive (free for the version used in this study) allows consideration for use. Although the test was fast-paced, there were no signs of distress in participants.

(Smith et al., 2024) recommended the need for a more efficient process around ADHD assessment and consideration of the use of digital technology to achieve this. Findings from this current study suggest that it would be relevant to consider the SART for this. Given the existing robust approach to full assessment (NICE, 2018), this type of

computerised task may be best placed to give information about an individual's neuropsychological functioning at the screening stage.

Future Research

Given the feasibility and acceptability indicated by this study, and the promising findings that higher error scores on the SART are consistent with higher ASRS scores, further investigation of the potential of the SART in ADHD screening seems pertinent. This may include extending this proof-of-principle study to a larger, sufficiently powered study.

As detailed by Table 3 in the results section, there are a number of parallels between this research and a study that could potentially be conducted in a more clinical context. It is useful to consider that the SART was able to be completed by people who suspect that they may have ADHD, and that information about the study and the consent gathering process is also likely to be similar, although potentially recorded differently. Areas that may require additional consideration for a clinical setting include the recruitment process and the implications of potentially using an online version of the SART that a participant could access from their own home.

A plan to progress this research base could be to complete a larger pilot study which repeats this methodology in an NHS setting. People referred for assessment of ADHD could be invited to complete the study protocol as outlined by the current paper and the analysis could compare results to that person's diagnostic outcome. Given that the present study only recruited students that were attending university, recruiting in a clinical setting could increase the representativeness of the adult ADHD population.

Other than the use of the SART in screening, it may also be beneficial to consider in future research whether the SART could be useful for monitoring ADHD symptoms in treatment studies and clinical practice.

Strengths and Limitations

There are limitations to this present study. The participants were university students who therefore will have been able enough to maintain a level of attention that allowed them to pursue higher education, which may not be representative of the wider population who have or suspect they have ADHD. Although participants were

asked to self-select for this study if they did not have a significant mental health problem, it would still be possible that participants could be experiencing lower-level mental health problems that may impact performance on the SART.

Conclusion

Waiting times for individuals to be assessed for ADHD in adulthood remain significant, and the impact of a delayed diagnosis of ADHD on a person's psychological wellbeing indicates the pressing requirement for an efficient but robust assessment process. This study presents preliminary evidence that sustained attention as measured by the SART is correlated with ADHD traits, supporting its use as a method to screen for ADHD in adults. The current study indicates feasibility and acceptability, alongside the need to consider ADHD medication in research. The findings offer extensive scope for further research in this area with the aim of ensuring that adults seeking assessment for ADHD can be given appropriate care and support to promote an understanding of their difficulties.

Declarations

Conflicting interests: The authors declare there are no conflicting interests.

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Ethical Approval: See Appendix 2.3

Data Availability: See appendix 2.12

References

Advokat, C. (2010). What are the cognitive effects of stimulant medications? Emphasis on adults with attention-deficit/hyperactivity disorder (ADHD). *Neuroscience & Biobehavioral Reviews*, *34*(8), 1256–1266. https://doi.org/10.1016/j.neubiorev.2010.03.006

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). Arlington, VA: American Psychiatric Publishing.

Brevik, E. J., Lundervold, A. J., Haavik, J., & Posserud, M. (2020). Validity and accuracy of the Adult Attention-Deficit/Hyperactivity Disorder (ADHD) Self-Report Scale (ASRS) and the Wender Utah Rating Scale (WURS) symptom checklists in discriminating between adults with and without ADHD. *Brain and Behavior*, *10*(6), e01605. https://doi.org/10.1002/brb3.1605

Canela, C., Buadze, A., Dube, A., Eich, D., & Liebrenz, M. (2017). Skills and compensation strategies in adult ADHD – A qualitative study. *PLOS ONE*, *12*(9), e0184964. https://doi.org/10.1371/journal.pone.0184964

Da Silva, B. S., Grevet, E. H., Silva, L. C. F., Ramos, J. K. N., Rovaris, D. L., & Bau, C. H. D. (2023). An overview on neurobiology and therapeutics of attention-deficit/hyperactivity disorder. *Discover Mental Health*, *3*(1), 2. https://doi.org/10.1007/s44192-022-00030-1

Dunlop, B., Wu, R., & Helms, K. (2018). Performance of the Adult ADHD Self-Report Scale-v1.1 in Adults with Major Depressive Disorder. *Behavioral Sciences*, *8*(4), 37. https://doi.org/10.3390/bs8040037

Esterman, M., & Rothlein, D. (2019). Models of sustained attention. *Current Opinion in Psychology*, *29*, 174–180. https://doi.org/10.1016/j.copsyc.2019.03.005

Green, J. G., DeYoung, G., Wogan, M. E., Wolf, E. J., Lane, K. L., & Adler, L. A. (2019). Evidence for the reliability and preliminary validity of the Adult ADHD Self-Report Scale v1.1 (ASRS v1.1) Screener in an adolescent community sample. *International Journal of Methods in Psychiatric Research*, *28*(1), e1751. https://doi.org/10.1002/mpr.1751

Grotewiel, M. M., Crenshaw, M. E., Dorsey, A., & Street, E. (2023). Experiences of hyperfocus and flow in college students with and without Attention Deficit Hyperactivity Disorder (ADHD). *Current Psychology*, *42*(16), 13265–13275. https://doi.org/10.1007/s12144-021-02539-0

Guo, N., Fuermaier, A. B. M., Koerts, J., Mueller, B. W., Diers, K., Mroß, A., Mette, C., Tucha, L., & Tucha, O. (2021). Neuropsychological functioning of individuals at clinical evaluation of adult ADHD. *Journal of Neural Transmission*, *128*(7), 877–891. https://doi.org/10.1007/s00702-020-02281-0

Hines, J. L., King, T. S., & Curry, W. J. (2012). The Adult ADHD Self-Report Scale for Screening for Adult Attention Deficit–Hyperactivity Disorder (ADHD). *The Journal of the American Board of Family Medicine*, *25*(6), 847–853. https://doi.org/10.3122/jabfm.2012.06.120065

Holst, Y., & Thorell, L. B. (2017). Neuropsychological Functioning in Adults With ADHD and Adults With Other Psychiatric Disorders: The Issue of Specificity. *Journal of Attention Disorders*, *21*(2), 137–148. https://doi.org/10.1177/1087054713506264

Kessler, R. C., Adler, L., Ames, M., Demler, O., Faraone, S., Hiripi, E., Howes, M. J., Jin, R., Secnik, K., Spencer, T., Ustun, T. B., & Walters, E. E. (2005). The World Health Organization adult ADHD self-report scale (ASRS): A short screening scale for use in the general population. *Psychological Medicine*, *35*(2), 245–256. https://doi.org/10.1017/S0033291704002892

Kirivanova, D. (2024). The correlation between ADHD traits and sustained attention: A behavioral and neural study. [Bachelor Thesis, Tilburg University]. https://arno.uvt.nl/show.cgi?fid=178249

Kurokawa, S., Nomura, K., Hosogane, N., Nagasawa, T., Kawade, Y., Matsumoto, Y., Morinaga, S., Kaise, Y., Higuchi, A., Goto, A., Inada, N., Kodaira, M., & Kishimoto, T. (2024). Reliability of Telepsychiatry Assessments Using the Attention-Deficit/Hyperactivity Disorder Rating Scale-IV for Children With Neurodevelopmental Disorders and Their Caregivers: Randomized Feasibility Study. *Journal of Medical Internet Research*, *26*(1), e51749. https://doi.org/10.2196/51749

Leib, S. I., Keezer, R. D., Cerny, B. M., Holbrook, L. R., Gallagher, V. T., Jennette, K. J., Ovsiew, G. P., & Soble, J. R. (2021). Distinct Latent Profiles of Working Memory and Processing Speed in Adults with ADHD. *Developmental Neuropsychology*, *46*(8), 574–587. https://doi.org/10.1080/87565641.2021.1999454

Long, N., & Coats, H. (2022). The need for earlier recognition of attention deficit hyperactivity disorder in primary care: A qualitative meta-synthesis of the experience of receiving a diagnosis of ADHD in adulthood. *Family Practice*, *39*(6), 1144–1155. https://doi.org/10.1093/fampra/cmac038

Lovett, B. J., Ferrier, D. E., Wang, T., & Jordan, A. H. (2021). Adult ADHD Self-Report Scale Screener Ratings in College Students: Concurrent Validity and Test–Retest Reliability. *Journal of Psychoeducational Assessment*, *39*(8), 1015–1019. https://doi.org/10.1177/07342829211034367

Lovett, B. J., & Harrison, A. G. (2021). Assessing adult ADHD: New research and perspectives. *Journal of Clinical and Experimental Neuropsychology*, *43*(4), 333–339. https://doi.org/10.1080/13803395.2021.1950640

Luderer, M., Kaplan-Wickel, N., Richter, A., Reinhard, I., Kiefer, F., & Weber, T. (2019). Screening for adult attention-deficit/hyperactivity disorder in alcohol dependent

patients: Underreporting of ADHD symptoms in self-report scales. *Drug and Alcohol Dependence*, *195*, 52–58. https://doi.org/10.1016/j.drugalcdep.2018.11.020

Machida, K., Barry, E., Mulligan, A., Gill, M., Robertson, I. H., Lewis, F. C., Green, B., Kelly, S. P., Bellgrove, M. A., & Johnson, K. A. (2022). Which Measures From a Sustained Attention Task Best Predict ADHD Group Membership? *Journal of Attention Disorders*, *26*(11), 1471–1482. https://doi.org/10.1177/10870547221081266

Marchetta, N. D. J., Hurks, P. P. M., De Sonneville, L. M. J., Krabbendam, L., & Jolles, J. (2008). Sustained and Focused Attention Deficits in Adult ADHD. *Journal of Attention Disorders*, *11*(6), 664–676. https://doi.org/10.1177/1087054707305108

Nasiri, E., Khalilzad, M., Hakimzadeh, Z., Isari, A., Faryabi-Yousefabad, S., Sadigh-Eteghad, S., & Naseri, A. (2023). A comprehensive review of attention tests: Can we assess what we exactly do not understand? *The Egyptian Journal of Neurology, Psychiatry and Neurosurgery*, *59*(1), 26. https://doi.org/10.1186/s41983-023-00628-4

National Institute for Health and Care Excellence. Attention deficit hyperactivity disorder: diagnosis and management (2019 September 13). [NICE guideline No. 87], 2018. Available at: https://www.nice.org.uk/guidance/ng87. Accessed May 29th, 2025.

Nikolas, M. A., Marshall, P., & Hoelzle, J. B. (2019). The role of neurocognitive tests in the assessment of adult attention-deficit/hyperactivity disorder. *Psychological Assessment*, *31*(5), 685–698. https://doi.org/10.1037/pas0000688

Nordby, E. S., Kenter, R. M. F., Lundervold, A. J., & Nordgreen, T. (2021). A self-guided Internet-delivered intervention for adults with ADHD: A feasibility study. *Internet Interventions*, *25*, 100416. https://doi.org/10.1016/j.invent.2021.100416

Oosterholt, B. G., Van Der Linden, D., Maes, J. H., Verbraak, M. J., & Kompier, M. A. (2012). Burned out cognition – cognitive functioning of burnout patients before and after a period with psychological treatment. *Scandinavian Journal of Work, Environment & Health*, *38*(4), 358–369. https://doi.org/10.5271/sjweh.3256

Potvin, S., Charbonneau, G., Juster, R.-P., Purdon, S., & Tourjman, S. V. (2016). Self-evaluation and objective assessment of cognition in major depression and attention deficit disorder: Implications for clinical practice. *Comprehensive Psychiatry*, *70*, 53–64. https://doi.org/10.1016/j.comppsych.2016.06.004

Ramos-Quiroga, J. A., Nasillo, V., Richarte, V., Corrales, M., Palma, F., Ibáñez, P., & Michelsen, M. (n.d.). Criteria and Concurrent Validity of DIVA 2.0: A Semi-Structured Diagnostic Interview for Adult ADHD. *Journal of Attention Disorders*.

Ramsay, J. R. (2017). Assessment and monitoring of treatment response in adult ADHD patients: Current perspectives. *Neuropsychiatric Disease and Treatment*, *13*, 221–232. https://doi.org/10.2147/NDT.S104706

Robertson, I. H., Manly, T., Andrade, J., Baddeley, B. T., & Yiend, J. (1997). `Oops!': Performance correlates of everyday attentional failures in traumatic brain injured and normal subjects. *Neuropsychologia*, *35*(6), 747–758. https://doi.org/10.1016/S0028-3932(97)00015-8

Rosso, G., Portaluppi, C., Teobaldi, E., Di Salvo, G., & Maina, G. (2023). Assessing Adult ADHD Through Objective Neuropsychological Measures: A Critical Overview. *Journal of Attention Disorders*, *27*(7), 786–794. https://doi.org/10.1177/10870547231167564

Skivington, K., Matthews, L., Simpson, S. A., Craig, P., Baird, J., Blazeby, J. M., Boyd, K. A., Craig, N., French, D. P., McIntosh, E., Petticrew, M., Rycroft-Malone, J., White, M., & Moore, L. (2021). *A new framework for developing and evaluating complex interventions: Update of Medical Research Council guidance*. https://doi.org/10.1136/bmj.n2061

Smith, M. C. F., Mukherjee, R. A. S., Müller-Sedgwick, U., Hank, D., Carpenter, P., & Adamou, M. (2024). UK adult ADHD services in crisis. *BJPsych Bulletin*, *48*(1), 1–5. https://doi.org/10.1192/bjb.2023.88

Song, P., Zha, M., Yang, Q., Zhang, Y., Li, X., & Rudan, I. (2021). The prevalence of adult attention-deficit hyperactivity disorder: A global systematic review and meta-analysis. *Journal of Global Health*, *11*, 04009. https://doi.org/10.7189/jogh.11.04009

Stibbe, T., Huang, J., Paucke, M., Ulke, C., & Strauss, M. (2020). Gender differences in adult ADHD: Cognitive function assessed by the test of attentional performance. *PLOS ONE*, *15*(10), e0240810. https://doi.org/10.1371/journal.pone.0240810

Theiling, J., & Petermann, F. (2016). Neuropsychological Profiles on the WAIS-IV of Adults With ADHD. *Journal of Attention Disorders*, *20*(11), 913–924. https://doi.org/10.1177/1087054713518241

Tourjman, S. V., Potvin, S., Corbalan, F., Djouini, A., Purdon, S. E., Stip, E., Juster, R.-P., & Kouassi, E. (2019). Rapid screening for cognitive deficits in attention deficit and hyperactivity disorders with the screen for cognitive impairment in psychiatry. *ADHD Attention Deficit and Hyperactivity Disorders*, *11*(2), 139–147. https://doi.org/10.1007/s12402-018-0268-7

Tucha, L., Fuermaier, A. B. M., Koerts, J., Buggenthin, R., Aschenbrenner, S., Weisbrod, M., Thome, J., Lange, K. W., & Tucha, O. (2017). Sustained attention in adult ADHD: Time-on-task effects of various measures of attention. *Journal of Neural Transmission*, *124*(S1), 39–53. https://doi.org/10.1007/s00702-015-1426-0

Young, S., Asherson, P., Lloyd, T., Absoud, M., Arif, M., Colley, W. A., Cortese, S., Cubbin, S., Doyle, N., Morua, S. D., Ferreira-Lay, P., Gudjonsson, G., Ivens, V., Jarvis, C., Lewis, A., Mason, P., Newlove-Delgado, T., Pitts, M., Read, H., … Skirrow, C. (2021). Failure of Healthcare Provision for Attention-Deficit/Hyperactivity Disorder in the United Kingdom: A Consensus Statement. *Frontiers in Psychiatry*, *12*. https://doi.org/10.3389/fpsyt.2021.649399

Appendices

Appendix 1.1 Prisma Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	10
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	11
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	15
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	15
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	16-17
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	16 (19)
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Appendix 1.2
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	17
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	17
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	17
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	17
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	18

Section and Topic	Item #	Checklist item	Location where item is reported
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	15
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	14
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	15
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	15
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	15
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	15
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	N/A
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	17
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	16
Study characteristics	17	Cite each included study and present its characteristics.	18
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	20-22
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	18
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	20-21
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	23-24
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A

Section and Topic	Item #	Checklist item	Location where item is reported
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	N/A
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	25-27
	23b	Discuss any limitations of the evidence included in the review.	27-28
	23c	Discuss any limitations of the review processes used.	27-28
	23d	Discuss implications of the results for practice, policy, and future research.	28-29
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	13
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	13
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	30
Competing interests	26	Declare any competing interests of review authors.	30
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	N/A

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

Appendix 1.2 Search Strategy

Search Strategy for PsychINFO (EBSCO)

1. DE "Attention Deficit Disorder with Hyperactivity"
2. TI “attention deficit” OR AB “attention deficit” OR KW “attention deficit”
3. TI “hyperactivity disorder*” OR AB “hyperactivity disorder*” OR KW “hyperactivity disorder*”
4. TI adhd OR AB adhd OR KW ADHD
5. TI addh OR AB addh OR KW addh
6. TI adhs OR AB adhs OR KW adhs
7. TI AD-HD OR AB AD-HD OR KW AD-HD
8. S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7
9. DE "Mindfulness-Based Cognitive Therapy"
10. TI “mindfulness-based cognitive therap*” OR AB “mindfulness-based cognitive therap*” OR KW “mindfulness-based cognitive therap*”
11. TI mbct OR AB mbct OR KW mbct
12. S9 OR S10 OR S11
13. DE "Placebo" OR DE "Randomized Clinical Trials" OR DE "Randomized Controlled Trials" OR DE "Experiment Controls" OR DE "Clinical Trials" OR MR "CLINICAL TRIAL"
14. TI ("random*" OR "sham" OR "placebo*" OR "Nonrandom*" OR "non random*" OR "non-random*" OR "quasi-random*" OR "quasirandom*" OR "pragmatic study" OR "pragmatic studies") OR AB ("random*" OR "sham" OR "placebo*" OR "Nonrandom*" OR "non random*" OR "non-random*" OR "quasi-random*" OR "quasirandom*" OR "pragmatic study" OR "pragmatic studies") OR SU ("random*" OR "sham" OR "placebo*" OR "Nonrandom*" OR "non random*" OR "non-random*" OR "quasi-random*" OR "quasirandom*" OR "pragmatic study" OR "pragmatic studies") OR KW ("random*" OR "sham" OR "placebo*" OR "Nonrandom*" OR "non random*" OR "non-random*" OR "quasi-random*" OR "quasirandom*" OR "pragmatic study" OR "pragmatic studies")
15. TI ((("singl*" OR "doubl*" OR "tripl*" OR "trebl*") W0 ("blind*" OR "dumm*" OR "mask*"))) OR AB ((("singl*" OR "doubl*" OR "tripl*" OR "trebl*") W0 ("blind*" OR "dumm*" OR "mask*"))) OR SU ((("singl*" OR "doubl*" OR "tripl*" OR "trebl*") W0 ("blind*" OR "dumm*" OR "mask*"))) OR KW ((("singl*" OR "doubl*" OR "tripl*" OR "trebl*") W0 ("blind*" OR "dumm*" OR "mask*")))
16. TI ((("clinical" OR "phase" OR "crossover" OR "cross-over" OR "multicent*" OR "multi-cent*" OR "equivalence" OR "superiority" OR "non-inferiority" OR "noninferiority" OR "quasiexperimental" OR "quasi-experimental") N2 ("study" OR "studies" OR "trial*"))) OR AB ((("clinical" OR "phase" OR "crossover" OR "cross-over" OR "multicent*" OR "multi-cent*" OR "equivalence" OR "superiority" OR "non-inferiority" OR "noninferiority" OR "quasiexperimental" OR "quasi-experimental") N2 ("study" OR "studies" OR "trial*"))) OR SU ((("clinical" OR "phase" OR "crossover" OR "cross-over" OR "multicent*" OR "multi-cent*" OR "equivalence" OR "superiority" OR "non-inferiority" OR "noninferiority" OR "quasiexperimental" OR "quasi-experimental") N2 ("study" OR "studies" OR "trial*"))) OR KW ((("clinical" OR "phase" OR "crossover" OR "cross-over" OR "multicent*" OR "multi-cent*" OR "equivalence" OR "superiority" OR

"non-inferiority" OR "noninferiority" OR "quasiexperimental" OR "quasi-experimental") N2 ("study" OR "studies" OR "trial*")))

17. TI ((("open label" OR "open-label") N4 ("study" OR "studies" OR "trial*"))) OR AB ((("open label" OR "open-label") N4 ("study" OR "studies" OR "trial*"))) OR SU ((("open label" OR "open-label") N4 ("study" OR "studies" OR "trial*"))) OR KW ((("open label" OR "open-label") N4 ("study" OR "studies" OR "trial*"))) S6 TI (("pragmatic" OR "practical") N2 ("trial*")) OR AB (("pragmatic" OR "practical") N2 ("trial*")) OR SU (("pragmatic" OR "practical") N2 ("trial*")) OR KW (("pragmatic" OR "practical") N2 ("trial*"))
18. TI ("control*" N2 ("study" OR "studies" OR "trial*" OR "group*")) OR AB ("control*" N2 ("study" OR "studies" OR "trial*" OR "group*")) OR SU ("control*" N2 ("study" OR "studies" OR "trial*" OR "group*")) OR KW ("control*" N2 ("study" OR "studies" OR "trial*" OR "group*"))
19. TI "allocated" OR AB "allocated" OR SU "allocated"
20. TI ("trial") OR KW ("trial")
21. S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20
22. TI adult* OR AB adult* OR KW adult*
23. S8 AND S12 AND S21 AND S22

Search Strategy for CINAHL (EBSCO)

1. (MH "Attention Deficit Hyperactivity Disorder")
2. TI “attention deficit” OR AB “attention deficit” OR SU “attention deficit”
3. TI “hyperactivity disorder*” OR AB “hyperactivity disorder*” OR SU “hyperactivity disorder*”
4. TI adhd OR AB adhd OR SU ADHD
5. TI addh OR AB addh OR SU addh
6. TI adhs OR AB adhs OR SU adhs
7. TI AD-HD OR AB AD-HD OR SU AD-HD
8. S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7
9. "Mindfulness-Based Cognitive Therapy"
10. TI “mindfulness-based cognitive therap*” OR AB “mindfulness-based cognitive therap*” OR SU “mindfulness-based cognitive therap*”
11. TI mbct OR AB mbct OR SU mbct
12. S9 OR S10 OR S11
13. (MH "Clinical Trials+")
14. PT Clinical trial
15. TX ((singl* n1 blind*) or (singl* n1 mask*)) OR TX ((doubl* n1 blind*) or (doubl* n1 mask*)) OR TX ((tripl* n1 blind*) or (tripl* n1 mask*)) OR TX ((trebl* n1 blind*) or (trebl* n1 mask*))
16. TX randomi* control* trial*
17. (MH "Random Assignment")
18. TX random* allocat*
19. TX placebo*
20. (MH "Placebos")
21. (MH "Quantitative Studies")
22. TX allocat* random*
23. S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22
24. (MH "Adult+")

25. TI adult* OR AB adult* OR SU adult*
26. S24 OR S25
27. S8 AND S12 AND S23 AND S26

Search Strategy for Medline (Ovid)

1. exp Attention Deficit Disorder with Hyperactivity/
2. Attention Deficit.ab,kf,ti.
3. Hyperactivity Disorder*.ab,kf,ti.
4. ADHD.ab,kf,ti.
5. ADDH.ab,kf,ti.
6. ADHS.ab,kf,ti.
7. AD-HD.ab,kf,ti.
8. #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7
9. “Mindfulness-Based” Cognitive Therap*.ab,kf,ti.
10. MBCT.ab,kf,ti.
11. #9 OR #10
12. Randomized Controlled Trials as Topic/
13. randomized controlled trial/
14. Random Allocation/
15. Double Blind Method/
16. Single Blind Method/
17. clinical trial/
18. clinical trial, phase i.pt
19. clinical trial, phase ii.pt
20. clinical trial, phase iii.pt
21. clinical trial, phase iv.pt
22. controlled clinical trial.pt
23. randomized controlled trial.pt
24. multicenter study.pt
25. clinical trial.pt
26. exp Clinical Trials as topic/
27. or/12-26
28. (clinical adj trial$).tw
29. ((singl$ or doubl$ or treb$ or tripl$) adj (blind$3 or mask$3)).tw
30. PLACEBOS/
31. placebo$.tw
32. randomly allocated.tw
33. (allocated adj2 random$).tw
34. or/28-33
35. 27 or 34
36. case report.tw
37. letter/
38. historical article/
39. or/36-38
40. 35 not 39
41. exp Adult/
42. Adult*.ab,kf,ti.
43. #41 OR #42

44. #8 AND #11 AND #40 AND #43

Search Strategy for Embase (Ovid)

1. Exp Attention Deficit Disorder with Hyperactivity/
2. Attention Deficit.ab,kf,ti.
3. Hyperactivity Disorder*.ab,kf,ti.
4. ADHD.ab,kf,ti.
5. ADDH.ab,kf,ti.
6. ADHS.ab,kf,ti.
7. AD-HD.ab,kf,ti.
8. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7
9. exp mindfulness-based cognitive therapy/
10. “Mindfulness-Based” Cognitive Therap*.ab,kf,ti.
11. MBCT.ab,kf,ti.
12. 9 OR 10 OR 11
13. Clinical Trial/
14. Randomized Controlled Trial/
15. controlled clinical trial/
16. multicenter study/
17. Phase 3 clinical trial/
18. Phase 4 clinical trial/
19. exp RANDOMIZATION/
20. Single Blind Procedure/
21. Double Blind Procedure/
22. Crossover Procedure/
23. PLACEBO/
24. randomi?ed controlled trial$.tw.
25. rct.tw.
26. (random$ adj2 allocat$).tw.
27. single blind$.tw.
28. double blind$.tw.
29. ((treble or triple) adj blind$).tw.
30. placebo$.tw.
31. Prospective Study/
32. or/13-31
33. Case Study/
34. case report.tw.
35. abstract report/ or letter/
36. Conference proceeding.pt.
37. Conference abstract.pt.
38. Editorial.pt.
39. Letter.pt.
40. Note.pt.
41. or/33-40
42. 32 not 41
43. Exp Adult/
44. Adult*.ab,kf,ti.
45. 43 OR 44

46. 8 AND 12 AND 42 AND 45

ClinicalTrials.gov
Condition/Disease: Attention Deficit Hyperactivity Disorder
Other Terms: Adult
Intervention/Treatment: Mindfulness Based Cognitive Therapy

World Health Organisation: International Clinical Trials Registry Platform
Title:
Condition: Attention Deficit Hyperactivity Disorder
Intervention: Mindfulness Based Cognitive Therapy

Appendix 2.1 MRP Reporting Checklist

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	38
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	38
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	39-44
Objectives	3	State specific objectives, including any prespecified hypotheses	44
Methods			
Study design	4	Present key elements of study design early in the paper	45
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	45
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	45-46
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	47-51
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	47-51
Bias	9	Describe any efforts to address potential sources of bias	N/A
Study size	10	Explain how the study size was arrived at	45-46
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	46-51
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	51
		(*b*) Describe any methods used to examine subgroups and interactions	51
		(*c*) Explain how missing data were addressed	N/A

		(*d*) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	52
		(b) Give reasons for non-participation at each stage	52
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	52
		(b) Indicate number of participants with missing data for each variable of interest	N/A
Outcome data	15*	Report numbers of outcome events or summary measures	52
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	52-56
		(*b*) Report category boundaries when continuous variables were categorized	52-56
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	55-56
Discussion			
Key results	18	Summarise key results with reference to study objectives	57
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	59-60
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	57-59
Generalisability	21	Discuss the generalisability (external validity) of the study results	57-60
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	61

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Appendix 2.2 Final Research Proposal
OSF | Appendix 2.2 Final Research Proposal.pdf

Appendix 2.3 Ethics Approval Letter

Document removed for confidentiality.

Appendix 2.4 Participant Information Sheet
OSF | Appendix 2.4 Participant Information Sheet.pdf

Appendix 2.5 Participant Information Sheet – Short Version
OSF | Appendix 2.5 Participant Information Sheet - Short Form.pdf

Appendix 2.6 Consent Form

OSF | Appendix 2.6 Consent Form.pdf

Appendix 2.7 Data Privacy Notice
OSF | Appendix 2.7 Privacy Notice.pdf

Appendix 2.8 Demographic Data Collection Form
OSF | Appendix 2.8 Demographic Data Collection.pdf

Appendix 2.9 Study Advert
OSF | Appendix 2.9 Study Advert.pdf

Appendix 2.10 Data Analysis Plan
OSF | Appendix 2.10 Data Analysis Plan.pdf

Appendix 2.11 Data Analysis Process Guidance
OSF | Appendix 2.11 Data Analysis Process Guidance.pdf

Appendix 2.12 Data Analysis Syntax for SPSS
OSF | Appendix 2.12 Data Analysis Syntax for SPSS.pdf

Appendix 2.13 Data Availability Statement

In accordance with the application to the University of Glasgow's Ethics committee for this research project, the data collected for this study was completed solely for the purpose of this study and therefore is not available to share.