The Effects of Mindfulness-Based Interventions on Functioning of Children and Youth with Attention Deficit Hyperactivity Disorder

A Systematic Literature Review

Cristina Pozneanscaia

One-year master thesis 15 credits
Interventions in Childhood

Spring Semester 2019

Supervisor: Mats Granlund
Examiner: Elaine Mc Hugh
ABSTRACT

Author: Cristina Pozneanscaia

The Effects of Mindfulness-based Interventions and yoga on Everyday Functioning of Children and Youth with ADHD
A Systematic Literature Review

Background: Given the incomplete benefits of the pharmacological therapy for ADHD and its over-prescription in children over the last decades, there is an explicit need for alternative treatments. Mindfulness-based Interventions (MBIs) are a family of emergent self-regulation practices including meditation, yoga and body-awareness exercises, found to be an effective therapy for ADHD. Due to poor methodological design and significant risk of bias across studies, mindfulness approach remains an investigational treatment.

Aim: This systematic review sought to identify and critically appraise the evidence on the functioning outcomes of MBIs in children and youth with ADHD.

Method: The literature search was conducted in 7 databases for psychology and social sciences to identify controlled trials – randomized- and non-randomized, evaluating MBIs published in peer-reviewed journal in English between 2000-2019. Only studies focusing on children and youth aged 7-18 years with documented ADHD symptoms were considered for inclusion.

Results: Six controlled trials were included and analysed. Meditation, breathing techniques, self-awareness and yoga exercises were the most common activities implemented across the 6 studies. Significant reduction of inattention and hyperactivity/impulsivity symptoms; and improvements of sustained attention, working memory and emotional regulation were reported across studies, with small to large effect size.

Conclusion: Despite the limitations, MBIs do prove to be an effective complementary treatment for reduction of the core ADHD symptoms and improvement of executive functioning (EF). Further research is needed to elucidate how these interventions improve social functioning and participation of children and youth with ADHD, which would enable a wider implementation of these practices at the community level.

Keywords: Mindfulness-based Interventions, MBIs, mindfulness, yoga, meditation, Attention Deficit Hyperactivity Disorder, ADHD
# Table of contents

1. Introduction ........................................................................................................... 1

2. Theoretical background .......................................................................................... 2
   2.1 Children with Attention Deficit Hyperactivity Disorder (ADHD) ..................... 2
   2.2 Biomedical approach to ADHD ..................................................................... 2
   2.3 Biopsychosocial approach to ADHD .............................................................. 3
       2.3.1 Mindfulness-based Interventions and ADHD ........................................ 4
   2.4 Study rationale .................................................................................................. 6

3. Aim and research questions .................................................................................... 6

4. Method ...................................................................................................................... 7
   4.1 Systematic literature review ........................................................................... 7
   4.2 Search strategy .................................................................................................. 7
   4.3 Selection criteria ............................................................................................... 7
   4.4 Screening process ............................................................................................. 9
       4.4.1 Title-Abstract level ................................................................................ 9
       4.4.2 Full-text level .......................................................................................... 9
   4.5 Data extraction ................................................................................................... 10
   4.6 Quality assessment ........................................................................................... 11
   4.7 Data analysis ..................................................................................................... 11

5. Results ..................................................................................................................... 11
   5.1 Characteristics of included studies ................................................................. 11
   5.2 Characteristics of participants ....................................................................... 12
   5.3 Characteristics of interventions and outcome measures .............................. 14
   5.4 Effects of interventions .................................................................................. 18

6. Discussion ............................................................................................................... 20
   6.1 Methodological limitations and future research ............................................ 23
   6.2 Practical implications ....................................................................................... 24

7. Conclusion .............................................................................................................. 24

8. References .............................................................................................................. 25

9. Appendices ............................................................................................................. 35
   9.1 Appendix A. Data extraction questions ........................................................... 35
   9.2 Appendix B. Quality assessment tool ............................................................... 38
   9.3 Appendix C. Included studies ....................................................................... 43
   9.4 Appendix D. Content of the sessions in Mindful Child (MC) and Mindful Parenting (MP) training ................................................................. 44
   9.5 Appendix E. Overview of interventions and results ........................................ 46
1 Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is among the most prevalent neurodevelopmental disorders in children and youth, characterized by impairing symptoms of inattention and/or hyperactivity/impulsivity (American Psychological Association [APA], 2013). Children and adolescents with ADHD are at greater risk of exhibiting poor executive functioning (EF) and academic achievement, as well as behavioural issues leading to social exclusion, delinquency and substance abuse (Sciberras, Roos & Efron, 2009; Mikami, 2013; Harty, Galanopoulos, Newcorn & Halperin, 2013). Moreover, the ADHD symptomology often co-occurs with various psychiatric disorders such as Oppositional defiant disorder (ODD), Conduct disorder (CD) and anxiety (Kraut et al., 2013). Thus, children with ADHD experience more daily limitations in functioning activities and social participation compared to their typical functioning peers.

Currently, the biomedical approach that comprises stimulant medication remains the first-line ADHD treatment. However, the produced outcomes are not persistent and what is more concerning, generate multiple short- and long-term side effects, e.g. insomnia, irritability and appetite loss (Khajehpiri, Mahmoudi-Gharaei, Faghihi, Karimzadeh & Mohammadi, 2014). Along with an increasing over-prescription of stimulant pharmacology for child ADHD over the past decades (McCarthy et al., 2012; Zuvekas & Vitiello, 2012), a high economic cost and undesired side effects, constrain parents to search for complementary ADHD therapies that go beyond the biomedical treatment approach.

Mindfulness-based interventions (MBIs) are an emergent psycho-social approach recently integrated in the Western psychiatry, that was found to be a prominent adjunctive treatment for children and adults with ADHD. MBIs aim to address self-regulation impairment that is considered to be the core deficit associated with ADHD (Barkley, 2011; Nienke, 2018). Operating as an extension of the biomedical approach, MBIs include practices that, in addition to physical barriers, target also psychological and environmental barriers hindering functioning of children and youth with ADHD symptoms. There is a growing body of evidence suggesting that MBIs can be an efficient treatment associated with reduced ADHD symptoms and improved behavioural and neurocognitive functioning in children, along with decreased parental stress (Carboni, Roach & Fredrick, 2013; Haydicky, Shecter, Wiener & Ducharme, 2015; Zhang et al., 2017). However, due to methodological limitations and poor quality of the existing studies, further research is needed to provide stronger evidence on the potential of these interventions on child ADHD populations.
2 Theoretical background

2.1 Children with Attention Deficit Hyperactivity Disorder (ADHD)

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by symptoms of inattention and/or hyperactivity/impulsiveness that currently affects approximately 5% of children worldwide (Schipper et al., 2015), and persists into adulthood in 65% of cases (Faraone et al., 2006). Additionally, gender has been assigned an important role in the incidence of ADHD, with boys being three times more likely to be diagnosed than their female peers (Willcutt, 2012; Stubbs, 2013).

ADHD aetiology has been widely associated with an interplay of genetic and environmental factors (Herbert & Esparham, 2017; Faraone et al., 2018). At the neurobiological level, ADHD and its core symptoms are linked to dysfunction in the cortico-striatal-thalamic-cortical loops of the brain (Bhat & Hechtman, 2016) and are influenced by the brain structure, neurotransmitter levels and neural pathways (Purper-Ouakil, Ramoz, Lepagnol-Bestel, Gorwood & Simonneau, 2011). Furthermore, maternal psychosomatic diseases, exposure to alcohol and tobacco are among the most common pregnancy-related risk factors predisposing and contributing to child ADHD (Amiri, Malek, Sadegfard & Abdi, 2012; Herbert & Esparham, 2017). At the same time, low SES has been associated with highest risk of childhood ADHD at the environmental level (Russell, Ford & Russell, 2015; Russell, Ford, Williams & Russell, 2016).

Children with ADHD experience a wider range of limitations in daily life activities and social participation including poor school achievement, behavioural difficulties, delinquency and substance abuse (Arnold, Hodgkins, Kahle, Madhoo & Kewley, 2015; Mikami, 2013; Harty, Galanopoulos, Newcorn & Halperin, 2013). Executive functioning (EF) impairments such as scarce attention skills and working memory in children and youth with ADHD have been associated with significantly lower academic performance and higher school drop out rate as compared to typical functioning peers (DuPaul & Langberg, 2015). Furthermore, social interactions and peer relationships represent another challenge for children with ADHD, who due to persistent symptoms of hyperactivity and impulsivity often experience stigmatization, bullying and rejection (Grygiel, Humenny, Rębsz, Bajcar & Świtaj, 2018; Becker et al., 2017). At the family level, behavioural impairment of children affected by ADHD has been associated with elevated levels of parental stress, parent-child conflict and marital discord (Wiener, Biondic, Grimbos & Herbert, 2016).

Over the last decades, there have been two major approaches in assessment of child ADHD: the predominant biomedical and the emergent biopsychosocial approach.

2.2 Biomedical approach to ADHD

In the Western countries, the biomedical model of illness and health has been dominant approach guiding healthcare system and policy-making over the last centuries. Within the biomedical model, illness or disability is attributed merely to biological dysfunction at the body level, separate and independent from psychological processes and social behaviour (Engels, 1977).
Clinical assessment of ADHD and comorbidity phenomena is carried out by means of the International Classification of Diseases ICD-10 [ICD-10] (WHO, 1992) and Diagnostic and Statistical Manual of Mental Disorders DSM-IV (APA, 1994) that focus on the biomedical aspects of the disorder. Currently, stimulant psychotropic medication is the first-line treatment for reducing core symptoms of ADHD in children and adults. Various Methylphenidate and Amphetamine formulations are in use since the 1880s, acting on dopamine and noradrenaline reuptake inhibition, and presynaptic release (Bhat & Hechtman, 2016). The findings of a recent comprehensive meta-analysis that compared efficacy and tolerability of medications for ADHD in 133 double-blind randomized controlled trials of children and adults, support the use of Methylphenidate as preferred first-choice medication for the short-term treatment of child ADHD, in terms of efficacy and safety (Cortese et al., 2018).

Despite the high response rate and considerable improvement of the core ADHD symptoms, there is still lack of evidence supporting the long-term efficacy and benefits of the pharmacotherapy. Moreover, its safety still remains controversial. Community concerns about the use of psychotropic pharmacology continue to surface as a consequence of an increasing over-diagnosis and over-prescription of stimulant pharmacology for child ADHD over the past decades (McCarthy et al., 2012; Zuvekas & Vitiello, 2012). Alongside with a high economic cost of medical treatment (Luthy et al., 2015), the multiple short- and long-term side effects represent another important issue. The use of psychotropic stimulants for ADHD in children has been associated with sleeping disorders, appetite and weight loss, headaches and irritability (Khajehpiri, Mahmoudi-Gharaei, Faghihi, Karimzadeh & Mohammadi, 2014; Bhat & Hechtman, 2016). Thus, an increasing number of parents search for complementary therapies for their children. Moreover, alternative methods of ADHD treatment have received support of many physicians who emphasized the importance of addressing social and behavioural skills of the child, as well as family needs, along with medical therapy only limited to control the symptoms (Zametkin & Ernst, 1999).

As suggested by the research, ADHD in a complex disorder that hinder different areas of everyday life of the affected children. Hence, there is an explicit need to adopt a holistic approach that goes beyond the biomedical perspective and focuses on functioning, in addition to disability.

2.3 Biopsychosocial approach to ADHD

Built upon the discontentment with the biomedical perspective, and in need of a more holistic approach, the biopsychosocial model holds that health and illness are the result of an interplay between biological, psychological, and social factors (Engel, 1977). The biopsychosocial approach overcomes the “Mind - Body duality” emphasized by the biomedical model, and goes beyond the medical diagnosis, drawing attention to other factors influencing functioning.

Derived from the biopsychosocial model, the International Classification of Functioning, Disability and Health – Children and Young People [ICF-CY] (WHO, 2007) is as a conceptual framework for recording health and functioning of children and youth, that can arguably be used for the assessment of ADHD. The major interacting domains of the ICF-CY include Body functions and structures; Activity;
Participation; and Environmental factors that operate as either barriers or facilitators (WHO, 2007). Thus, at the Body structures level, ADHD is associated with neuroanatomical modifications (e.g. dysfunctions of the right hemisphere, changes in brain volumes, caudate nucleus, corpus callosum, the frontal area of the basal ganglia and the cerebellum (Salamanca, 2014)), which cause multiple limitations at the Body functions level - poor attention and listening, impulsivity and aggressiveness. The impairments at the Body level, in their turn, operate as barriers of Activity and Participation at home-, school- and society level, making it difficult for children with ADHD to perform daily self-care, to succeed in the classroom and to plan, organise and engage in activities and social interactions with peers. Lastly, it is crucial to consider the impact of various Personal and Environmental factors that comprise characteristics of the child (e.g. gender, age, temperament), their family (parental mental health and SES), as well as close and more distal ecology (classroom structure, education curriculum, social policy, culture, etc.).

Within the biopsychosocial model, ADHD can be assessed from a broader perspective compared to the biomedical model alone, as it has been recognized that this disorder is determined by both biological and environmental factors. The biopsychosocial approach and the ICF-CY allow to bring together the information on diagnosis, societal and environmental peculiarities of the affected child, focusing on the aspects of functioning. Within the ICF-CY framework, functioning is an umbrella term that encompasses all body functions, activities and participation, whereas participation operates as its societal perspective and is defined as a person’s involvement in a life situation (WHO, 2007). Within the Family of Participation-related Constructs [fPRC], self-regulation refers to a “set of executive processes allowing the individual to direct and monitor their thinking, emotions, actions and interactions” (Imms, Granlund, Wilson, Steenbergen, Rosenbaum & Gordon, 2016, p. 20). Self-regulation deficits are considered to be the core issue associated with ADHD in children and adults (Barkley, 2011; Nienke et al., 2018).

### 2.3.1 Mindfulness-based Interventions and ADHD

Mindfulness-based Interventions (MBIs) are a family of emergent self-regulation practices that “focus on training attention and awareness in order to bring mental processes under greater voluntary control and thereby foster general mental well-being and development and/or specific capacities such as calm, clarity and concentration” (Walsh & Shapiro, 2016, p.228-229). Derived from Buddhist tradition and often considered to be a “third wave” of behavioural therapy (Hayes, Follette & Linehan, 2004), MBIs have been successfully integrated in the Western psychiatry in the last decades. First introduced in the clinical setting by Jon Kabat-Zinn in the 1970s as a complementary stress reduction and relaxation therapy, MBIs are now implemented in schools, clinics, hospitals and prisons for addressing anxiety disorders, depression, chronic pain, substance abuse and other health issues (Househam & Solanto, 2016). Currently, the majority of existing MBIs integrated in the psychiatry, with Mindfulness-Based Stress Reduction [MBSR] (Kabat-Zinn, 2003) and Mindfulness-Based Cognitive Therapy [MBCT] (Segal, Williams & Teasdale, 2002) being among the most popular, involve elements of meditation, self-awareness, yoga and breathing exercises, in addition to traditional therapeutic approach used in cognitive therapy. Mindfulness practice was initially implemented in adult populations with different psychiatric disorders and has recently become
a popular child-centred intervention.

According to Holzel et al. (2011), the interaction between attention control, emotional regulation and self-awareness is responsible for enhanced self-regulation (see Figure 2). The results of a recent activation likelihood estimation meta-analysis (ALE) conducted by Sperduti, Martinelli and Piolino (2012) allowed to identify several brain areas activated during the meditative state of mind, which have been associated with attention control, mind wandering and emotional response, and self-awareness mechanisms (Sperduti, Martinelli & Piolino, 2012).

Figure 1

*Mindfulness and self-regulation (adapted from Tang, Posner, Holzel 2015)*

Circumscribed within the biopsychosocial model, MBIs operate at biological/physical level - by implementing yoga and breathing exercises; at psychological level - by entering meditative state of mind and applying sensory awareness and self-acceptance; and at social level - by targeting behaviour skills and by means of group practices. In line with the ICF-CY framework, through working with self-regulation mechanisms, mindfulness addresses physical, psycho-cognitive and environmental barriers, which enables the implementation of a holistic multidimensional approach and makes it a promising intervention for assessment of ADHD symptoms.

Several recent studies have already evaluated the impact of MBIs in child and adult ADHD populations, shedding light on multiple benefits of this therapeutic approach (Mitchell, Zylowska & Kollins, 2015; Carboni, Roach & Fredrick, 2013; Haydicky, Shecter, Wiener, Ducharme & Joseph, 2015; Cairncross & Miller, 2016; Lee, Ma, Ho, Tsang, Zheng & Wu, 2017).
2.4 Study rationale

The results of a recent systematic review and meta-analysis that evaluated the efficacy of yoga, mindfulness and meditation interventions for youth with ADHD (Chimiklis et al., 2018) reported significant positive effects on child ADHD symptomology, executive functioning and on-task behavior, as well as on parent-child relationship, parent stress and mindfulness \((p < 0.05)\) (Chimiklis et al., 2018). It was the first study in the field that used quantitative approach and investigated the effects specifically in child population. However, the review adopted extended selection criteria, including single-arm-, case studies and within-subject design studies. Out of 11 included studies, nine had within-subject design, and only two studies were randomized controlled trials (RCTs) with considerable methodological limitations (Chimiklis et al., 2018). Hence, due to lack of control group and randomization, the majority of the reviewed evidence was underpowered and thus presented significant risk of bias. Moreover, it is still not clear how various mindfulness activities and components affect behavioural and cognitive outcomes (Chimiklis et al., 2018).

3 Aim and research questions

The present thesis aims to explore and critically review the existing evidence on various Mindfulness-based-interventions for ADHD children and youth. The study will be guided by the following research questions formulated by means of PICO(s) framework (Richardson et al., 1995):

1. What does the literature say about the effects of MBIs on functioning of children and youth with ADHD?
2. What components of MBIs are associated with improved functioning of children and youth with ADHD?

<table>
<thead>
<tr>
<th>Population</th>
<th>Intervention</th>
<th>Comparison/Control</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children and youth with ADHD</td>
<td>Mindfulness-based Interventions (MBIs)</td>
<td>No treatment</td>
<td>Improved functioning</td>
</tr>
</tbody>
</table>
4 Method

4.1 Systematic literature review

A systematic review was conducted in order to summarise and critically review the findings of relevant literature, selected according to specific inclusion and exclusion criteria. A systematic literature review is a research method that aims to collect and organise empirical evidence meeting specific election criteria in order to answer specific research questions (Higgins & Green, 2011). The review process was operated following the literature review guidelines provided by Jesson, Matheson & Lacey (2011) and Cochrane Handbook for Systematic Reviews of Interventions (Higgins & Green, 2011). The review was based on the protocol-driven methodology that guided the search and data extraction process. The use of PICO model helped the author answer the established research questions.

4.2 Search strategy

The original search for this review was performed in March 2019. The literature search was carried out using the following online databases for social and health sciences: CINAHL, ERIC, MEDLINE, AMED (Allied and Complementary Medicine Database – for Alterative and Complementary Medicine treatments), PsycINFO, PubMed and Scopus. The adopted search strings comprised thesaurus Medical Subject Headings (MeSH), as well as specific key-words and combinations directly related to the research questions and selection criteria. Search combinations varied mildly within different databases to optimize the search process. Boolean operators were used to connect the search terms and to narrow down search results. Truncations were utilized to perform free search when appropriate.

In the databases PsycINFO and PubMed a combined search method was implemented to retrieve pertinent articles. The Thesaurus MeSH terms for “ADHD” and “Mindfulness” were combined with specific free search words related to recently adopted MBIs-related terms, such as: “Mindful meditation”, “Mindfulness-based cognitive therapy”, “Yoga”, etc. that were retrieved from relevant literature. In all the other databases only free search terms strings were adopted: (“Mindful*” OR “meditation”) AND “ADHD”.

The search process was documented by means of a search protocol that included database title, dates of conducted search, search strings and number of results retrieved.

4.3 Selection criteria

The inclusion and exclusion criteria that guided the literature selection and the subsequent data extraction process were based on the employed PICO approach. For the present review, only studies evaluating child-orientated interventions containing aspects of mindfulness and yoga were considered. Studies evaluating family MBIs, with target population comprised by both children and their parents, were also included, whereas studies focusing exclusively on parents, teachers and other adults were excluded. For a higher evidence level purpose, and to minimise bias and confounding, only controlled trials – randomized control trials (RCT) and non-randomized control trials (NRCT), were considered for inclusion.
A formal ADHD diagnosis or documented high value ADHD symptoms, clinically established, was another inclusion criterion. Children and youth with other types of neurodevelopmental or psychological conditions, where ADHD was not a primary diagnosis, were considered ineligible. The age range of participants was comprised between seven and 18 years for the following reasons. According to parent-reported data collected between 2003 and 2007 by National Survey of Children’s Health (NSCH), the median ages for moderate and mild ADHD diagnosis are six and seven years old respectively (Visser et al., 2013). Furthermore, mindfulness was found to be effective and appropriate to be taught to children as young as seven years old (Semple, Reid & Miller, 2005).

Only studies that focus on improvement of functioning were considered for inclusion, and had to present a discrete documented outcome measurement.

Theses, book chapters, systematic reviews, as well as conferences and other grey literature items were not included. All the searches were limited to full-text scientific peer reviewed articles published in English language between 2000 and March 2019. The inclusion and exclusion criteria are summarized in the Table 2.

### Table 2

**Selection criteria**

<table>
<thead>
<tr>
<th>Population</th>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age range: 7-18 y.o.</td>
<td></td>
<td>Other type of diagnosis</td>
</tr>
<tr>
<td>Formal ADHD diagnosis with/without comorbidity (e.g. ODD, CD, anxiety)</td>
<td></td>
<td>ADHD is not primary diagnosis</td>
</tr>
<tr>
<td>Documented ADHD symptomology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>Mindfulness-based Interventions (MBIs): yoga, meditation</td>
<td>ADHD interventions not including aspects of mindfulness Interventions for parents, teachers, adults</td>
</tr>
<tr>
<td></td>
<td>Child- or family-centred interventions</td>
<td></td>
</tr>
<tr>
<td>Comparison</td>
<td>Include control group/comparison intervention</td>
<td>No control group/comparison intervention</td>
</tr>
<tr>
<td></td>
<td>With typical functioning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>With other interventions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>With no intervention</td>
<td></td>
</tr>
<tr>
<td>Outcome</td>
<td>Focus on improving functioning</td>
<td>ND outcome measurement</td>
</tr>
<tr>
<td></td>
<td>Include discrete outcome measurement</td>
<td></td>
</tr>
<tr>
<td>Study design</td>
<td>Controlled trials:</td>
<td>Within-subject design, Cross-sectional and case studies, Qualitative studies, Systematic reviews</td>
</tr>
<tr>
<td></td>
<td>Randomized control trials (RCT)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-randomized control trials (NRCT)</td>
<td></td>
</tr>
</tbody>
</table>
4.4 Screening process

The screening process of the retrieved articles was performed with the help of Covidence (Mavergames, 2013), a professional online tool developed for assisting systematic review process, including title-abstract screening, full-text screening, data abstraction and quality assessment. At the initial stage, a total of 309 studies retrieved from PsycINFO, PubMed, CINAHL, ERIC, MEDLINE, AMED and Scopus were imported to Covidence, which allowed to identify 104 duplicates. It was further proceeded with the title-abstract- and afterwards, with the full-text screening of the remaining articles \((n = 205)\). Flow chart diagram depicted by Figure 2 provides a summary of the screening process.

4.4.1 Title-Abstract level

Out of the 205 articles remained for the title-abstract screening, 184 studies were further excluded after the selection criteria were applied. Most of the studies were ineligible due to different intervention type (e.g. not including aspects of mindfulness or yoga intervention), wrong population focus (e.g. were aimed merely at parents, teachers and adults in general), and due to different diagnosis or where ADHD was not a primary focus (e.g. yoga or MBIs for children with ASD, depression, anxiety, etc.). A total of 21 studies were left out for the full-text screening that followed.

4.4.2 Full-text level

Full-text screening was performed on the remaining 21 articles that were examined, again based on the selection criteria. Nine articles did not comprise any control group or comparison intervention and therefore were excluded, as the study design adopted for these intervention studies did not allowed to examine the real effects of MBIs and yoga on children and youth ADHD. Additional two studies were excluded as they were aimed at adults, while other two studies focused on preschool aged children (3-5 y.o. and 5-7 y.o.). Finally, one study was excluded due to missing results, and another one was not available full-text. Ultimately, a total of six \((n = 6)\) studies were considered eligible for the further quality assessment, data extraction and analysis.
4.5 Data extraction

A customized data extraction protocol in Excel format was utilized to retrieve relevant information from the selected articles. The structure of the protocol was adapted to the aim and research questions, and contained sections dedicated to: study details (e.g. article and journal title, authors, year of publication and country), aim and research questions or hypotheses, main characteristics of participants and control group (e.g. number, age range, Mean (SD), gender, diagnosis, medication status, demographic characteristics), recruitment process and sampling strategy, detailed description of the content, performance and the effects of the interventions on everyday functioning, outcome measurement, as well as results and practical implications. Questions adapted for the extraction protocol are provided in the Appendix A.
4.6 Quality assessment

All the articles meeting the preliminary inclusion criteria underwent a quality assessment. Quality Assessment Tool for Quantitative Studies developed by Effective Public Health Practice Project [EPHPP] (1998) was implemented allowing to cover the following domains: selection bias, study design, confounders, blinding, data collection methods, withdrawals and dropouts, intervention integrity and analysis. The rating components were the following: “Strong”, “Moderate” and “Weak”. Based on the results of the assessment, only two studies were rated as strong- (no “weak” ratings); whilst the remaining four studies had moderate methodological power (one “weak rating”). The quality assessment tool is provided in the Appendix B.

For validation purpose, a second independent researcher conducted a review of the preliminary included articles on a title-abstract- and full text levels, based on the established selection criteria. No contradictions or discrepancies were met with respect to inclusion, and mutual agreement was reached on all six articles.

4.7 Data analysis

Analysis of the data extracted from the selected literature followed two main steps. In attempt to answer the first research question, the effects of the interventions were analysed, and the results were synthesised and presented in categorised. Next, to answer the second research question, the content of different types of MBIs was analysed in order to identify and compare the core components associated with improved functioning in children and youth with ADHD.

5 Results

5.1 Characteristics of included studies

Six studies met the inclusion criteria and allowed to answer the establish research questions. An overview of the studies selected for the present literature review, including authors, year of publication, title, country and study design, is provided in Appendix C. Each study was assigned an identification number (ID) that will be utilized to simplify future citation.

Out of 6 studies, three were randomized control trials (2, 3, 5) and the other three used a quasi-experimental design (1, 4, 6), where participants were allocated to either intervention or control group/waitlist without random assignment. Three studies included a within-group waitlist to control for the effects of time and repeated measurement (1, 2, 4). Two studies included a control group (3, 6). One study used a multicentre three-way parallel group RCT design (5), where the effects were measured for intervention group, comparison intervention and control groups. Most of the articles were published between 2017 and 2018, one article in 2012 (1), and another one in 2004 (3). The geographical setting varied across studies and comprised Australia, Canada, the Netherlands, Taiwan and two studies set in Iran.
5.2 Characteristics of participants

Participants of the selected studies were children of both genders, predominantly boys, with age range comprised between seven and 17 years, lower-middle to high SES. One study included exclusively adolescent girls (2), and another study comprised only boys (3). The sample size varied from 19 to 56 participants.

All the participants presented ADHD symptomology including inattentive and/or hyperactive-impulsive types. The diagnosis or symptoms were confirmed by psychiatric physicians and/or school paediatricians, measured according to DSM-IV, DSM-V or SNAP-IV (self-report and parent form). Three participants of study (1) had a co-morbid Oppositional Defiant Disorder (ODD), study (3) included also children with co-morbid Anxiety Disorder and Learning Disabilities (N = nd), and study (4) included 27 participants with one or more co-morbid diagnoses, such as Anxiety Disorder, Conduct Disorder (CD) or Oppositional Defiant Disorder (ODD).

Medication status of the participants differed across studies. In all but one study (2), participants included both unmedicated and medicated children, intaking either Methylphenidate, Dexamphetamine or other pharmacological preparation for ADHD. Participants of study (1) maintained the same dosage during waitlist, treatment and follow-up. In another study (5), medication dosage was equalized across groups by an expertise physician. In the study (6), participants were medicated, but were instructed to refrain from medicines and caffeine intake for at least 24h before undergoing measurements. In the study (3), all medicated participants were stabilized after periods of titration on Dexamphetamine and/or Methylphenidate to address related symptoms (e.g. anxiety and sleeping issues), and the dosage was adjusted according to feedback from parents and schools. Moreover, parents were instructed to assess child’s behaviour while in an unmedicated state (e.g. before and after school, during weekends and holidays). Lastly, only one study included not medicated participants (2). Table 3 provides a detailed summary of participants characteristics.
Table 3
Participants characteristics

<table>
<thead>
<tr>
<th>Intervention group</th>
<th>Control group/comparison intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN* N</td>
<td>Age range</td>
</tr>
<tr>
<td>1 18</td>
<td>8-12</td>
</tr>
<tr>
<td>3 11</td>
<td>8-13</td>
</tr>
<tr>
<td>4 34</td>
<td>11-17</td>
</tr>
<tr>
<td>5 7</td>
<td>7-11</td>
</tr>
<tr>
<td>6 24</td>
<td>8-12</td>
</tr>
</tbody>
</table>

Note: IN*: study identification number
5.3 Characteristics of interventions and outcome measures

Three studies examined the effects of different variations of mindfulness trainings (1, 2, 4), whilst other three studies (3, 5, 6) examined the impact of “yoga programs”. Both types of interventions shared analogous activity patterns. The interventions addressed various functioning variables, that are comprised in the Table 4. Main activities and components incorporated by each intervention program are illustrated in the Table 5.

The average duration of the treatment was 12 weeks, and the duration of each session varied from 40 to 90 minutes. The majority of the interventions were conducted in groups composed by children, whilst one study (1) evaluated a family mindfulness program piloted in parallel groups composed by children and their parents. All interventions were delivered by either family cognitive-behaviour therapists/psychotherapists specialised in mindfulness, or certified yoga instructors. Most of the interventions were conducted in clinical setting, while other took place outside the classroom or in a dance studio. Prior to the treatment, participants of all the studies received informative training and support materials that provided children with a better understanding of ADHD symptomology and core components of the treatment.

In the studies 1, 2, 4 and 6, participants allocated in the control or waitlist group did not receive any treatment from pre-test to post-test assessment. In the study 3, participants in the control group engaged in cooperative games and activities that were conducted for one hour once a month, and that involved talking, listening, turn-taking and sharing equipment. Lastly, in the study 5, in addition to a no treatment control group, there was a comparison intervention, which involved 24 sessions of Neuro-feedback treatment, 45 minutes each, lasted for eight weeks.

Table 4

<table>
<thead>
<tr>
<th>Functioning variable</th>
<th>(1) MBI</th>
<th>(2) MBIs</th>
<th>(3) Yoga</th>
<th>(4) MBI</th>
<th>(5) Yoga</th>
<th>(6) Yoga</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inattention</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impulsivity/Impulse control</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sustained attention</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Memory</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotions</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Behaviour</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Discrimination ability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Inhibition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Perfectionism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>ADHD comorbidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>
There were two outcome measure waves – pre-test and post-test, in all but one study (1), which comprised an 8-week follow-up assessment. Outcome measure varied from self-reported and parent-teacher rating scales to various computerized tasks carried out by children. Data and effect sizes were processed using different statistical analyses such as one-way analysis of covariance (ANCOVA), one-way repeated measures analysis of variance (ANOVA) and t-tests.

All the treatments and interventions evaluated in the included studies were reviewed by and received approval from the responsible Ethics Committees. Appendix E provides a summary of interventions, frequency and duration, measured functioning variables, comparison interventions and results.

**Mindfulness-based interventions (MBIs)**

Three studies examined the effects of different variations of MBIs (1, 2, 4). Study 1 evaluated the effectiveness of Mindful Child Training (MC) and the parallel Mindful Parenting (MP) for their parents, on children’s ADHD symptoms. Children’s Inattention, Hyperactivity/Impulsivity, as well as ODD and CD, were rated by parents and teachers on a 4-point Likert scale by means of Disruptive Behaviour Disorder Rating Scale [DBDRS] (Pelham et al., 1992) before, after the training and at 8-week follow-up. The treatment was based on Mindfulness-Based Cognitive Therapy [MBCT] (Segal et al., 2012) and Mindfulness-Based Stress Reduction Training [MBSR] (Kabat-Zinn, 1990); that was readapted for use with parents and children and organised in themes. The aim of the intervention was to teach children to focus and enhance their attention, awareness and self-regulation by means of mindful exercises, organised in different themes, and homework assignments. A token reward system was implemented to increase children’s motivation and compliance. Appendix D provides an overview of the content of Mindful Child (MC) and Mindful Parenting (MP) training.

The mindfulness program in the RCT (2) was based on the steps described in *The Mindfulness Prescription for Adult ADHD* (Zylowska, 2012) and the content of the sessions was analogous to previous studies evaluating MBIs (Zylowska, 2008; Mitchell et al., 2013). This study investigated the impact of mindful meditation training on executive functioning (EF) and emotional dysregulation in an all-female sample of adolescents, in a pre-test and post-test condition. Continuous Performance Test [CPT] (Corbett, Constantine, Hendren, Rocke & Ozonoff, 2009) was adopted to assess continuous attention dysfunction and response inhibition, where participants were asked to execute different computerized tasks. Additionally, Digit Span (Forward and Backward) subtest and Letter– Number Sequencing subtest of working memory index of Wechsler Intelligence Scale for Children-Fourth Edition [WISC-IV] (Wechsler, 2003); Stroop Word-Colour Interference Test; and Tower of London Test (TLT; Kovács, 2013) allowed to assess children’s working memory, inhibition and planning ability respectively. A 5-point self report test, The Difficulties in Emotion Regulation Scale [DERS] (Gratz & Roemer, 2004), was implemented to assess different components of emotional dysregulation. The main themes incorporated by the treatment were Attention and Five Senses; Mindful Breathing; Mindfulness of Sound, Breathe and Body; Mindfulness of Body Sensations and Movement; Mindfulness of Thoughts; Mindfulness of Feelings; Mindful Listening and Speaking;
and Mindful Decisions and Actions. Additionally, participants of this study received homework assignments and practices.

Study 4 examined the impact of Integra Mindfulness Martial Arts (Integra MMA) on Electroencephalogram (EEG) indices of attention using theta power, beta power and theta/beta ratio (TBR) measurements, pre-test to post-test. While EEG was recorded continuously, children performed a single-point focus rest task, Computerized rest task (adapted from Lewis, Lamm, Segalowitz, Stieben & Zelaro, 2006); and two active attention tasks: Go/No-Go task (adapted from a task developed by Garavan, Ross & Stein, 1999); and Selective auditory attention task (Lackner, Santesso, Dywan, Wade & Segalowitz, 2013). The program incorporated elements of mindfulness, yoga, Cognitive Behavioural Therapy and martial arts and home practice, and was elaborated to address attention, inhibition and self-regulation issues in youth with ADHD. Acceptance, nonjudgement and letting go were among the core concepts of the treatment.

**Yoga programs**

Study 3 evaluated the effects of yoga program on attention and behaviour skills in an all-male sample. The program adopted in this study was developed from previous publications (Nagenda, Mohan & Shriram, 1988; Saraswati, 1990) and a trial conducted by Jensen (2002). Children were examined before and right after the intervention on the Conners’ Parent and Teacher Rating Scales–Revised: Long (CPRS-R:L & CTRS-R:L; Conners, 1997), the Test of Variables of Attention (TOVA; Greenberg, Cormna & Kindschi, 1997), and the Motion Logger Actigraph. In this study, boys were engaged in standard yoga practices that involved respiratory, postural, relaxation and concentration training. Parents were encouraged to assist their children with daily home practices.

In the randomized control trial (5), yoga exercise intervention was examined for the effects on cognitive activity and memory of children, from pre-test to post-test, compared to Neurofeedback intervention and a control group. Sustained attention, impulse control/impulsivity were assessed using Continuous Performance Test [CPT] (Ruz et al., 1965). Sustained attention and short-term memory were examined by means of Wechsler Intelligence Scale for Children-Revised (WISC-R). The yoga program incorporated multiple activities that, in addition to standard yoga practice, covered breathing, attention and concentration exercises.

Study 6 investigated the effects on sustained attention and discrimination function before and right after the yoga exercise program. Participants were administered the Visual Pursuit Test of the Vienna Test System (Schuhfried GmbH, Austria), a computerized psychological test that allowed to measure sustained attention in the visual area; and the Determination Test in order to assess the discrimination ability for reaction speed, reactive stress tolerance and attention deficits. The yoga sessions were conducted in a dance studio with an average temperature of 24-26°C. In order to monitor the intensity of the main activity and to compare the differences among the periods of warming-up, main activity and cooling-down, during the entire program each participant’s HR was registered at one-minute intervals. The main activities included concentration and balance exercises, as well as performance of different breathing and body awareness techniques.
### Table 5

**Mindfulness-based interventions (MBIs) and yoga programs: core activities and components**

<table>
<thead>
<tr>
<th>IN</th>
<th>Intervention</th>
<th>Activities</th>
<th>IN</th>
<th>Intervention</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mindful Child Training (MC)</td>
<td>Breathing meditation</td>
<td>3</td>
<td>Yoga program</td>
<td>Respiratory Training; selective use of oral and nasal passages for respiratory flow intended to increase breath awareness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sensory awareness exercises</td>
<td></td>
<td></td>
<td>Postural Training; stretching, load bearing, flexions, extensions, inversions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Body awareness exercises</td>
<td></td>
<td></td>
<td>Relaxation training; becoming progressively aware and relaxing body parts and muscles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Body scan</td>
<td></td>
<td></td>
<td>Concentration Training; (Trataka technique): focus on a word shape followed by seeing the image with eyes closed and continuing to see the image on a blank piece of paper</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yoga</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Distraction awareness exercises</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Awareness of automatic responding exercises</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Breathing space in difficult situations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Homework</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Mindfulness Meditation Training</td>
<td>Mindfulness meditation</td>
<td>5</td>
<td>Yoga program</td>
<td>Meditation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mindful listening</td>
<td></td>
<td></td>
<td>Relaxation of body and mind</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Homework</td>
<td></td>
<td></td>
<td>Deep breathing</td>
</tr>
<tr>
<td>4</td>
<td>Integra Mindfulness Martial Arts (Integra MMA)</td>
<td>Mindfulness meditation; sitting and walking meditation</td>
<td>6</td>
<td>Yoga program</td>
<td>Stretching and warming-up</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Body scan</td>
<td></td>
<td></td>
<td>Concentration exercises</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yoga</td>
<td></td>
<td></td>
<td>Balance exercises</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elements of CBT</td>
<td></td>
<td></td>
<td>Attention exercises</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Martial Arts</td>
<td></td>
<td></td>
<td>Breathing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Homework</td>
<td></td>
<td></td>
<td>Body awareness</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Flexibility</td>
</tr>
</tbody>
</table>
5.4 Effects of interventions

Interventions evaluated in the selected literature aimed at a large range of variables, comprising the core ADHD symptoms and other executive functioning components. Overall, all the studies reported significant improvements for the intervention groups at post-test, with small to large size effects. Table 6 provides a summary of the effect size reported for each study and intervention. The main results of the six included studies are summarised in categories and reported further.

Inattention and Hyperactivity/Impulsivity

Two studies (1, 3) reported significant reduction of parent-rated ADHD symptoms for the intervention group from pre- to post-test. There was a significant decrease of Inattention and Hyperactivity/Impulsivity reported in the study 1 (p < .01, Cohen's d = .80), (p < .01, Cohen's d = .56), respectively; and in the study 3 (ADHD Index, p = .019, Cohen’s d = .29), (Global Index Restless/Impulsive, p = .008, Cohen’s d = .73). In contrast, no significant improvements were reported by teachers (1, 3) pre- to post-intervention, except for Inattention rate (p = .10, Cohen’s d = .39) (1). Lastly, study 2 reported significantly lower self-rated Impulsivity score at post-test compared to control group (F (1,27) = 7.97, p = .009, partial η² = .23).

Sustained attention

Substantial improvements in sustained attention skills were reported by three studies (4, 5, 6). There was a significant effect of yoga interventions on Sustained attention-related variables over time (pre- to post-test), compared to control groups, as reported by the study 5 (F = 4.28, p = .009) and study 6 (Accuracy rate, F (1,47) = 4.26, p = .045, partial η² = .08); (Reaction time, F (1,47) = 8.20, p = .006, partial η² = .15). The results of the EEG investigation reported in the study 4 also indicated significant improvement in attentional ability of the treatment group, indexed by decreased Theta/beta Ratio (TBR) at post-test (Go/No-Go task, F (1, 48) = 6.86, p = .012) and (Selective Auditory Attention Task, F (1, 46) = 4.002, p = .051).

Memory

Two studies (2, 5) reported improved Memory functions in children from treatment group at post-test. A within-group analysis in the study 2 revealed an improved working memory in participants of the treatment group (t = -3.42, p = .004). The results of the univariate analysis in the study 5 showed significant effect of yoga on short-term memory of treatment group between pre-test and post-test as compared to control group (Number sequencing, F = .059, p = .004, partial η² = .772) and (Coding, F = 11.238, p = .015, partial η² = .652).
Emotional regulation

The treatment group in the study 2 reported a significantly lower total score of Emotion dysregulation at post-test, comprising nonacceptance of emotion responses, lack of emotional awareness and clarity, emotional regulation-, goal-orientated behavior- and impulse control difficulties ($F(1,27) = 6.41, p = .02$, partial $\eta^2 = .19$). There were significant effects for the yoga group on Global Index of Emotional lability, comprising reduction in mood swings, crying fits and temper outbursts ($p = .001$, Cohen’s $d = .79$), as reported by parents in the study 3.

Table 6

<table>
<thead>
<tr>
<th>Functioning variable</th>
<th>Small ES</th>
<th>Medium ES</th>
<th>Large ES</th>
<th>ND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inattention</td>
<td>(1)MBI**</td>
<td>(1)MBI*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>(3)Yoga*</td>
<td>(1)MBI*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impulsivity/Impulse control</td>
<td>(1)MBI* (3)Yoga*</td>
<td>(2)MBI***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sustained attention</td>
<td>(5)Yoga (6)Yoga</td>
<td>(4)MBI***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memory</td>
<td>(5)Yoga</td>
<td>(2)MBI***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotions</td>
<td>(3)Yoga*</td>
<td>(2)MBI***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discrimination ability</td>
<td>(6)Yoga</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inhibition</td>
<td>(2)MBI</td>
<td>(2)MBI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Planning</td>
<td>(2)MBI</td>
<td>(2)MBI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perfectionism</td>
<td>(3)Yoga*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADHD comorbidity</td>
<td>(3)Yoga*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*parent rated  
**teacher rated  
***self-reported/computerized test
6 Discussion

This systematic review sought to investigate the existing evidence on Mindfulness-based Interventions as an emergent treatment for children and youth with ADHD. The literature search identified six controlled trials meeting the selection criteria, which were included in the data analysis. To answer the established research questions, the effects and content of MBIs were analysed with respect to functioning outcomes.

Overall, all six studies showed multiple favourable effects on the core ADHD symptoms such as inattention, hyperactivity and impulsiveness, and indicated significant improvements in sustained attention, working memory and emotional regulation across child and youth ADHD population. Three included studies reported significant reductions of at least one ADHD symptom. Child inattention and hyperactivity/impulsivity decreased substantially at the completion of mindfulness- or yoga intervention, as reported by parents and children (van der Oord, Bögels & Peijnenburg, 2012; Jensen & Kenny, 2004; Kiani, Hadianfard & Mitchell, 2017), although teachers’ rating in two of these studies did not reflect any significant change, except for the symptoms of inattention (Jensen & Kenny, 2004). Furthermore, there were significant improvements in different areas of executive functioning (EF) which included enhanced sustained attention, working memory and emotional regulation, reported by another group of studies (Sibalis, Milligan, Pun, McKeough, Schmidt & Segalowitz, 2017; Chou & Huang, 2017; Rezaei, Salarpour & Najafian, 2018). The effect sizes of the interventions reported for the majority of the studies varied from moderate to large. These findings are not surprising as they replicate what has been reported by the previous meta-analytic reviews that found MBIs to be an effective treatment for ADHD in children and adults (Caincross & Miller, 2016; Chimiklis et al., 2018). This systematic review contributes to the existing knowledge by providing stronger evidence supported by a more methodologically rigorous study design, including only controlled trials.

The content analysis of interventions revealed that meditation, breathing techniques, self-awareness and yoga exercises were the most common activities implemented across the six studies included in this review. Estimating which activities led to what outcome, or drawing conclusions on whether any specific mindfulness or yoga intervention was more effective than other might be difficult due to the heterogeneity of the content and the effect size span of different mindful treatments across the studies. It can be argued that all these major components or better their aggregation, might be associated with the reported positive outcomes, as both yoga and mindfulness programs proved to be effective in reducing ADHD symptoms and in improving executive functioning. Rather, in addition to the content, it might be relevant to focus on the outcomes of the interventions in their complexity. As suggested by Hölzel et al. (2011), attention control, emotional regulation and self-awareness are three interrelated components that are responsible for improved self-regulation (see Figure 2). Interestingly, the results of the present systematic review reported significant improvements of indexes related to all these major components. However, these outcome variables were not measured within the frames of the same study. As emphasized by Imms et al. (2016),...
self-regulation is arguably the most crucial ability, responsible for individual’s social functioning and participation, and at the same time represents the main challenge for children and adults with ADHD. MBIs proved to be effective in improving main components of self-regulation. As such, future research should assess the effects of these interventions on self-regulation by adopting variables that target attention control, emotional regulation and self-awareness simultaneously.

Curiously, the geographical span of the studies in this review covered almost all continents and included Europe, Asia, Middle East, Australia and North America, which might indicate the generalizability of the findings. ADHD is among the most researched neurodevelopmental disorders with a worldwide incidence, and MBIs have been gaining more popularity in the clinical setting across the globe. Although the evidence suggests that MBIs might be an effective treatment for ADHD, supported by substantial effect sizes across the studies, the results should be interpreted with caution and in the context of several limitations and considerations.

Participants
The interventions evaluated in the reviewed studies targeted young ADHD population that included both boys and girls of different age ranges, ADHD subtypes and comorbidity. Within the six studies, participants were predominantly early adolescent boys. While a higher ADHD prevalence among males is not surprising (Willcutt, 2012; Stubbs, 2013), none of the included studies considered how each of the reported outcomes is associated and distributed in relation to gender and specific age of the participants. Importantly, another concern that is worth attention is whether MBIs had more effect on children with inattentive, hyperactive/impulsive or combined ADHD type. Further research should investigate the impact and differentiating role of gender, age and different ADHD subtypes when evaluating the effects of such interventions.

More significantly, there was a substantial lack of reported information regarding the medication status of participants. Only in one study participants were not taking any stimulant ADHD medication, while the majority included both medicated and unmedicated children, treated with either Methylphenidate, Dexamphetamine or other pharmacological preparation for ADHD. Even though some studies provided information on the dosage equalization and implemented the medication refrain prior the assessment, most of them did not inform about the duration of the medication regimen at the pre-intervention assessment, nor about the continuity and dosage of the preparation at treatment and control/waitlist condition. Thus, a significant medication bias might account for the effects of those interventions that reported medium to large effect size. Notably, due to the lack of high quality RCT’s, still very little is known about the effectiveness of MBIs as compared to stimulant medication and other ADHD treatment. As such, in the absence of substantial research, MBIs may be considered as an effective adjunctive intervention for children already stabilized on medication, rather than first-line stand-alone ADHD treatment.

Interventions
The majority of the studies assessed the effects of child-only interventions, while only one study evaluated a combined parent-child mindful training, which reported favourable outcomes for both children and
their parents. The results indicated a significant reduction of parent-rated ADHD behavior of both parents themselves and their children, as well as reduction in parental stress, hyperactivity and increase of mindful awareness at the completion of the intervention and at follow-up test (van de Oord, Bögels & Peijnenburg, 2012). These findings are consistent with the previous research that evaluated combined parent-child mindfulness treatment (Harrison, Manocha & Rubia, 2004; Zhang et al., 2016). It can be argued that child-parent dyadic interventions might have stronger effect for the child and parent-child relationship, compared to child-centred intervention alone. Future research is required to compare outcomes of child-only and combined parent-child mindfulness interventions.

The overall duration of the majority of interventions across the included studies was 8 weeks, whilst only two studies implemented a 20-week program. Although the effect size reported for these interventions did not vary from the rest of the studies, the results of one of the 20-week yoga programs suggested that the greater number of attended classes and amount of home practice were associated with better outcomes on Hyperactive-Impulsive subscale and Emotional lability, with a trend for Inattentive subscale (Jensen & Kenny, 2004). There is a growing body of research indicating that mindful meditation practices lead to neuro-plastic changes in specific brain structures and functions, and have been associated with increased cortical thickness, and both grey- and white-matter volume and density (Grant, Courtemanche, Duerden, Duncan & Rainville, 2010; Hölzel et al., 2011; Kang et al., 2013). Despite the fact that mindfulness provides effects already after a short-term intervention, given the complexity of the underlying neurological processes, longer and more consistent interventions might be more effective and have a longer-lasting outcomes.

Lastly, in the majority of the included studies participants allocated in the control or waitlist group did not receive any treatment from pre-test to post-test assessment. Children from the control group in two studies engaged in cooperative activities involving talking, listening, turn-taking and sharing equipment; and received Neuro-feedback treatment. Both studies reported significant improvements on different ADHD and executive functioning variables for the comparison treatment group. Significant improvements on Hyperactivity, Anxious/Shy and Social problems scales were found for the control- but not for the yoga group in the study conducted by Jensen & Kenny (2004). Neuro-feedback was found to be more effective than yoga in some variables of memory and cognitive activity (Rezaei, Salarpor & Najafian, 2018). While it is difficult to explain why participating in cooperative activities had more effect on some subscales as they were only conducted for one hour once a month, the results of the Neuro-feedback are less surprising. Neuro-feedback intervention was more consistent and included 24 sessions, 45 minutes each, that lasted for eight weeks. This type of intervention was proved to be the only method comparable with stimulant medication in curing and reducing hyperactive symptoms (Rezaei, Salarpor & Najafian, 2018). Overall, no significant change was reported for the control group population in any other study, as compared to treatment group.

**Outcome measures**

One of the main limitations of this review is related to the measurement of functioning outcomes. The
The concept of functioning and its complexity has not been fully comprehended and addressed across the included studies. The outcome variables and their measures implemented within the selected literature covered only Body structures (theta, beta and theta/beta attention indexes), Body functions (inattention, hyperactivity, impulsivity/impulse control, sustained attention, memory, emotional regulation, discrimination function, ADHD comorbidity) and Activity levels (inhibition, planning) (see WHO, 2007). However, none of the included studies addressed nor measured Participation outcomes, as an important social facet of functioning. Only one study addressed Social problems variable (against other 13 focusing on cognitive aspects of behaviour) as a part of the Conners’ Parent and Teacher Rating Scales–Revised: Long (CPRS-R:L & CTRS-R:L; Conners, 1997) (Jensen & Kenny, 2004). This is not sufficient to make any assumptions, specifically because participants of the yoga group failed to show any significant improvements on the mentioned subscale. As such, it can be concluded that studies selected for this systematic review addressed exclusively executive functioning (EF) outcomes, rather than social functioning. One can argue that due to the interrelatedness of the ICF-CY domains, improvements in Body structures and functions, and Activity domains may consequently cause improvements in Participation outcomes (see WHO, 2007). Hypothetically, children who underwent different MBIs showing improved executive functioning and decreased ADHD symptoms, might potentially demonstrate higher academic performance, improved peer-interactions and other benefits. However, it is not possible to draw any definitive conclusions without adopting adequate outcome measures that would embrace all the aspects of functioning. In contrast with the biomedical model focusing on the diagnosis and symptoms reduction, MBIs are relied upon the biopsychosocial approach, providing a more comprehensive approach aiming at functioning in all its forms, which should therefore be measured accordingly. Methodologically rigorous research evaluating MBIs and addressing variables that cover different areas of everyday life of ADHD children at home-, school- and social levels, is required.

6.1 Methodological limitations and future research

In attempt to adopt a more rigorous method and provide stronger evidence on the effects of the evaluated interventions, only controlled trials – randomized- and non-randomized, were considered for inclusion in this systematic review. As such, many relevant studies were excluded due to missing control group and poor methodology, and thus were lost for the data analysis. Restricted selection criteria resulted also in a small number of included studies, and thus the overall sample size was small, which significantly limits statistical power. Furthermore, the quality of the included trials varied across studies, and the majority presented significant limitations. Only three out of six trials were randomized; and only one of them had appropriate randomisation and provided explicit information on the randomization process. Out of six trials, only two studies included an active treatment control group, whereas in the remaining four trials participants were allocated to waitlist group and did not receive any treatment, which significantly limits the possibility to make distinction between the outcomes caused by the mindful intervention and those caused by other influencing factors. Lastly, follow-up assessment of the mindfulness treatment was implemented only in one study, which does not allow to evaluate long-term effects of such interventions.
Although controlled trials and RCTs in particular, are widely considered as golden evidence standard, there are several ethical and scientific issues linked to this study design. Intervention withholding and exploitation of the research subjects, as well as their autonomy and confidentiality, are among the main concerns that should be taken into account, especially when such vulnerable populations as children are involved (Resnik, 2008).

Given previous considerations and limitations across the included studies, further research should adopt high-quality controlled trials that are in line with appropriate ethical standards, and include an adequate follow-up assessment, which would allow to reduce risk of bias and minimise ethical issues. Furthermore, additional research is needed to compare the effects of MBIs to other types of ADHD treatment; and to identify potential differentiating role of age, gender and ADHD subtypes on the outcomes of such interventions.

### 6.2 Practical implications

Despite multiple limitations, the results of this systematic review, in line with the previous research, do suggest that MBIs such as yoga and meditation have positive impact on executive functioning in young ADHD population, and might potentially benefit children in different areas of everyday life. However, in the absence of a more robust evidence, MBIs may be considered as an effective complementary intervention for children who are already stabilized on medication, rather than a first-line stand-alone ADHD treatment. Furthermore, parental involvement may be appropriate in order to reach better outcomes for the whole family. Treatment developers and policy makers should consider a wider implementation of these interventions in school and clinical settings in order to maximise the cost-effective alternatives for the families of children with ADHD.

### 7 Conclusion

Given the incomplete benefits of the pharmacological therapy for ADHD and its over-prescription in children over the last decades, there is an explicit need for alternative approaches. Mindfulness-based Interventions such as meditation and yoga remain an investigational treatment. Poor methodological design and significant risk of bias across studies make it difficult to fully evaluate the impact of these interventions on ADHD populations. This systematic review contributes to the existing knowledge by providing stronger evidence supported by a more methodologically rigorous study design. Despite the limitations, MBIs do prove to be an effective complementary treatment for children who are already stabilized on medication. Elements of meditation, breathing, yoga- and self-awareness exercises were associated with significant reduction of ADHD and improved executive functioning in children. Further research is needed to elucidate how these interventions improve social functioning and participation of children and youth with ADHD, which would enable a wider implementation of these practices at the community level.
8 References


doi:10.5402/2012/458064


https://doi.org/10.1177/1087054714566076


https://doi.org/10.1177/1087054715625301

https://doi.org/10.1007/s10826-018-1148-7

doi:10.7717/peerj.2883


doi: 10.1016/j.psychres.2008.02.005


Available from: https://merst.ca/ephpp/


doi:10.1177/1087054713513328


doi: 10.1203/PDR.0b013e318212b40f.


doi: 10.1371/journal.pone.0128248


Stubbs, J. H. (2013). ADHD in young boys: A correlational study among early childhood educators in Louisiana. Dissertations 830. Available at: https://aquila.usm.edu/dissertations/830


doi:10.1016/j.jaac.2013.09.001


doi: http://dx.doi.org/10.1007/s10802-015-0050-7


Retrieved from http://www.who.int/classifications/icf/en

Zhang, D., Chan, S. K. C., Lo, H. H. M., Chan, C. Y. H., Chan, J. C. Y., Ting, K. T., Gao, T. T., ...


9 Appendices

9.1 Appendix A. Data extraction questions

Data extraction questions

Study details
1. Author(s), year, title, country
2. What is the purpose of the study?
   a. Transcribe, or write ND if not documented
3. What are the research questions/hypotheses? Transcribe or write ND if not documented
   a. Research Questions
   b. Hypotheses

Recruitment and sampling strategy
1. How were participants recruited?
   a. Mail out
   b. Advertisement
   c. Phone
   d. Email
   e. Referenced
   f. Previous study
   g. Public document
   h. Not documented
   i. Other. Specify
2. Where were participants recruited from?
   a. School
   b. Health clinic/Hospital
   c. Community setting
   d. Not documented
   e. Other. Specify
3. Which sampling strategy was used?
   a. Convenience
   b. Purposive
   c. Random
   d. Other. Specify

Participants characteristics: Intervention group
1. Number of participants
2. Age of participants
   a. Age range
   b. Mean, SD
3. Gender
   a. Male N= 
   b. Female N= 
4. Primary diagnosis of sample
   a. Provided?
      i. Yes. Transcribe
      ii. Not documented
   b. Diagnosis confirmed clinically?
      i. Yes
      ii. No
      iii. Not documented
5. Medication status  
   a. Yes. Transcribe  
   b. No  
   c. Not documented  
6. Demographic characteristics  
   a. Provided?  
      i. Yes. Transcribe  
      ii. Not documented

Participants characteristics: Control group  
1. Number of participants  
2. Age of participants  
   a. Age range  
   b. Mean, SD  
3. Gender  
   a. Male N=  
   b. Female N=  
4. Primary diagnosis of sample  
   a. Provided?  
      i. Yes. Transcribe  
      ii. Not documented  
   b. Diagnosis confirmed clinically?  
      i. Yes  
      ii. No  
      iii. Not documented  
5. Medication status  
   a. Yes. Transcribe  
   b. No  
   c. Not documented  
6. Demographic characteristics  
   a. Provided?  
      i. Yes. Transcribe  
      ii. Not documented

Interventions  
1. What was the intervention?  
   a. Description of the intervention in text  
   b. Frequency of performance – description in text  
   c. Total duration – description in text  
2. Were the child/parents involved?  
   a. Child  
   b. Parents  
   c. Both  
3. How was the intervention performed?  
   a. Groups  
   b. Individual  
   c. Mixed  
4. Where was the intervention performed?  
   a. Home  
   b. Community  
   c. Clinical setting  
   d. Classroom  
   e. At school/outside  
   f. Multiple. Transcribe  
   g. Not documented
5. Who was supervising/guiding the intervention?
   a. Certified instructor (specialised in yoga, meditation, mindfulness)
   b. Psychologist
   c. PT
   d. Behaviour therapist
   e. Teacher
   f. Social worker
   g. Assistant
   h. Researcher
   i. Parents
   j. Not documented

Comparison Intervention
1. What was the comparison/control intervention?
   a. Description of the intervention in text
   b. Frequency of performance – description in text
   c. Total duration – description in text
2. Were the child/parents involved?
   a. Child
   b. Parents
   c. Both
3. How was the intervention performed?
   a. Groups
   b. Individual
   c. Mixed
4. Where was the intervention performed?
   a. Home
   b. Community
   c. Clinical setting
   d. Classroom
   e. At school/outside
   f. Multiple. Transcribe
   g. Not documented
5. Who was supervising/guiding the intervention?
   a. Certified instructor (specialised in yoga, meditation, mindfulness)
   b. Psychologist
   c. PT
   d. Behaviour therapist
   e. Teacher
   f. Social worker
   g. Assistant
   h. Researcher
   i. Parents
   j. Not documented

Outcomes
6. How was Everyday Functioning defined in the study?
   a. Transcribe
   b. Not documented
7. ICF level of Functioning addressed?
   a. Body Function/Body Structure
   b. Activity
   c. Participation
8. Outcome measure list (Transcribe)
9. Frequency of measurement (Transcribe)
9.2 Appendix B. Quality assessment tool

Quality Assessment Tool for Quantitative Studies

Component ratings

A) SELECTION BIAS

(Q1) Are the individuals selected to participate in the study likely to be representative of the target population?

1 Very likely
2 Somewhat likely
3 Not likely
4 Can’t tell

(Q2) What percentage of selected individuals agreed to participate?

1 80 – 100% agreement
2 60 – 79% agreement
3 less than 60% agreement
4 Not applicable
5 Can’t tell

RATE THIS SECTION:

STRONG (1) MODERATE (2) WEAK (3)

B) STUDY DESIGN

Indicate the study design

1 Randomized controlled trial
2 Controlled clinical trial
3 Cohort analytic (two group pre + post)
4 Case-control
5 Cohort (one group pre + post (before and after))
6 Interrupted time series
Was the study described as randomized? If NO, go to Component C.
No Yes

If Yes, was the method of randomization described? (See dictionary)
No Yes

If Yes, was the method appropriate? (See dictionary)
No Yes

**RATE THIS SECTION:**

STRONG (1) MODERATE (2) WEAK (3)

---

**C) CONFOUNDERS**

(Q1) Were there important differences between groups prior to the intervention?

1 Yes
2 No
3 Can’t tell

The following are examples of confounders:

1 Race
2 Sex
3 Marital status/family
4 Age
5 SES (income or class)
6 Education
7 Health status
8 Pre-intervention score on outcome measure

(Q2) If yes, indicate the percentage of relevant confounders that were controlled (either in the design (e.g. stratification, matching) or analysis)?

1 80 – 100% (most)
2 60 – 79% (some)
3 Less than 60% (few or none)
4 Can’t Tell

---

**RATE THIS SECTION:**

STRONG (1) MODERATE (2) WEAK (3)
D) BLINDING

(Q1) Was (were) the outcome assessor(s) aware of the intervention or exposure status of participants?

1 Yes
2 No
3 Can’t tell

(Q2) Were the study participants aware of the research question?

1 Yes
2 No
3 Can’t tell

RATE THIS SECTION:

STRONG (1) MODERATE (2) WEAK (3)

E) DATA COLLECTION METHODS

(Q1) Were data collection tools shown to be valid?

1 Yes
2 No
3 Can’t tell

(Q2) Were data collection tools shown to be reliable?

1 Yes
2 No
3 Can’t tell

RATE THIS SECTION:

STRONG (1) MODERATE (2) WEAK (3)

F) WITHDRAWALS AND DROP-OUTS

(Q1) Were withdrawals and drop-outs reported in terms of numbers and/or reasons per group?

1 Yes
2 No
3 Can’t tell
4 Not Applicable (i.e. one-time surveys or interviews)
(Q2) Indicate the percentage of participants completing the study. (If the percentage differs by groups, record the lowest).

1 80 -100%
2 60-79%
3 less than 60%
4 Can’t tell
5 Not Applicable (i.e. Retrospective case-control)

RATE THIS SECTION:

STRONG (1)  MODERATE (2)  WEAK (3)

(G) INTERVENTION INTEGRITY

(Q1) What percentage of participants received the allocated intervention or exposure of interest?

1 80 -100%
2 60-79%
3 less than 60%
4 Can’t tell

(Q2) Was the consistency of the intervention measured?

1 Yes
2 No
3 Can’t tell

(H) ANALYSES

(Q1) Indicate the unit of allocation (circle one)

community
organization/institution
practice/office
individual

(Q2) Indicate the unit of analysis (circle one)

community
organization/institution
practice/office
individual
(Q3) Are the statistical methods appropriate for the study design?

1 Yes
2 No
3 Can’t tell

(Q4) Is the analysis performed by intervention allocation status (i.e. intention to treat) rather than the actual intervention received?

1 Yes
2 No
3 Can’t tell

---

Global Rating Component Ratings

<table>
<thead>
<tr>
<th></th>
<th>Selection bias</th>
<th>Strong</th>
<th>Moderate</th>
<th>Weak</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Strong</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>Study design</td>
<td>Strong</td>
<td>Moderate</td>
<td>Weak</td>
</tr>
<tr>
<td>C</td>
<td>Confounders</td>
<td>Strong</td>
<td>Moderate</td>
<td>Weak</td>
</tr>
<tr>
<td>D</td>
<td>Blinding</td>
<td>Strong</td>
<td>Moderate</td>
<td>Weak</td>
</tr>
<tr>
<td>E</td>
<td>Data collection and method</td>
<td>Strong</td>
<td>Moderate</td>
<td>Weak</td>
</tr>
<tr>
<td>F</td>
<td>Withdrawals and dropouts</td>
<td>Strong</td>
<td>Moderate</td>
<td>Weak</td>
</tr>
</tbody>
</table>

GLOBAL RATING FOR THIS PAPER (circle one):

1 STRONG (no WEAK ratings)
2 MODERATE (one WEAK rating)
3 WEAK (two or more WEAK ratings)
# 9.3 Appendix C. Included studies

**Included studies: an overview**

<table>
<thead>
<tr>
<th>IN*</th>
<th>Authors and year</th>
<th>Title</th>
<th>Country</th>
<th>Study design</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Rezaei, M., Salarpor Kamarzard, T. &amp; Mahdi Najafian Razavi, M. (2018)</td>
<td>The Effects of Neurofeedback, Yoga Interventions on Memory and Cognitive Activity in Children with Attention Deficit/Hyperactivity Disorder: A Randomized Controlled Trial</td>
<td>Iran</td>
<td>Multicentre three-way parallel group RCT</td>
</tr>
<tr>
<td>6</td>
<td>Chou, CC. &amp; Huang, CJ. (2017)</td>
<td>Effects of an 8-week yoga program on sustained attention and discrimination function in children with attention deficit hyperactivity disorder</td>
<td>Taiwan</td>
<td>Non-randomized control trial</td>
</tr>
</tbody>
</table>

IN*: study identification number
### 9.4 Appendix D. Content of the sessions in Mindful Child (MC) and Mindful Parenting (MP) training

*Content of the sessions in Child (MC) and Parent mindfulness (MP) training from van der Oord, S., Bögels, S. M & Peijnenburg, D. (2012)*

<table>
<thead>
<tr>
<th>Session</th>
<th>MC-Theme</th>
<th>MC-Exercise</th>
<th>MP-Theme</th>
<th>MP-Exercise</th>
</tr>
</thead>
</table>
| 1       | From Mars | With parents: “raisin” exercise  
Child session: sensory awareness exercises; “raisin” exercise with chips; breathing meditation | From Mars | With children: “raisin” exercise  
Parental session: psycho-education on ADHD/ mindfulness, breathing meditation, doing homework for yourself & helping child with home-work |
| 2       | My Body   | Breathing meditation, body awareness exercises, body-scan, yoga-exercises | My Body | Breathing meditation, body-scan |
| 3       | My Breath | Breathing meditation, breath awareness exercises, body-scan, yoga-exercises | My Breath | Body-scan, breathing space, breath & body-awareness meditation |
| 4       | Distraction | Breathing meditation; distraction awareness exercises, body-scan, yoga-exercise | Automatic responding | Breath & body awareness meditation, psycho-education stress & automatic responding, exercise awareness of positive interaction with child, breathing space |
| 5       | Automatic responding | With parents: breathing meditation, group-evaluation  
Child session: breathing space, awareness of automatic responding exercises, body-scan, yoga-exercises | Habits and Automatic responding | With children: breathing meditation, group-evaluation  
Parent session: breath & hearing meditation, psycho-education responding to stressful situations with child & using breathing space in stressful situations |
<table>
<thead>
<tr>
<th></th>
<th>Up to now</th>
<th>Communication with your child</th>
<th>Breathing meditation, exercise breathing space in stressful situation with your child, body-scan</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Breathing meditation, repetition learned skills, breathing space in difficult situations, body-scan by one of the children, hearing meditation with bell, yoga-exercises</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Practice</td>
<td>Accepting your child</td>
<td>Breathing meditation, exercise breathing space in stressful situation with your child</td>
</tr>
<tr>
<td>8</td>
<td>On my own</td>
<td>On your own Letting go</td>
<td>With children: breathing meditation, body-scan, yoga &amp; meditation with children as instructors, meditation schedule for next 2 months, evaluation training</td>
</tr>
<tr>
<td></td>
<td>With parents: breathing meditation, body-scan, yoga &amp; meditation with children as instructors, meditation schedule for next 2 months, evaluation training</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 9.5 Appendix E. Overview of interventions and results

#### Overview of interventions: frequency and duration, functioning outcome measure, comparison intervention and results

<table>
<thead>
<tr>
<th>IN</th>
<th>Intervention</th>
<th>Frequency and duration</th>
<th>Functioning outcome measure</th>
<th>Comparison intervention</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mindful Child Training (MC)</td>
<td>8 weekly 90 min sessions</td>
<td>Inattention, Hyperactivity/Impulsivity, Parental stress, Parental ADHD, Parental mindfulness, attention and awareness</td>
<td>No treatment</td>
<td>Significant reduction of inattention (ES = .80, large ES) and hyperactivity/impulsivity symptoms (ES = .56, medium ES) on the parent-rated DBDRS from pre- to post-test in the treatment group; significant reduction of inattention and hyperactivity/impulsivity (ES = .80/.59 respectively) with small to large effect sizes, from pre- to follow-up; teacher rating of hyperactivity/impulsivity showed non-significant effects from pre- to post test and from pre- to follow-up test, whilst inattention rate from pre-to post-test reached significance (p = .10; ES = .39, small ES). Significant reduction of the parental inattention and hyperactivity/impulsivity symptoms, with small effect sizes (ES = .36 and .48 respectively). Furthermore, parents showed significantly more mindful awareness (ES = .28, small ES); and at follow-up parental stress (PSI) (ES = .57; medium ES) and overactivity (PS) showed a significant reduction (ES = .85; large ES).</td>
</tr>
<tr>
<td></td>
<td>Mindful Parenting (MP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Mindful Meditation Training</td>
<td>8 weekly 90 min sessions</td>
<td>Executive functions (EF): inhibition, planning, working memory, Emotion dysregulation: nonacceptance of emotion responses, goal-directed behaviour, impulse control, emotional awareness</td>
<td>No treatment</td>
<td>Significant post-test between groups difference in inhibition scores (F(1, 27) = 7.58, p = .01; large size effect (partial $\eta^2 = .22$)); planning scores (F(1, 27) = 4.88, p = .04; large size effect (partial $\eta^2 = .15$)). Significant decrease in total score of emotion dysregulation at post-test in treatment group compared to control group (F(1, 27) = 6.41, p = .02; large effect size (partial $\eta^2 = .19$)); statistically significant lower score in Nonacceptance of Emotion Responses (F(1, 27) = 9.67, p = .004), and Impulse Control Difficulties (F(1, 27) = 7.97, p = .009) in comparison to the control group with large effect sizes (partial $\eta^2 = .26$ and .23, respectively). Significant decrease in total score of Emotion dysregulation for the treatment group (t = 3.63, p = .003) but not for control group. Significant effects for the yoga group on Oppositional (p = .003, Cohen’s d = .77); Global Index Emotional Lability (p = .001, Cohen’s d = .79); Global Index Total (p = .001; Cohen’s d = .73); Global Index Restless/Impulsive (p = .008, Cohen’s d = .73) and ADHD Index (p = .019, Cohen’s d = .29). Significant</td>
</tr>
<tr>
<td>3</td>
<td>Yoga program</td>
<td>20 weekly 1-hour sessions</td>
<td>Inattention, Hyperactivity, Anxiety, Perfectionism, Social problems</td>
<td>Cooperative games and activities: talking, listening, turn-taking, sharing equipment</td>
<td></td>
</tr>
</tbody>
</table>
Cristina Pozneanscaia

| 4 | Integra Mindfulness Martial Arts TM (Integra MMATM) | 20 weekly 90 min sessions | Attention control (EEG indices): theta; beta; theta/beta ration (TBR) | No treatment |

**Restlessness/impulsiveness**

**Emotional Lability**

Effects for the control group: Hyperactivity ($p = .004$, Cohen's $d = .39$; with a trend for the yoga group, $p = .079$); Anxious/Shy ($p = .028$, Cohen's $d = .59$; with a trend for the yoga group, $p = .072$) and Social Problems ($p = .034$, Cohen's $d = .85$). Significant improvements in both groups: Perfectionism ($p = .032$, control $p = .028$, Cohen's $d = .58$); DSM-IV Hyperactive/Impulsive ($p = .036$, control $p = .016$, Cohen's $d = .17$) and DSM-IV Total ($p = .024$, control $p = .016$, Cohen's $d = .1$). No significant differences observed for yoga/control groups reported by teachers, except for a trend favouring the yoga group on Global Index Total ($p = .056$).

No significant main effects or interactions for theta power, beta power, or TBR for eyes-closed or eyes-open resting state trials; significant decrease in the TBR from pre-test ($M = 3.63, SD = 0.748$) to post-test ($M = 3.43, SD = 0.826$), $t(30) = 2.472, p = .019$, for Go trials of treatment group, but not for controls; significant decrease in TBR from pre-test ($M = 3.75, SD = 0.979$) to post-test ($M = 3.41, SD = 0.947$), $t(30) = 2.747, p = .001$, for No-Go trials, whereas controls showed a significant increase in TBR from pre-test ($M = 3.42, SD = 0.898$) to post-test ($M = 3.71, SD = 0.964$), $t(18) = -2.530, p = .021$. For AT trials, non-significant decrease from pre-test ($M = 3.74, SD = 0.816$) to post-test ($M = 3.71, SD = 1.21$), $t(28) = 1.77, p = .177$ for treatment group, whereas controls showed a significant increase in TBR from pre-test ($M = 3.34, SD = 0.707$) to post-test ($M = 3.62, SD = 0.914$), $t(18) = -2.576, p = .019$. For UT trials, non-significant increase in TBR from pre-test ($M = 3.60, SD = 0.796$) to post-test ($M = 3.68, SD = 1.04$), $t(28) = -0.666, p = .511$ for treatment group, whereas no significant change from pre-test ($M = 3.63, SD = 0.934$) to post-test ($M = 3.58, SD = 0.857$) was found for the control group, $t(18) = 0.391, p = .700$. Group × Condition × Time interactions were not significant for theta power, $F(1, 46) = 0.478, p = .493$, or beta power, $F(1, 46) = 0.013, p = .911$. 

47
|   | Yoga program | 24 sessions of 45 min over 8 weeks | Sustained attention  
|   |              |                                  | Impulse control/Impulsivity  
|   |              |                                  | Short-term memory  
|   |              |                                  | Neuro-feedback (NF)  
|   |              |                                  | and no treatment  
|   | Significant effect of neuro-feedback on attention variables in comparison between the pre-test and post-test with the control group ($p = .00$ and $F = 40.484$). Significant effect of yoga intervention on attention variables in comparison between pre-test and post-test with the control group ($p = .009$ and $F = 4.28$); digit memory ($p = .004$ and $F = .059$). Significant difference between the mean of scores of response error of the neuro-feedback and yoga groups ($p = .008$); significant difference between the mean of scores of correct responses of neuro-feedback and yoga groups ($p = .007$).  

|   | 6 Yoga exercise intervention | 16 sessions of 40 min over 8 weeks | Sustained attention  
|   |                              |                                  | Discrimination function  
|   |                              |                                  | No treatment  
|   | For VPT: a higher accuracy rate at the post-test in yoga group compared to control group ($t_{47} = 2.70, p = .010, d = 0.78$); faster RT reported by yoga group at the post-test compared to control group ($t_{47} = -4.18, p < .001, d = -1.20$). For DT: a higher response accuracy at the post-test compared to control group ($t_{47} = 3.74, p < .001, d = 1.09$).  
