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Effects of interventions of mindfulness on executive functions in adults: a systematic review

Efeitos de intervenções de *mindfulness* nas funções executivas de adultos: uma revisão sistemática

Efectos de las intervenciones de *mindfulness* sobre las funciones ejecutivas en adultos: una revisión sistemática

Iana Silva Lemos[1]
Geovan Menezes de Sousa Júnior[2]
Geissy Lainny de Lima Araújo[2]
Júnnia Maria Moreira[1]
Ivani Brys[3]

[1] Universidade Federal do Vale do São Francisco
[2] Universidade Federal do Rio Grande do Norte
[3] Universidade Federal do Vale do São Francisco; Universidade Federal de Santa Maria

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Correspondence:
Ivani Brys, ivani.brys@ufsm.br

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Abstract: Executive functions are cognitive processes that allow individuals to deal with unexpected obstacles, see the same situation from different perspectives, focus on a task, and resist impulses. Mindfulness interventions may improve executive functions by directly training these functions while reducing factors that impair them. To better understand these effects, a systematic review of randomized controlled trials on the effects of mindfulness interventions on executive functions in adults aged 18 to 60 years, published in the last 5 years was conducted. A total of 1304 articles were found, and after removing duplicates and reviewing titles and abstracts, 32 articles remained. After a thorough reading of these articles and bias risk analysis, 6 articles were included in the study. All the studies included in the review found positive effects on different executive functions, such as attention, cognitive control, and psychological flexibility, resulting from participation in these types of interventions, with four of these studies showing greater effects compared to the control group. Mindfulness-based interventions demonstrate potential for improving inhibitory control, working memory, and cognitive flexibility in both clinical and non-clinical populations.

Keywords: mindfulness; executive functions; psychological flexibility; working memory; inhibitory control

Resumo: Funções executivas são processos cognitivos que permitem com que se possa lidar com obstáculos inesperados, ver a mesma situação por diferentes perspectivas, se concentrar em uma atividade e resistir a impulsos. Intervenções de *mindfulness* podem melhorar as funções executivas porque treinam de forma direta essas funções ao mesmo tempo em que reduzem fatores que as prejudicam. Para melhor compreensão destes efeitos, foi realizada uma revisão sistemática de ensaios controlados randomizados, publicados nos últimos 5 anos, sobre efeitos de intervenções de *mindfulness* nas funções executivas de adultos, com idades entre 18 e 60 anos. Foram encontrados 1304 artigos, após remoção das duplicatas e leitura de título e resumo, restaram 32 artigos. Após leitura completa desses artigos e análise de risco de viés, 6 artigos foram incluídos no estudo. Em todos os estudos incluídos na revisão foram encontrados efeitos positivos sobre diferentes funções executivas, como atenção, controle cognitivo e flexibilidade psicológica, advindos da participação desses tipos de intervenções, sendo que em quatro destes estudos, os efeitos foram maiores que os observados no grupo controle. Intervenções baseadas em *mindfulness* demonstram potencial para a melhora de funções executivas de controle inibitório, memória de trabalho e flexibilidade cognitiva tanto para populações clínicas como não-clínicas.

Palavras-chave: mindfulness; funções executivas; flexibilidade cognitiva; memória de trabalho; controle inibitório

Resumen: Las funciones ejecutivas son procesos cognitivos que permiten afrontar obstáculos inesperados, ver una misma situación desde diferentes perspectivas, centrarse en una actividad y resistir impulsos. Las intervenciones de *mindfulness* pueden mejorar las funciones ejecutivas porque las entrenan directamente y reducen los factores que las perjudican. Para una mejor comprensión de estos efectos, se realizó una revisión sistemática de ensayos controlados aleatorios, de los últimos 5 años, sobre los efectos de las intervenciones de *mindfulness* en las funciones ejecutivas en adultos, con edades entre 18 y 60 años. Se encontraron 1304 artículos, luego se eliminar duplicados, y al leer el título y el resumen quedaron 32 artículos. Después de la lectura completa de estos artículos y el análisis del riesgo de sesgo, restaron 6 artículos. En todos los estudios se encontraron efectos positivos sobre diferentes funciones ejecutivas, como la atención, el control cognitivo y la flexibilidad psicológica, derivados de la participación de este tipo de intervenciones, y en cuatro de estos estudios, los efectos fueron mayores que los observados en el grupo de control. Las intervenciones basadas *mindfulness* demuestran potencial para mejorar las funciones ejecutivas de control inhibitorio, la memoria de trabajo y la flexibilidad cognitiva tanto para poblaciones clínicas como no clínicas.
Palabras clave: mindfulness; funciones ejecutivas; flexibilidad cognitiva; memoria de trabajo; control cognitivo

It is understood that for an individual to adapt adequately and succeed in today's social context, a range of skills such as self-control, flexibility, discipline, and creativity, among others, is essential. The performance of these skills is linked to the proper functioning of executive functions, which are cognitive or mental processes that enable individuals to handle unexpected obstacles, view the same situation from different perspectives, concentrate on a task, and resist impulses (Diamond, 2013).

Studies demonstrate the importance of executive functions for mental and physical health, associating them with various benefits. Individuals with well-functioning executive functions tend to achieve better professional and academic results, satisfaction in marital relationships, prosocial behaviors, higher quality of life, weight control, resistance to substance abuse, greater ability to form and maintain friendships, among other advantages (Cásedas et al., 2020; Diamond & Ling, 2016). This underscores the fundamental role of executive functions in increasing the likelihood of a healthy and balanced life.

Executive functions can be categorized into three core components: inhibitory control, working memory, and cognitive flexibility. From these higher-order functions, other abilities such as reasoning, planning, and problem-solving can derive (Cásedas et al., 2020; Diamond, 2013; Diamond & Ling, 2016; Im et al., 2021). Another possible classification divides them into inhibition, updating, and shifting functions (Zhou et al., 2020). For this study, executive functions were categorized into three main types: inhibitory control or inhibition, working memory or updating, and cognitive flexibility or shifting.

According to Cásedas et al. (2020), inhibitory control, also referred to as inhibition (Millett et al., 2021), involves the ability to regulate one's attention, thoughts, emotions, and behavior to overcome internal predispositions or external temptations in pursuit of long-term goals. It enables individuals to choose how to respond in a given situation, resist impulses, and modify habits. In the attentional domain, it allows selective focus on a task while suppressing other stimuli and suppressing unwanted memories and thoughts (Diamond, 2013). On a neural level, inhibitory control is associated with activity in the dorsolateral prefrontal cortex and anterior cingulate cortex (Millett et al., 2021).

Working memory, or updating (Millett et al., 2021), refers to the mental capacity to hold and process information simultaneously (Cásedas et al., 2020; Diamond, 2013). It involves monitoring and replacing outdated or irrelevant information with new, more relevant data (Zhou et al., 2020). Working memory is critical for influencing other cognitive functions like reasoning and problem-solving, as it requires maintaining multiple pieces of information simultaneously, reorganizing them, and establishing interrelations (Diamond & Ling, 2016). Brain regions associated with this executive function include the frontal lobes, specifically the dorsolateral prefrontal cortex (Millett et al., 2021).

Finally, cognitive flexibility or shifting (Millett et al., 2021) is crucial in novel and challenging situations that require adaptation, new ways of understanding or solving problems, or viewing the same situation from different angles (Diamond & Ling, 2016). Other aspects of cognitive flexibility include the ability to admit mistakes, seize new opportunities, and change one's mindset (Diamond, 2013). According to Cásedas et al. (2020), cognitive flexibility is the capacity to modify mental frameworks to adapt efficiently to environmental demands. This function depends on the activity of frontal, occipital, and parietal brain regions (Millett et al., 2021).

Executive functions influence many important areas of life (Teper et al., 2013), and their optimal functioning increases the chances of success and improvements in various domains (Diamond & Ling,

2016). Consequently, it is crucial to understand what happens when there are dysfunctions in this system. Some causes of such dysfunctions include aging, strokes, and attention deficit hyperactivity disorder (ADHD) (Cásedas et al., 2020), as well as stress, sleep deprivation, sadness, poor physical health, among others (Zhou et al., 2020). Research indicates that executive functions are among the first to be affected when an individual's life is not going well (Diamond, 2013).

The effects of stress, loneliness, sadness, poor physical health, and other factors can be so detrimental that they resemble symptoms of psychological disorders like ADHD. Problems with executive functions are linked to a range of negative outcomes, such as poor academic performance, behavioral issues, reduced reasoning abilities, low self-control, and memory problems (Zhou et al., 2020).

According to Diamond and Ling (2016), interventions that yield better results for executive functions not only directly train these functions but also address factors that impair them while enhancing factors that improve them. Programs that neglect stress reduction, happiness enhancement, or social connection may fail to achieve significant improvements in executive functions (Diamond & Ling, 2016).

Given this, mindfulness-based interventions appear to have the potential to address these demands. Over the past decades, such interventions have grown exponentially, showing significant evidence of physical and mental health benefits across different populations (Cásedas et al., 2020; Im et al., 2021; Millett et al., 2021; Zhou et al., 2020;). Mindfulness can be defined as a state of awareness achieved by focusing on the present moment with an open, accepting, and nonjudgmental attitude (Gill et al., 2020; Mak et al., 2018; Millett et al., 2021).

Among the main benefits observed are reduced stress, anxiety, and depression levels, improved management of chronic pain, increased emotional regulation, well-being, and decreased consumption of alcohol and other substances (Alizadehgoradel et al., 2019; Creswell, 2017; Im et al., 2021; Zhou et al., 2020). Empirical evidence also indicates that mindfulness interventions benefit executive functions (Cásedas et al., 2020; Im et al., 2021), with results visible even in short-term interventions (Zhou et al., 2020).

Taking this into account, it can be hypothesized that mindfulness-based interventions could effectively improve executive functions. Beyond reducing factors such as stress and depression that negatively affect these functions, such interventions also functionally and structurally modify brain regions, including the anterior cingulate cortex, dorsolateral prefrontal cortex, insula, and gray matter density in the hippocampus (Creswell, 2017; Millett et al., 2021).

In recent years, systematic reviews and meta-analyses have been conducted to better investigate the effects of mindfulness interventions on executive functions (Cásedas et al., 2020; Im et al., 2021; Millett et al., 2021). Overall, these studies show significant effects of mindfulness interventions on improving executive functions. However, most studies reviewed are from before 2017. Articles including more recent studies exhibit disparities in criteria regarding intervention types, study designs, conceptualization of executive functions and mindfulness, types of tests analyzed, and other factors.

Based on this context, it is important to conduct a systematic review of randomized controlled trials examining the effects of mindfulness interventions on executive functions in adults aged 18 to 60 over the past five years. This would provide an update on the topic and analyze whether new or distinct results emerge based on the criteria defined in the present study.

Materials and Methods

The present study is a systematic review conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement 2020 (Page et al., 2021) and registered on the International Prospective Register of Systematic Reviews (PROSPERO) platform (CRD42022349640).

Literature Review

To conduct the study searches, two reviewers utilized the Web of Science, PubMed, PsycINFO, and Scopus databases to find articles published in the last five years (2017–2022). The descriptor terms used to create the keywords were based on terms found on the MeSH platform. After several tests, the defined search strategy was as follows: (mindfulness) OR (mindfulness intervention) OR (mindfulness

meditation) AND ((“psychological flexibility) OR (cognitive flexibility) OR (executive functions) OR (self-control) OR (inhibitory control)

Eligibility Criteria

The studies included in the research were randomized controlled trials conducted in the last five years and published in English. The target population comprised adults aged between 18 and 60 years. The mindfulness interventions included in the studies were required to follow established protocols such as Mindfulness-Based Stress Reduction (MBSR), Mindfulness-Based Cognitive Therapy (MBCT), among others.

Methodological Analysis

The online platform CADIMA was used for screening, with article selection performed independently by two researchers in a blinded process. Subsequently, the Risk of Bias Tool (ROB-2) was used to assess the risk of bias.

Data Extraction

For data extraction, a table was created containing descriptive information about the studies, including: the number of participants, mean age range, type of intervention, type of control group, the executive function studied, and main results.

Results

Search Results

After applying the search strategy to the databases, 1,304 articles were identified, of which 225 duplicates were removed. A total of 1,079 articles were screened by title and abstract, resulting in the exclusion of 1,047 articles. Thirty-two articles were assessed through full-text reading, of which 24 were excluded for not using mindfulness practices based on an established protocol, involving participants older than 60 years, or not being randomized studies. For the risk of bias analysis, 8 articles remained. Among these, 6 studies presented a low risk of bias and were included in the final analysis. Figure 1 presents the PRISMA diagram of the study.

General Characteristics of the Studies

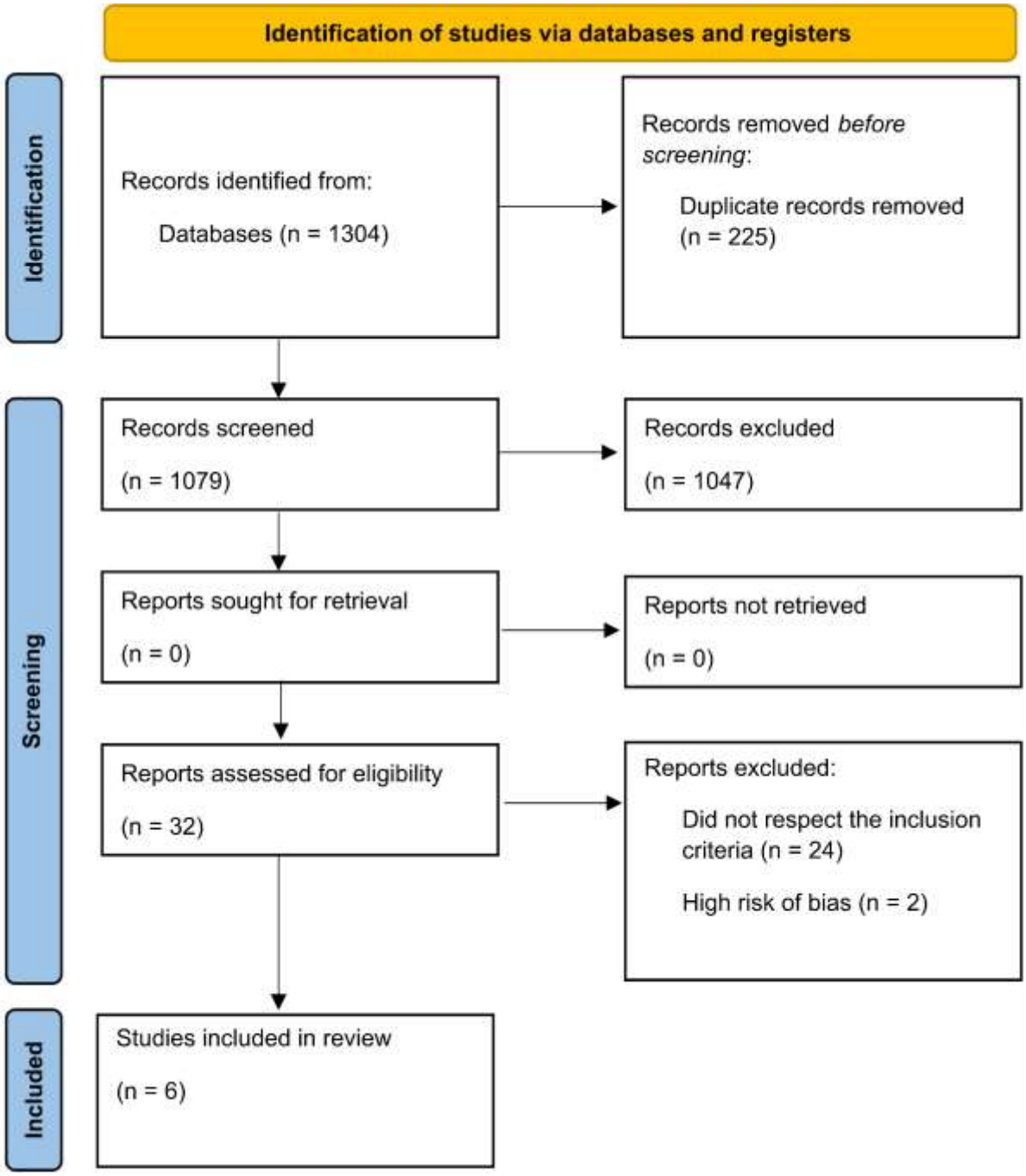
All the studies included in the review (Alizadehgoradel et al., 2021; Garland et al., 2019; Hoxhaj et al., 2018; Quan et al., 2018; Zhu et al., 2019; Zou et al., 2020) met the criteria of being randomized controlled trials with mindfulness interventions based on an existing protocol (e.g., Mindfulness-Based Stress Reduction - MBSR), involving participants aged 18 to 60 years and presenting a low risk of bias. All studies included either active or passive control groups and evaluated cognitive functions.

Three studies (Quan et al., 2018; Zhu et al., 2019; Zou et al., 2020) focused on non-clinical populations, while the other three involved clinical populations: participants with chronic pain (Garland et al., 2019), methamphetamine use disorder (Alizadehgoradel et al., 2021), or adults diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) (Hoxhaj et al., 2018).

Regarding participants' gender and age, all studies showed baseline distributions without major disparities. Randomization methods ensured balance in terms of age, gender, and other variables between intervention and control groups, resulting in a low risk of bias. Further details about participants' gender distribution and mean age can be found in Table 1.

Figure 1

PRISMA flowchart



Note. PRISMA Flow Diagram (Page et al., 2021).

Table 1

General characteristics of the participants

Study reference and year of publication	N_{MBI} (women) N_{GC} (women)	Sample	Age [Media (SD)]
Zhu et al. (2019)	24(18) 24(16)	Non-clinical	24.13 (5.11) - MBI 24.25 (5.17) - GC
Garland et al. (2019)	19 (70%) 20 (67%)	Patients with chronic pain	46.8 (13.5) - MBI 46.7 (12.6) - GC
Alizadehgoradel et al. (2021)	16 (0) - tDCS 15 (0) - MBSAT 17 (0) - tDCS + MBSAT 16 (0) - Placebo	Methamphetamine use disorder	19.43 (1.20) - tDCS 19.46 (1.12) - MBSAT 19.52 (1.23) - tDCS + MBSAT 19.43 (1.15) - Placebo
Hoxhaj et al. (2018)	41 (23) 40 (19)	ADHD patients	40.51 (9.48) -MBI 38.50 (11.83) - GC
Quan et al. (2018)	24 (11) 24 (13)	Non-clinical	19.2 (1.3)
Zou et al. (2020)	26 (69.23%) 28 (72.41%)	Non-clinical	34.12 (7.63) - MBI 33.6 (8.24) - GC

Nota. SD: Standard Deviation; GC: Group Control; MBI: Mindfulness-based Intervention; tDCS: transcranial direct current stimulation; MBSR: Mindfulness-based Stress Reduction; ADHD: Attention Deficit/Hyperactivity Disorder; MORE: Mindfulness-Oriented Recovery Enhancement; MBSAT: Mindfulness-Based Substance Abuse Treatment; MAP: Mindfulness Awareness Practices; MBCT: Mindfulness-Based Cognitive Therapy.

Executive Functions and Mindfulness Interventions

The executive functions analyzed in the reviewed studies included attention (Hoxhaj et al., 2018; Zhu et al., 2019), cognitive control and inhibition (Garland et al., 2019), executive functions and craving (Alizadehgoradel et al., 2021), executive control and orientation (Quan et al., 2018), and cognitive flexibility (Zou et al., 2020).

The mindfulness interventions were as follows: Mindfulness-Based Stress Reduction (MBSR), lasting 12 weeks (Zhu et al., 2019); Mindfulness-Oriented Recovery Enhancement (MORE), lasting 8 weeks (Garland et al., 2019); Mindfulness-Based Substance Abuse Treatment (MBSAT), lasting 6 weeks with two sessions per week (Alizadehgoradel et al., 2021); Mindfulness Awareness Practices (MAP), lasting 8 weeks (Hoxhaj et al., 2018); Mindfulness-Based Cognitive Therapy (MBCT), lasting 7 days (Quan et al., 2018); and MBSR, lasting 8 weeks (Zou et al., 2020).

Two studies used a waitlist as a passive control group (Zhu et al., 2019; Zou et al., 2020), while the other studies included active control groups such as support groups (Garland et al., 2019), transcranial direct current stimulation (tDCS), tDCS combined with MBSAT, and placebo (Alizadehgoradel et al., 2021), psychoeducation (Hoxhaj et al., 2018), and relaxation (Quan et al., 2018). Additional details about each intervention can be found in Table 1.

Cognitive Tasks and Instruments Used

The tasks and instruments used in each study are summarized in Table 2. The cognitive tasks used to assess executive functions varied across studies. Zhu et al. (2019) used the Continuous Performance Test (CPT) to analyze sustained attention and the Stroop Test to evaluate response inhibition. Garland et al. (2019) used the Emotional Go/No-Go task to assess inhibitory responses in the context of negative emotional interference.

Alizadehgoradel et al. (2021) employed the Go/No-Go task for cognitive control, the N-Back Test for working memory, the Wisconsin Card Sorting Test (WCST) to assess prefrontal cortex performance, and the Balloon Analogue Risk Task (BART) to evaluate risk-taking behaviors and decision-making under risk.

Hoxhaj et al. (2018) used the CAARS scale, which includes 8 subscales to evaluate ADHD-related symptoms, including inattention. Quan et al. (2018) assessed orientation and executive control using the Attention Network Test. Zou et al. (2020) used the CFI scale, a 20-item Likert-type scale, to evaluate cognitive flexibility.

Effects of Mindfulness on Inhibitory Control, Working Memory, and Cognitive Flexibility

In terms of attention, Zhu et al. (2019) found that a 12-week MBSR intervention significantly improved sustained attention and positive emotions in the mindfulness group compared to the waitlist control group. Similarly, Hoxhaj et al. (2018) observed significant improvements in attention and associated ADHD symptoms following an 8-week MAP intervention compared to psychoeducation, with effects persisting after six months (follow-up).

Regarding cognitive control or inhibitory control, both Garland et al. (2019) and Alizadehgoradel et al. (2021) found significant improvements in the mindfulness groups compared to control groups. For working memory, Alizadehgoradel et al. (2021) reported significant gains in the MBSAT group compared to the placebo group.

Quan et al. (2018) demonstrated increased responsiveness to orientation and executive control after a 7-day MBCT intervention compared to a relaxation control group. For cognitive flexibility, both clinical (Alizadehgoradel et al., 2021) and non-clinical (Zou et al., 2020) populations showed significant improvements in mindfulness groups compared to controls. These results are summarized in Table 2.

Table 2

Types of interventions and main results

Study reference and year of publication	MBI	Duration	Control	Domains analyzed	Main results	Utilized tests and tasks
Zhu et. al. (2019)	MBSR	12 weeks	Passive (Waitlist)	Attention	Significant improvements in positive emotions and sustained attention in participants of the MBI group.	Continuous Performance Test (CPT) e Stroop Test
Garland et. al. (2019)	MORE	8 weeks	Active (Support group)	Cognitive control, inhibition	MORE intervention participants increased response inhibition in the context of negative emotional interference	Emotional Go/NoGo
Alizadehgoradel et. al. (2021)	MBSAT	6 weeks (2 sessions per week)	Active (tDCS, tDCS + MBSAT, Placebo)	Executive functions and craving	Combined therapy (tDCS + MBSAT) improved working memory, inhibitory control, cognitive flexibility and reduced craving for the psychoactive substance compared to other intervention groups.	Emotional Go/NoGo, N-Back Test, Wisconsin Card Sorting Test (WCST) and Balloon Analogue Risk Task (BART)
Hoxhaj et. al. (2018)	MAP	8 weeks	Active (Psychoeducation)	Attention - Inattention	Both groups showed improvements in attention and symptoms associated with ADHD and maintained the improvement even after 6 months of intervention (follow-up).	CAARS
Quan et. al. (2018)	MBCT	7 days	Active (Relaxation)	Executive control and orientation	The MBCT group was more responsive to guidance and executive control compared to the control group.	Attention Network Test
Zou et. al. (2020)	MBSR	8 weeks	Passive (Waitlist)	Cognitive flexibility	Participants in the MBSR group had greater improvement in cognitive flexibility compared to the control group.	CFI

Note. ADHD: Attention-deficit/hyperactivity disorder; MBI: Mindfulness-based Intervention); MBSR: Mindfulness-based Stress Reduction; MAP: Mindfulness Awareness Practices; MORE: Mindfulness-Oriented Recovery Enhancement; MBCT: Mindfulness-Based Cognitive Therapy; MBSAT: Mindfulness-Based Substance Abuse Treatment; tDCS: transcranial direct current stimulation.

Description of Protocols Used in the Studies

The interventions in all studies were based on well-established protocols with substantial evidence supporting their mental and physical health benefits for clinical and non-clinical populations. Five different protocols were identified: Mindfulness-Based Stress Reduction (MBSR) (Zhu et al., 2019; Zou et al., 2020); Mindfulness-Oriented Recovery Enhancement (MORE) (Garland et al., 2019);

Mindfulness-Based Substance Abuse Treatment (MBSAT) (Alizadehgoradel et al., 2021); Mindfulness-Based Cognitive Therapy (MBCT) (Quan et al., 2018); and Mindfulness Awareness Practices (MAP) (Hoxhaj et al., 2018).

Further details on each protocol can be found in Table 3. Across the included studies, all protocols demonstrated significant effects on executive functions, with 4 out of 6 studies showing greater benefits in the mindfulness intervention groups compared to control groups.

Table 3

Description of protocols

Protocol	Duration	Main goals	Types of practices used
[1] MBSR	The standard intervention consists of weekly group meetings (generally lasting 6 to 8 weeks) and an average duration of 2 hours per meeting	Program aimed at reducing stress and promoting health where different themes and practices are worked on with the aim of training and developing mindfulness skills. It involves practices such as body scanning, focusing on breathing, focusing on bodily sensations, among others	It involves practices such as body scanning, focusing on breathing, focusing on bodily sensations, among others
[2] MORE	This intervention model generally consists of 8 sessions lasting an average of 2 hours	It is a program that integrates techniques for mindfulness training, cognitive-behavioral therapy and principles of positive psychology, widely used as a complementary intervention in pharmacological treatment with opioids. It seeks to work on aspects related to identifying automatic behaviors and promoting pain coping skills, encouraging acceptance rather than suppressing the experience, among others	It involves body scanning and breathing techniques, among others
[3] MBSAT	The program is divided into a total of 12 sessions, each with a specific topic to be discussed	It is a mindfulness intervention program aimed at young substance users. This program incorporates formal and informal mindfulness practices as well as didactic training on topics such as: the effect of substance use on health, drugs and the brain, triggers, cravings, among others	It involves meditation techniques focusing on breathing, body scanning and compassion meditation
[4] MBCT	The MBCT intervention is generally divided into 6 to 8 weekly sessions with different themes and practices	Individuals learn to recognize and disengage from dysfunctional cognitive processes that are automatically activated with a focus on reducing stress and depression	It combines meditation practices, yoga exercises, body scanning, among others, with elements of cognitive-behavioral therapy such as psychoeducation
[5] MAP	The program has the format of 6 to 8 weekly sessions with an average duration of 2.5 hours per meeting	It is an intervention based on MBSR and MBCT that aims to develop an attitude of acceptance and non-judgment in participants. The main objective is to promote self-regulation of attention as well as help deal with negative thoughts and emotions in a constructive way	It involves different meditation practices, which, unlike other types of mindfulness interventions, start with a shorter practice time (5 minutes) and gradually increase, preventing participants from overloading or demotivating the practice

Notes. [1] Vibe et al. (2017); [2] Garland (2014), and Garland and Howard (2013); [3] Himelstein and Saul (2015), and Alizadehgoradel et al. (2019); [4] van der Velden et al. (2015), and Liberali (2017); [5.] Hoxhaj et al. (2018).

Discussion

The present study constitutes a systematic review of scientific studies published over the past five years (2017–2022) on the effects of mindfulness-based interventions on the executive functions of adults (aged 18 to 60). All the articles included in this review employed mindfulness-based protocols and assessed their effects on at least one executive function. Across the six studies included, positive

effects on various executive functions were observed following participation in mindfulness interventions. In four of the six studies, mindfulness interventions showed significant differences compared to control groups.

General Characteristics of Participants

The studies included both clinical and non-clinical populations of men and women aged 18 to 60. This age range was chosen as a criterion for this review, given that most studies on executive functions tend to focus on specific developmental stages such as childhood, adolescence, or old age—periods more susceptible to rapid brain changes or cognitive decline (Im et al., 2021).

According to Ferguson et al. (2021), the 20–60 age range, often overlooked in literature on the subject, presents more significant changes in executive function development or decline than previously thought. These authors analyzed inhibitory control, working memory, cognitive flexibility, and planning across healthy individuals aged 10 to 86, observing that working memory and planning capacities continue to develop after adolescence, while inhibitory control shows a notable decline beginning at age 30 (Ferguson et al., 2021). However, the studies included in this review did not provide significant findings linking a specific age range to better or worse executive function performance.

Both clinical and non-clinical populations showed significant improvements in at least one aspect of executive functions. A recent study by Didehban et al. (2024) supports this outcome, as the authors reported better effects of a group-based mindfulness and acceptance protocol compared to a waitlist group in participants with anxiety disorders. These results pertain to both anxiety symptoms and executive functions. Notably, the study by Didehban et al. (2024) was likely excluded from this review because it was published during the preparation of this study and thus fell outside the defined temporal scope. Such findings reinforce the hypothesis that mindfulness-based interventions effectively enhance executive functions, both directly—improving inhibitory control, working memory, and cognitive flexibility—and indirectly, by reducing stress, depression, and other symptoms, thereby improving quality of life (Alizadehgoradel et al., 2021; Garland et al., 2019; Hoxhaj et al., 2018; Quan et al., 2018; Zhu et al., 2019; Zou et al., 2020). According to Diamond and Ling (2016), interventions that act both directly and indirectly are ideal for improving executive functions as they not only train these functions but also mitigate factors that impair them, such as stress and poor sleep quality.

Promising evidence also emerges from comparative interventions like Rational Emotive Behavior Therapy (REBT). Tóth et al. (2023) observed improvements in competitive anxiety, perfectionism, irrational beliefs, and executive functions (e.g., cognitive flexibility and inhibition) resulting from REBT, while mindfulness interventions primarily improved cognitive flexibility.

The format of the intervention protocol also appears to be a relevant variable. For example, Vieth and von Stockhausen (2023) observed no differential effects on executive functions in a non-clinical sample when comparing brief mindfulness interventions (three or four sessions focusing on breath mindfulness) with controls such as relaxation training or listening to podcasts. However, none of the studies included in this review employed brief interventions, so this variable was not discussed further.

Protocols Used and Their Effects on Executive Functions

The findings suggest that all mindfulness-based protocols produced benefits for inhibition-related functions, including attention, cognitive control, and inhibitory or executive control (Alizadehgoradel et al., 2021; Garland et al., 2019; Hoxhaj et al., 2018; Quan et al., 2018; Zhu et al., 2019), in both clinical and non-clinical adult populations. These results align with the literature, which shows extensive evidence of mindfulness practices improving both behavioral and neural aspects of inhibition-related functions. Moreover, these benefits can be maintained for up to five months post-intervention (Gallant, 2016).

Other executive functions also showed improvements, such as working memory and cognitive flexibility (Alizadehgoradel et al., 2021) and orientation (Quan et al., 2018). However, fewer studies have reported significant changes in these functions, a trend consistent with existing literature (Cásedas et al., 2020; Gallant, 2016; Millett et al., 2021). This scarcity of evidence might be explained by the fact that these changes are more pronounced in populations with cognitive decline, such as individuals over 65 years old, which might explain the absence of such data in studies on adolescents and young adults (Gallant, 2016).

Limitations and Suggestions for Future Studies

This review aimed to establish clear inclusion criteria to ensure greater methodological and conceptual homogeneity regarding executive functions, assessment methods, participant randomization, intervention models, and other factors. However, despite these efforts, discrepancies in terminologies (e.g., inhibitory control, executive control, cognitive control) were observed among the analyzed studies, potentially leading to varied interpretations depending on the definitions of executive functions employed. This limitation is common in randomized controlled trials on this topic, as well as in systematic reviews and meta-analyses. Future studies should aim for more precise definitions of executive functions to reduce interpretative variability.

Another significant limitation was the lack of detailed operationalization of the mindfulness interventions (e.g., specific session content or main techniques used), hindering the comparability of studies and deeper discussion. Discrepancies in the demographics and cultural contexts of study populations also limited the generalizability of findings. Future research should aim for greater standardization regarding target populations (e.g., cultural and socioeconomic factors) and provide more detailed descriptions of mindfulness protocols (e.g., duration, objectives, main techniques) to facilitate in-depth discussions and correlations between specific protocols or techniques and their effects on executive functions.

Further limitations include variability in tasks and questionnaires used to assess executive functions. While many studies employed well-validated cognitive tasks, some used questionnaires such as the CAARS (Hoxhaj et al., 2018) or CFI (Zou et al., 2020), which may not be sufficient to infer direct changes in executive functions. Future studies should better identify cognitive tasks and questionnaires that most validly assess specific executive functions, ideally using multiple measures for each construct.

Finally, the lack of follow-ups in some studies limited understanding of the long-term effects of mindfulness interventions. Although follow-ups may be challenging in research contexts, they are highly recommended to ensure the reliability and durability of intervention outcomes. Moreover, variability in control groups (e.g., waitlists, psychoeducation, relaxation training) complicates the reliability and generalizability of findings. Defining more effective control group interventions could significantly benefit future research, particularly systematic reviews and meta-analyses.

Future studies should also explore mindfulness interventions delivered via technology (e.g., mobile apps) and their effects on adult executive functions, as mindfulness practices have increasingly incorporated technological formats in recent studies, although research on their impact on executive functions remains limited. Additionally, future research should evaluate the effects of mindfulness interventions on executive functions as a whole rather than focusing primarily on attention and cognitive flexibility. A broader assessment would provide deeper insights into the topic.

Conclusions

In summary, mindfulness-based protocols demonstrate potential for improving inhibitory control, working memory, and cognitive flexibility in both clinical and non-clinical populations. These interventions could represent an effective form of treatment with a positive influence on individuals' health and quality of life. However, the findings of this review are not conclusive. Future studies must focus on achieving greater conceptual standardization of executive functions and the tasks and tests used to evaluate them. Regarding mindfulness interventions, a clearer definition of control group types and further investigation of neural mechanisms involved is also necessary. This research field holds the potential to significantly contribute to the development of more effective treatments that prevent illness and promote health and well-being. Based on the findings of this review, mindfulness interventions show great promise for contributing to adult health prevention and promotion efforts.

Referencias

Alizadehgoradel, J., Imani, S., Nejati, V., & Fathabadi, J. (2019). Mindfulness-based substance abuse treatment (MBSAT) improves executive functions in adolescents with substance use disorders. *Neurology, Psychiatry and Brain Research*, *34*, 13-21. https://doi.org/10.1016/J.NPBR.2019.08.002

Alizadehgoradel, J., Imani, S., Nejati, V., Vanderhasselt, M. A., Molaei, B., Salehinejad, M. A., Ahmadi, S., & Taherifard, M. (2021). Improved executive functions and reduced craving in youths with methamphetamine addiction: Evidence from combined transcranial direct current stimulation with mindfulness treatment. *Clinical Psychopharmacology and Neuroscience*, *19*(4), 653. https://doi.org/10.9758/CPN.2021.19.4.653

Cásedas, L., Pirruccio, V., Vadillo, M. A., & Lupiáñez, J. (2020). Does mindfulness meditation training enhance executive control? A systematic review and meta-analysis of randomized controlled trials in adults. *Mindfulness*, *11*(2), 411-424. https://doi.org/10.1007/S12671-019-01279-4/TABLES/2

Creswell, J. D. (2017). Mindfulness Interventions. *Annual Review of Psychology, 68*, 491-516. https://doi.org/10.1146/ANNUREV-PSYCH-042716-051139

Diamond, A. (2013). Executive functions. *Annual Review of Psychology, 64*, 135-168. https://doi.org/10.1146/ANNUREV-PSYCH-113011-143750

Diamond, A., & Ling, D. S. (2016). Conclusions about interventions, programs, and approaches for improving executive functions that appear justified and those that, despite much hype, do not. *Developmental Cognitive Neuroscience*, *18*, 34-48. https://doi.org/10.1016/J.DCN.2015.11.005

Didehban, R., Zemestani, M., Asmundson, G. J., & Bakhshaie, J. (2024). Changes in metacognitions and executive functions during mindfulness and acceptance-based intervention among individuals with anxiety disorders: A randomized waitlist-controlled trial. *Journal of Contextual Behavioral Science*, *33*, 100818. https://doi.org/10.1016/j.jcbs.2024.100818

Ferguson, H. J., Brunsdon, V. E. A., & Bradford, E. E. F. (2021). The developmental trajectories of executive function from adolescence to old age. *Scientific Reports*, *11*(1), 1-17. https://doi.org/10.1038/s41598-020-80866-1

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

Garland, E. L. (2014). Disrupting the downward spiral of chronic pain and opioid addiction Qwith mindfulness-oriented recovery enhancement: a review of clinical outcomes and neurocognitive targets. *Journal of Pain & Palliative Care Pharmacotherapy*, *28*(2), 122-129. https://doi.org/10.3109/15360288.2014.911791

Garland, E. L., & Howard, M. O. (2013). Mindfulness-oriented recovery enhancement reduces pain attentional bias in chronic pain patients. *Psychotherapy and Psychosomatics*, *82*(5), 311-318. https://doi.org/10.1159/000348868

Garland, E. L., Bryan, M. A., Priddy, S. E., Riquino, M. R., Froeliger, B., & Howard, M. O. (2019). Effects of mindfulness-oriented recovery enhancement versus social support on negative affective interference during inhibitory control among opioid-treated chronic pain patients: A pilot mechanistic study. *Annals of Behavioral Medicine*, *53*(10), 865-876. https://doi.org/10.1093/ABM/KAY096

Gill, L. N., Renault, R., Campbell, E., Rainville, P., & Khoury, B. (2020). Mindfulness induction and cognition: A systematic review and meta-analysis. *Consciousness and Cognition*, *84*. https://doi.org/10.1016/J.CONCOG.2020.102991

Himelstein, S., & Saul, S. (2015). *Mindfulness-based substance abuse treatment for adolescents: a 12-session curriculum*. Routledge. https://doi.org/10.4324/9781317607052

Hoxhaj, E., Sadohara, C., Borel, P., D'Amelio, R., Sobanski, E., Müller, H., Feige, B., Matthies, S., & Philipsen, A. (2018). Mindfulness vs psychoeducation in adult ADHD: a randomized controlled trial. *European Archives of Psychiatry and Clinical Neuroscience*, *268*(4), 321-335. https://doi.org/10.1007/S00406-018-0868-4

Im, S., Stavas, J., Lee, J., Mir, Z., Hazlett-Stevens, H., & Caplovitz, G. (2021). Does mindfulness-based intervention improve cognitive function?: A meta-analysis of controlled studies. *Clinical Psychology Review*, *84*, 1019 https://doi.org/10.1016/J.CPR.2021.101972

Liberali, R. (2017). Mindfulness-based cognitive therapy in major depressive disorder - systematic review and metanalysis. *Fisioterapia Em Movimento*, *30*(suppl 1), 335-349. https://doi.org/10.1590/1980-5918.030.S01.AR03

Mak, C., Whittingham, K., Cunnington, R., & Boyd, R. N. (2018). Efficacy of mindfulness-based interventions for attention and executive function in children and adolescents- a Systematic Review. *Mindfulness*, *9*(1), 59-78. https://doi.org/10.1007/S12671-017-0770-6/TABLES/6

Millett, G., D'Amico, D., Amestoy, M. E., Gryspeerdt, C., & Fiocco, A. J. (2021). Do group-based mindfulness meditation programs enhance executive functioning? A systematic review and meta-analysis of the evidence. *Consciousness and Cognition*, *95*, 103195. https://doi.org/10.1016/J.CONCOG.2021.103195

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, *372*. https://doi.org/10.1136/BMJ.N71

Quan, P., Wang, W., Chu, C., & Zhou, L. (2018). Seven days of mindfulness-based cognitive therapy improves attention and coping style. *Social Behavior and Personality*, *46*(3), 421-430. https://doi.org/10.2224/SBP.6623

Teper, R., Segal, Z. V., & Inzlicht, M. (2013). Inside the mindful mind. *Current Directions in Psychological Science, 22*(6), 449-454. https://doi.org/10.1177/0963721413495869

Tóth, R., Turner, M. J., Mannion, J., & Tóth, L. (2023). The effectiveness of rational emotive behavior therapy (REBT) and mindfulness-based intervention (MBI) on psychological, physiological and executive functions as a proxy for sports performance. *BMC Psychology*, *11*(1), 442. https://doi.org/10.1186/s40359-023-01486-8

van der Velden, A. M., Kuyken, W., Wattar, U., Crane, C., Pallesen, K. J., Dahlgaard, J., Fjorback, L. O., & Piet, J. (2015). A systematic review of mechanisms of change in mindfulness-based cognitive therapy in the treatment of recurrent major depressive disorder. *Clinical Psychology Review*, *37*, 26-39. https://doi.org/10.1016/J.CPR.2015.02.001

Vibe, M. de, Bjørndal, A., Fattah, S., Dyrdal, G. M., Halland, E., & Tanner-Smith, E. E. (2017). Mindfulness-based stress reduction (MBSR) for improving health, quality of life and social functioning in adults: a systematic review and meta-analysis. *Campbell Systematic Reviews*, *13*(1), 1-264. https://doi.org/10.4073/CSR.2017.11

Vieth, E., & von Stockhausen, L. (2023). Effects of short mindful breathing meditations on executive functioning in two randomized controlled double-blinded experiments. *Acta Psychologica*, *239*, 104006. https://doi.org/10.1016/j.actpsy.202|3.104006

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

Zhu, T., Xue, J., Montuclard, A., Jiang, Y., Weng, W., & Chen, S. (2019). Can mindfulness-based training improve positive emotion and cognitive ability in Chinese non-clinical population? A pilot study. *Frontiers in Psychology*, *10*(JULY). https://doi.org/10.3389/FPSYG.2019.01549

Zou, Y., Li, P., Hofmann, S. G., & Liu, X. (2020). The mediating role of non-reactivity to mindfulness training and cognitive flexibility: A randomized controlled trial. *Frontiers in Psychology*, *11*, 527897. https://doi.org/10.3389/FPSYG.2020.01053/BIBTEX

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