THE PRACTICE OF YOGA FOR ENHANCING EXECUTIVE FUNCTIONS IN DEVELOPMENTAL AGE WITHIN EDUCATIONAL SETTINGS: A SYSTEMATIC REVIEW

LA PRATICA DELLO YOGA PER MIGLIORARE LE FUNZIONI ESECUTIVE IN ETÀ EVOLUTIVA IN CONTESTI EDUCATIVI: UNA REVISIONE SISTEMATICA

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ABSTRACT
This systematic review examines the effect of yoga- and mindfulness-based interventions on developmental executive functions within educational settings. Following a systematic literature search, ten articles were included. Results show benefits in sustained attention, inhibitory control, working memory, cognitive flexibility and emotional regulation highlighting their multidimensional potential in educational settings

Questa revisione sistematica esamina l'effetto degli interventi basati sullo yoga e sulla mindfulness sulle funzioni esecutive in età evolutiva all'interno dei contesti educativi. In seguito ad una sistematica ricerca della letteratura, sono stati inclusi dieci articoli. I risultati mostrano benefici per quanto riguarda attenzione sostenuta, controllo inibitorio, memoria di lavoro, flessibilità cognitiva e regolazione emotiva evidenziando il loro potenziale multidimensionale nei contesti educativi

KEYWORDS
Yoga; Mindfulness; Executive Functions; Children; Educational Settings
Yoga; Mindfulness; Funzioni Esecutive; Bambini; Contesti educativi

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Introduction

In recent years, the scientific community has shown increasing interest in the role of executive functions in overall development in children and adolescents. Executive functions include cognitive functions such as sustained attention, working memory, inhibitory control, and cognitive flexibility, and are configured as core competences for numerous other functions such as behavioural regulation, problem-solving, and adaptation to complex contexts(Predoiu et al., 2025). It is now widely known that adequate executive function development contributes to higher social and emotional competence in children and adolescents, as well as to better educational outcome(Wong, 2024; Yin et al., 2024).

Indeed, several research studies have shown that higher levels of executive control are linked to better coping strategies, greater resilience, and reduced vulnerability to internalizing problems such as anxiety and depression(Hart, 2025). In parallel, executive function efficiency appears to be a significant predictor of academic success, directly influencing academic performance (Piepiora et al., 2025). Thus, these findings underscore the importance of interventions and strategies that can foster the development of executive function from the earliest years of life(Troisi Lopez et al., 2023).

Within this context, numerous practices have been studied and proposed to improve and enhance executive functions during the developmental age, such as structured play, music, and sports. Among motor and body activities, yoga and mindfulness have attracted particular attention in recent years, emerging as promising strategies not only for improving cognitive abilities but also for promoting psychological well-being(Campelo et al., 2025; Cerdá et al., 2023).

Yoga- and mindfulness-based interventions, originally used to promote better stress and anxiety management in adults population, have subsequently been adapted in children during the neurodevelopmental stage as well, finding application in numerous settings from school to clinical settings(Piepiora et al., 2025). In fact, the scientific evidence that has emerged suggests that these practices are able to improve emotional self-regulation, attention management, and coping with stressful situations in normotypic children and adolescents (Hart, 2025).

However, although the preliminary results are very promising, the existing literature has some critical limitations. Firstly, many studies have focused on clinical populations, such as children with autism spectrum disorders or attention-deficit/hyperactivity disorder, limiting the extension of results to the population

with typical development (Provenzi et al., 2025). Moreover, the marked methodological heterogeneity - relating to the duration, frequency of interventions, methods of administration and outcome measures adopted - makes it difficult to draw unambiguous conclusions as to which intervention protocol characteristics may be most effective (Piepiora et al., 2025).

On the basis of these considerations, the aim of this work is to conduct a systematic review of literature to examine the effects of yoga- and mindfulness-based interventions on the executive functions and psychological well-being of normed children and adolescents. In particular, the purpose is to synthesise the main available findings, highlight critical methodological issues, and outline future perspectives for research and practical application in education.

1. Methods

2.1 Literature search

A systematic literature search was conducted using three databases: PubMed, Cochrane Library, and Scopus. The search aimed to identify experimental studies investigating the effects of yoga interventions on executive functions in children and adolescents. Among the various search strings explored, two were ultimately selected based on their higher relevance and greater number of appropriate records retrieved. The final keyword strings used were: "yoga" AND "executive function" AND "children" and also "yoga" AND "executive function" AND "school". Only articles written in English were considered, and no restrictions were applied regarding the year of publication. The last search was conducted on 18 March 2025. The search and initial screening were performed independently by the authors.

2.2 Inclusion and Exclusion Criteria

Studies were selected according to predefined criteria based on the PICOS framework (Population, Intervention, Comparison, Outcomes, Study design).(Amir-Behghadami & Janati, 2020).

Included studies involved children and adolescents aged 3 to 18 years with typical developmental profiles. Interventions had to involve yoga, either as a stand-alone practice or combined with mindfulness, implemented in school or extracurricular settings. Although the presence of a control group (e.g., physical education, no

intervention, or standard classroom activity) was not mandatory for inclusion, comparative designs were recorded when available.

Eligible outcomes included at least one executive function domain (such as sustained attention, working memory, or inhibitory control) or an indicator of psychological well-being (such as reduced anxiety or stress, improved emotion regulation, or increased resilience). Only experimental studies, including randomized controlled trials (RCTs) and controlled non-randomized studies, were included. Studies were excluded if they were review articles, qualitative in nature, case reports, opinion pieces, or theoretical contributions. In addition, study protocols that fully met the PICOS criteria were also considered eligible for inclusion for this review, provided they clearly described the target population, intervention, comparison group and expected outcomes. This decision was made to capture emerging research efforts in this field and to ensure full coverage of high-quality studies, even in cases where outcome data were not yet available at the time of the review.

2. Results

A total of 136 records were initially identified through searches in PubMed, Scopus, and the Cochrane Library. After removing duplicates, 76 articles were retained for screening. 19 articles were then assessed for eligibility, and following application of the predefined inclusion criteria, 10 studies were ultimately included in this systematic review (Figure 1). The studies were heterogeneous in terms of design, population, and intervention protocol but were all aimed at evaluating the effects of yoga and mindfulness interventions on executive functions (EF) and psychosocial well-being in typically developing children and adolescents. All the article included are reported in the Table 1.

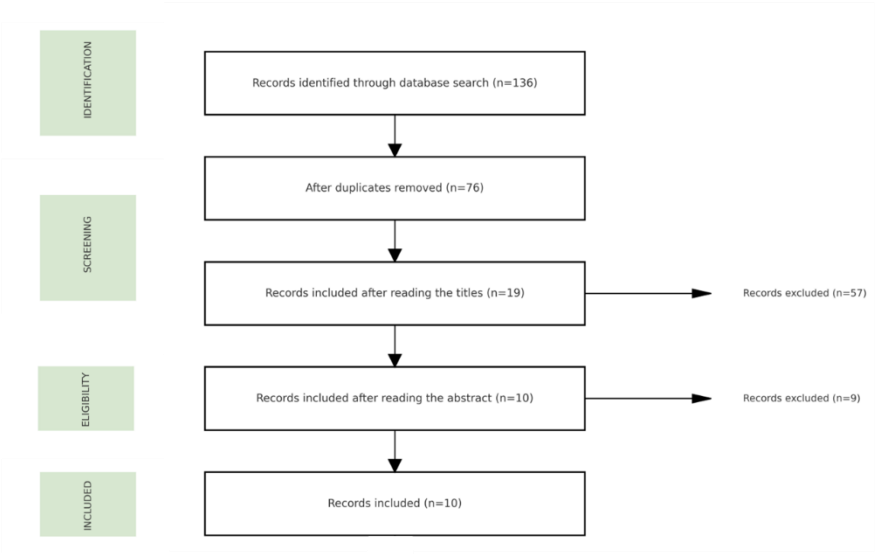

Figure 1: Flow chart of records search and selection process.

3.1 Population Characteristics

The included studies involved a broad developmental range of typically developing children and adolescents, with participant ages spanning from 3 to 16 years. Sample sizes varied from small exploratory cohorts with fewer than 30 children (Richter et al., 2016) to large-scale randomized trials with over 800 participants (Vhavle et al., 2019).

In terms of setting, nine out of ten studies conducted the intervention in school-based environments, including kindergartens, primary schools, and secondary schools. Only one study was conducted in a non-school context, specifically an orphanage(Purohit & Pradhan, 2017).

The demographic profile of participants was notably diverse. Some studies focused on high-risk or underserved populations, such as African-American preschoolers from urban school systems(Bazzano et al., 2023; Dariotis et al., 2016), or adolescents from economically disadvantaged regions in India(Parajuli et al., 2022; Vhavle et al., 2019). Other studies included preschoolers and early primary school children from mainstream education systems in France (Courbet et al., 2022a), Germany(Richter et al., 2016), and Italy (Toffoli et al., 2025). None of the selected studies included children with diagnosed neurodevelopmental conditions, in

accordance with the review's inclusion criteria, which focused solely on neurotypical populations.

3.2 Intervention Protocols

The yoga and mindfulness interventions implemented across the selected studies exhibited notable variability in terms of structure, intensity, and integration within the school curriculum. All studies included components of yoga practice, primarily based on sequences of physical postures (Asana), breathing exercises (Pranayama), and guided relaxation or meditation. In numerous protocols, these practices were enriched with mindfulness-based activities, such as focused attention exercises, body scans, and emotion regulation strategies.

The duration of interventions ranged from 6 to 32 weeks, depending on the educational setting and research design. The shortest interventions were six weeks in length (Richter et al., 2016; Zelazo et al., 2018), whereas the most extensive programs lasted for two full academic semesters (Bazzano et al., 2023). Frequency of practice also varied significantly from once a week (Bazzano et al., 2023; Toffoli et al., 2025) to five sessions per week in more intensive protocols (Parajuli et al., 2022; Vhavle et al., 2019).

Session duration typically ranged between 20 and 60 minutes. Most programs were delivered during regular school hours and were taught by qualified instructors, including certified yoga teachers, clinical psychologists, educators trained in mindfulness, or specialized physical education staff.

Some interventions, such as those described by Bazzano et al. and Toffoli et al., integrated yoga and mindfulness activities into broader socio-emotional learning curricula(Bazzano et al., 2023; Toffoli et al., 2025). Others, like those conducted by Parajuli et al. and Vhavle et al., focused specifically on cognitive enhancement through structured physical-mindfulness activities (Parajuli et al., 2022; Vhavle et al., 2019).

3.3 Executive Function Outcomes

Executive functions were assessed across the included studies using a variety of standardized cognitive tasks. The Color-Word Stroop Test, used to evaluate inhibitory control and cognitive flexibility, was administered in studies by Parajuli et al. (2022) and Purohit & Pradhan (2017). The Trail Making Test, assessing processing speed, visual attention, and cognitive set-shifting, was also employed in these two studies. The Digit Span Test and Digit Symbol Substitution Test, both

measures of working memory and information processing, were utilised in the trials by Purohit & Pradhan (2017) and Vhavle et al. (2019). In preschool-aged children, the Head-Toes-Knees-Shoulders (HTKS) task, assessing behavioural regulation through working memory, attentional control, and inhibition, was used by Bazzano et al. (2023) and Zelazo et al. (2018). Toffoli et al. (2025) employed computerised paradigms like the Dynamic Temporal Prediction (DTP) task and the Modified Flanker Task, offering measures of adaptive cognitive control under conditions of varying environmental predictability.

Authors (Year)	**Study Design**	**Sample and Age**	**Intervention**	**Outcomes**	**Main Findings**
Bazzano et al. (2023)	Controlled intervention	122 intervention, 579 control; 3-5 yrs	Yoga & Mindfulness, 32 weeks	Self-regulation, resilience, behavior	Improved self-control, initiative, protective factors
Courbet et al. (2022)	RCT Protocol	64 classes preschool; 4-5 yrs	Yoga & Mindfulness SEL, 24 weeks	EF, SEL, school performance	Study ongoing
Dariotis et al. (2016)	Qualitative exploratory	22 students; 10-13 yrs	School-based mindful yoga, 16 weeks	Stress reduction, emotional regulation	Students reported better emotion regulation
Nigg (2024)	Controlled trial	157 children; 10-11 yrs	Hatha Yoga vs PE, 12 weeks	Physical activity, psychosocial indicators	Yoga comparable to PE in physical activity
Parajuli et al. 2022	RCT	116 adolescents; 11-16 yrs	Yoga vs Physical Exercise, 2 months	EF, attention, working memory	Yoga > PE for EF, attention, memory
Purohit & Pradhan (2017)	RCT	80 adolescents; 11-16 yrs	Yoga vs Routine activity, 3 months	EF (Stroop, Digit Span, Trail Making)	Yoga group improved all EF tests
Richter et al. (2016)	Controlled pilot study	24 children; 6-11 yrs	Yoga vs Physical Skill Training, 6 weeks	Self-concept, coping strategies	Improved coping strategies in yoga group
Toffoli et al. (2025)	Pre-Post Exploratory	174 children; 4-7 yrs	Yoga & Mindfulness, 8 weeks	Adaptive cognitive control	Improved adaptation, cognitive control
Vhavle et al. (2019)	RCT	802 adolescents; 11-16 yrs	Yoga vs Physical Exercise, 2 months	EF, attention, working memory	Yoga better for working memory and EF
Zelazo et al. (2018)	RCT	218 children; 4-5 yrs	Mindfulness + Reflection, 6 weeks	Executive Function (HTKS, MEFS)	Mindfulness improved EF over time

Table 1. Summary of the studies included in the systematic review, reporting authorship, study design, sample characteristics, interventions, main outcomes (executive functions [EF], social-emotional learning [SEL], psychological well-being), and key findings. Acronyms used: EF = Executive Functions; SEL = Social-Emotional Learning; PE = Physical Education; RCT = Randomized Controlled Trial.

3. Discussion

The purpose of this systematic review was to evaluate the effects of yoga and mindfulness-based interventions on executive functions in children and adolescents in educational settings. The results of this review indicate that these practices have the potential to improve several aspects of executive functioning, including sustained attention, working memory, inhibitory control, and cognitive flexibility.

Compared with the existing literature, which has predominantly focused on clinical populations such as children with autism spectrum disorder or attention-deficit/hyperactivity disorder (ADHD)(Artchoudane et al., 2019; Chimiklis et al., 2018), this review highlights the effectiveness of yoga and mindfulness programs in neurotypical populations as well. Previous reviews have confirmed the positive impact of mindfulness on emotional regulation and cognitive performance in young people(Hagen et al., 2021; Rashedi et al., 2021); however, relatively little work has addressed children with typical development in educational settings. Therefore, the present findings contribute valuable evidence to support the preventive and promotive potential of such interventions for broader educational and cognitive development.

Among the larger randomized controlled trials, Parajuli et al. (2022) and Vhavle et al. (2019) demonstrated that students participating in yoga interventions achieved superior outcomes in measures of attention, working memory, and cognitive flexibility compared to students engaged in standard physical exercise programs(Parajuli et al., 2022; Vhavle et al., 2019). Similarly, adolescents residing in an orphanage demonstrated significant improvements in inhibitory control and information processing speed following a yoga-based intervention (Purohit & Pradhan, 2017). In younger populations, two of the studies included in this review, it has been observed enhancements in behavioural regulation and task performance among preschool children following yoga and mindfulness training (Bazzano et al., 2023; Zelazo et al., 2018). Toffoli et al. (2025) further confirmed that children aged 4 to 7 years who engaged in an integrated yoga-mindfulness

curriculum demonstrated greater adaptability and proactive control in attention-demanding tasks. In contrast to all other works included in the literature review, Richter et al. (2016) did not observe significant changes in cognitive performance after the yoga intervention, although improvements in coping strategies and perceived physical competence were reported.

Outcome data from Courbet et al. (2022) are not yet available, but their ongoing study is expected to provide important insights into the effects of yoga and mindfulness on executive functions in preschool settings.

In addition to yoga and mindfulness-based interventions, the broader scientific literature offers a wide range of approaches aimed at enhancing executive functions within educational settings. Numerous studies have investigated the effectiveness of alternative strategies, including computer-based cognitive training programs(Diamond & Lee, 2011), structured physical activity interventions (Best, 2010; Hillman et al., 2008), and social-emotional learning (SEL) curricula(Durlak et al., 2011). Each of these methods targets specific aspects of cognitive or emotional functioning, providing valuable insights into how self-regulatory skills can be fostered in children and adolescents. Computerised programs typically focus on isolated cognitive domains such as working memory or attentional control in children with ADHD (Klingberg et al., 2002), whereas physical activity interventions, particularly those emphasising aerobic exercise, have been linked to improvements in cognitive flexibility, attentional capacity, and inhibitory control (Hillman et al., 2008). SEL programs, on the other hand, prioritise the promotion of emotional regulation, social competence, and interpersonal skills, indirectly supporting the maturation of executive functions (Durlak et al., 2011).

It is important to highlight that, although the main focus of this review was on the effects of yoga and mindfulness on executive functions, many of the included studies also reported positive effects on psychological well-being and social-emotional skills. Indeed, improvements were observed stress reduction, emotional regulation, coping strategies and resilience (Bazzano et al., 2023; Dariotis et al., 2016; Purohit & Pradhan, 2017). These findings suggest that yoga and mindfulness interventions may offer broader benefits than cognitive enhancement by fostering emotional self-regulation and psychological resilience, skills essential for adaptive functioning in educational and social contexts. These results are consistent with evidence currently found in the literature. In fact, a recent systematic review has shown promising effects of yoga on psychological well-being in school-age children, reporting significant improvements in emotional regulation, reduced levels of stress and anxiety, and a general enhancement of overall psychological well-

being(Courbet et al., 2022b). However, despite these positive trends, several methodological considerations should be noted. Significant heterogeneity was evident across the included studies in terms of intervention content, duration, frequency, delivery mode, and instructor qualifications. Interventions ranged from six weeks to eight months, and session frequency varied between once weekly and five times per week. Moreover, although many studies employed validated cognitive tasks to measure executive functions, some relied on behavioural observations or self-report measures, which may introduce subjectivity. Sample sizes were also different, with some studies comprising fewer than thirty participants, thus limiting statistical power. Nonetheless, the review possesses notable strengths. A comprehensive search strategy was employed across multiple databases with strict application of predefined eligibility criteria, ensuring a rigorous selection process.

The inclusion of studies from diverse geographical and socio-economic contexts further enhances the generalizability of the findings. Furthermore, the focus on typically developing children, rather than clinical populations, addresses a gap in the current literature. Future research should prioritise the standardization of intervention protocols to enable better comparisons across studies. High-quality randomised controlled trials with larger sample sizes and robust long-term follow-up assessments are needed to verify the sustainability of observed cognitive gains. Additionally, future investigations should explore the specific contribution of different intervention components—such as physical movement, breathing exercises—to executive functioning outcomes.

Conclusions

In conclusion, this systematic review shed light highlights the promising role of yoga- and mindfulness-based interventions in improving executive functions and promoting psychological well-being of children and adolescents within educational settings. The available evidence suggests that these practices can promote improvements in key domains such as sustained attention, working memory, inhibitory control, and cognitive flexibility, thereby supporting both development and d in social-emotional well-being, as well as improved educational outcomes.

Although the results are encouraging, significant methodological heterogeneity persists among studies, underscoring the need for greater standardization of intervention protocols and assessment tools. Future research should prioritize

high-quality randomized controlled trials with larger sample sizes, long-term follow-up evaluations, and comparative designs that isolate the specific contributions of different intervention components.

Author contributions

R.M.: Conceptualization, Methodology, Literature search supervision, Writing – original draft preparation.
A.P.: Literature screening, Data extraction, Writing – initial draft sections.
E.G.: Literature screening, Data extraction, Writing – initial draft sections.
M.D.L.: Literature screening, Data extraction, Writing – initial draft sections.
E.T.L.: Conceptualization, Writing – review and editing

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