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EFFECT OF HOLISTIC MOVEMENT PRACTICES IN ENHANCING MENTAL AND COGNITIVE WELL-BEING OF ADOLESCENTS FROM DIVERSE BACKGROUNDS: A PILOT STUDY

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ABSTRACT

The present pilot study examined the feasibility, acceptability, and preliminary effects of a 12-week Integrated Holistic Movement Practices Programme for Adolescents (IHMPP-A) on mindfulness, mental well-being, and cognitive flexibility among participants from diverse sociocultural and ethnolinguistic backgrounds in Northeast India. Being a pilot study, only the first four of 12 modules were implemented. The study employed a quasi-experimental pretest-posttest waitlist design (Participants = 48: Experimental = 24, Waitlist = 24) to assess the programme's effect. The intervention comprised validated and evidence-based yoga and mindfulness practices. The study used the CHIME-A, MHC-SF, and CFI to assess mindfulness, mental well-being, and cognitive flexibility, respectively. Significant gains in mindfulness ($t = 10.48$, $p < .001$, $d = 1.20$), mental health ($t = 7.49$, $p < .001$, $d = 0.65$), and cognitive flexibility ($t = 5.15$, $p = < .001$, $d = 0.55$) were shown by the experimental group, but the waitlist group showed no significant changes. Time × group interactions for mindfulness ($\eta p2 = 0.58$), mental health ($\eta p2 = 0.44$), and cognitive flexibility ($\eta p2 = 0.16$) were also statistically significant. The IHMPP-A is an effective program for promoting adolescents' mindfulness, mental health and cognitive flexibility in school settings. The study's findings indicate that implementation of the program in routine conditions may enhance engagement and outcomes. It could be incorporated into the curriculum, providing another tool for adolescent well-being.

KEYWORDS: Holistic Movement Practices, Adolescents, Mental Well-Being, Embodied Cognition.

Introduction

Adolescence is a developmental phase marked by profound neurobiological and socioemotional transformations (WHO, 2025). Adolescents (10 – 19 years of age) experience significant maturation of emotional regulation capacities, executive functions, and identity formation (McGorry et al., 2024; Uhlhaas et al., 2023; Solmi et al., 2022). As a period of growth and development, it is also vulnerable to amplified stress, anxiety, and emotional dysregulation (Liu et al., 2025; Racine et al., 2021; Dahl et al., 2018). Global evaluations show that one in seven adolescents encounters mental health difficulties, which emerge during adolescence mostly and persist into adulthood (WHO, 2025; Racine et al., 2021).

Research documents adolescent self-regulation as a multi-level process involving dynamic interactions among physiological systems, psychological processes, executive functioning, and sociocultural context (Gajda et al., 2025; Xue et al., 2025; Blakemore & Mills, 2014). From an embodied cognition perspective, cognitive and emotional processes are profoundly grounded in sensorimotor systems, interoceptive awareness, and autonomic regulation (Shapiro, 2011; Schmalzl et al., 2015). Adolescent development may be uniquely shaped by Holistic Movement Practices (HMPs), which deliberately utilize posture, breath, and focus attention to address bottom-up physiological regulation and top-down attentional control (Vergeer et al., 2021; Vergeer & Biddle, 2021).

As schools seek practical ways to boost adolescent well-being, Mindfulness and yoga-based interventions have risen to the forefront. These interventions provide accessible frameworks to promote cognitive and mental well-being in school settings (Cartwright et al., 2025; McCurdy et al., 2024). Meta-analyses and systematic reviews confirm that mindfulness-based interventions lead to small to moderate improvements in emotional regulation, stress reduction, and overall psychological well-being in adolescents (Dunning et al., 2019; Klingbeil et al., 2017). Beyond psychological benefits, School-based yoga programs have also been linked to improved autonomic equilibrium, which facilitates stress reduction and effective mood regulation (Khalsa et al., 2018).

Despite these promising findings, the existing literature remains constrained by several critical gaps. Primarily, yoga and mindfulness are frequently investigated as isolated modalities, which limits the understanding of their potential synergistic integration. Furthermore, research often prioritizes the focus on mitigation of symptoms over broader developmental constructs such as flourishing mental health or executive adaptability. Finally, there is a notable scarcity of studies conducted in culturally diverse settings where sociocultural factors likely influence how contemplative engagements are received and internalized.

The current study addresses these gaps by formulating and assessing the Integrated Holistic Movement Practices Programme for Adolescents (IHMPP-A), a 12-week school-based intervention encompassing yogic postures (*asanas*), breathing techniques (*pranayamas*), and mindfulness practices. Grounded in principles of embodied regulatory development, the programme combines a cohesive curriculum that synthesizes physical movement, breath awareness, and attentional training. These contemplative elements are delivered via a developmentally sensitive framework tailored to adolescents' neurobiological needs.

The theoretical foundation of the study, rooted in embodied cognition, intellectualizes adolescence as an integrated multi-level regulatory system. Embodied processes, enfolding physical movement, sensorimotor engagement, and interoception, offer the substrate for neurobiological regulation (Shapiro, 2011; Matko et al., 2022). Neurobiological developments such as autonomic balance and interoceptive awareness are intersected with psychological regulation, containing mindfulness and attentional control. These regulatory capacities, in turn, are combined with executive and well-being outcomes, such as multidimensional mental health and cognitive flexibility (Gard et al., 2014; Schmalzl et al., 2015). This regulatory integration progresses within a broader sociocultural and ethnolinguistic ecology that shapes interpretation, engagement, and meaning–making (Ryder et al., 2011).

As a central component of self-regulation, mindfulness is characterized as a non-judgmental focus on present-moment experiences (Kabat-Zinn, 2003), and has been associated with vital developmental gains in youth. Research indicates these practices facilitate improved emotional regulation, attention, prosocial behaviour, and reduced internalizing symptoms in adolescents (Tang et al., 2015; Monsillion et al., 2023). Neurodevelopmental proof implies that mindfulness practices may strengthen prefrontal regulatory systems that support emotional regulation and adaptive responding (Tang et al., 2015). Recent large-scale reviews underscore that while overall effects are modest, interventions

grounded in clear theoretical frameworks and transferred with commitment demonstrate stronger outcomes (Klingbeil et al., 2017; Carsley et al., 2018). Mindfulness has been associated with improvements in emotion regulation, reduced rumination, and enhanced meta-cognitive awareness (Dunning et al., 2019; Yuan, 2021; Klingbeil et al., 2022). Research further reveals that mindfulness practices are linked with improved attentional control, reduced amygdala reactivity, and strengthened connectivity within fronto-parietal executive networks (Tang et al., 2015; Young et al., 2018; King et al., 2020). Yet, empirical studies examining these relationships within integrated movement-based interventions are constrained.

Existing developmental science highlights the necessity to hypothesise adolescent mental health not merely as the absence of disorder but as the presence of positive functioning and adaptive regulatory capacity (Keyes, 2002; Iasiello et al., 2020). Advancing multidimensional mental health, including emotional, psychological, and social well-being, aligns with global priorities, featuring adolescent well-being as a developmental property rather than simply preventing disorder (WHO, 2023).

Cognitive flexibility, outlined as the ability to modify perspectives, adapt to changing demands, and disengage from firm cognitive prototypes, is a central paradigm in adolescent development (Diamond, 2013; Zelazo, 2020). Reduced flexibility is allied with rumination and anxiety, whereas improved flexibility estimates adaptive coping and resilience (Dennis & Vander Wal, 2010; Gabrys et al., 2018). Executive functions that support flexibility continue to mature during adolescence, and practices strengthening attentional regulation and reducing automatic reactivity are associated with greater flexibility. Although adult studies link mindfulness with improved cognitive flexibility (Moore & Malinowski, 2009), evidence in adolescence remains comparatively limited.

Against this theoretical background, the present study advances a conceptual model of IHMPP-A and adolescent outcomes. The study was conducted with 48 mid-adolescents (24 experimental, 24 waitlist) from diverse sociocultural and ethnolinguistic backgrounds in Northeast India. The researchers employed a quasi-experimental design to evaluate the effect of the 12-week IHMPP-A in a school setting. Mindfulness was assessed using the Comprehensive Inventory of Mindfulness Experiences – Adolescents (CHIME-A), mental health with Mental Health Continuum – Short Form (MHC-SF), and cognitive flexibility with Cognitive Flexibility Inventory (CFI).

This study assesses the feasibility, acceptability, and preliminary effects of the 12-week Integrated Holistic Movement Practices Programme for Adolescents (IHMPP-A) on mindfulness, mental well-being, and cognitive flexibility of participants from diverse sociocultural and ethnolinguistic backgrounds in Northeast India. Given the amplified vulnerability to stress, anxiety, and emotional dysregulation during the period (Liu et al., 2025; Racine et al., 2021; Dahl et al., 2018), the study aims to evaluate whether the IHMPP-A can be flawlessly integrated into regular school settings to augment adolescent mindfulness levels, mental health, and cognitive flexibility.

The objectives of the present study were to evaluate the effect of IHMPP-A on adolescents' mindfulness, mental health, and cognitive flexibility, examine correlations among the three constructs, and assess whether mindfulness predicts mental health and cognitive flexibility. The study evaluates the programme efficacy while examining the associative and predictive links between these theoretically grounded variables.

The study augments the understanding of how holistic movement practices affect adolescent regulatory development by integrating embodied movement and attentional training within a culturally diverse educational context. This study's methodological rigour is upheld by the seamless alignment between its theoretical framework, conceptual specifications, and empirical design. Ultimately, these findings offer robust evidence regarding the impact and interrelationships among mindfulness, mental health, and cognitive flexibility in adolescence.

Methods

Research Design

The study employed a quasi-experimental pre- and post-test design with an equivalent waitlist group under a routine school setting. Students of Classes VIII and IX participated in the study. The University's Institutional Review Board provided the ethical approval (Ref. CU: RCEC/00654/06/24). The principal of the concerned school, participating students, and their parents/guardians rendered written informed consent. The study was conducted in accordance with the ethical principles of beneficence and equity, and participants were not denied routine educational support at the school.

Setting and Participants

The intervention was implemented in a semi-urban English medium private secondary school in Assam, Northeast India. The researchers identified the district and selected the intervention school purposively, in accordance with the inclusion and exclusion criteria. The school was chosen for its students' sociocultural diversity and for the support of its management, which helped the programme's implementation. Participants were 48 mid-adolescents (experimental = 24; waitlist = 24) from Classes VIII and IX. The Gender distribution was balanced (50% boys and girls in each group). The predominant inclusion criterion was that participants were aged 14 to 17 years (i.e., mid-adolescence) and that they were from diverse sociocultural and ethnolinguistic backgrounds. Regular school attendance was another inclusion criterion. Failure to fulfil the inclusion criteria formed the exclusion criteria for the sample selection.

Six students in all were excluded from the analytic sample (intervention n=2; waitlist n=4): two students were absent during baseline assessment (intervention n=1; waitlist n=1) due to illness or other emergency; another intervention student was excluded due to lack of parental consent to participate in the intervention (intervention n=1); and three waitlist students were excluded for nonparticipation in post-test (waitlist n=1) (Figure 1). Social demographic details such as name, class, age, gender, contact details (Email IDs / Mobile Numbers), tribe / community, and Social Economic Status (SES) were collected from the participants. SES was determined using Kuppuswamy's scale (Mandal & Hossain, 2024).

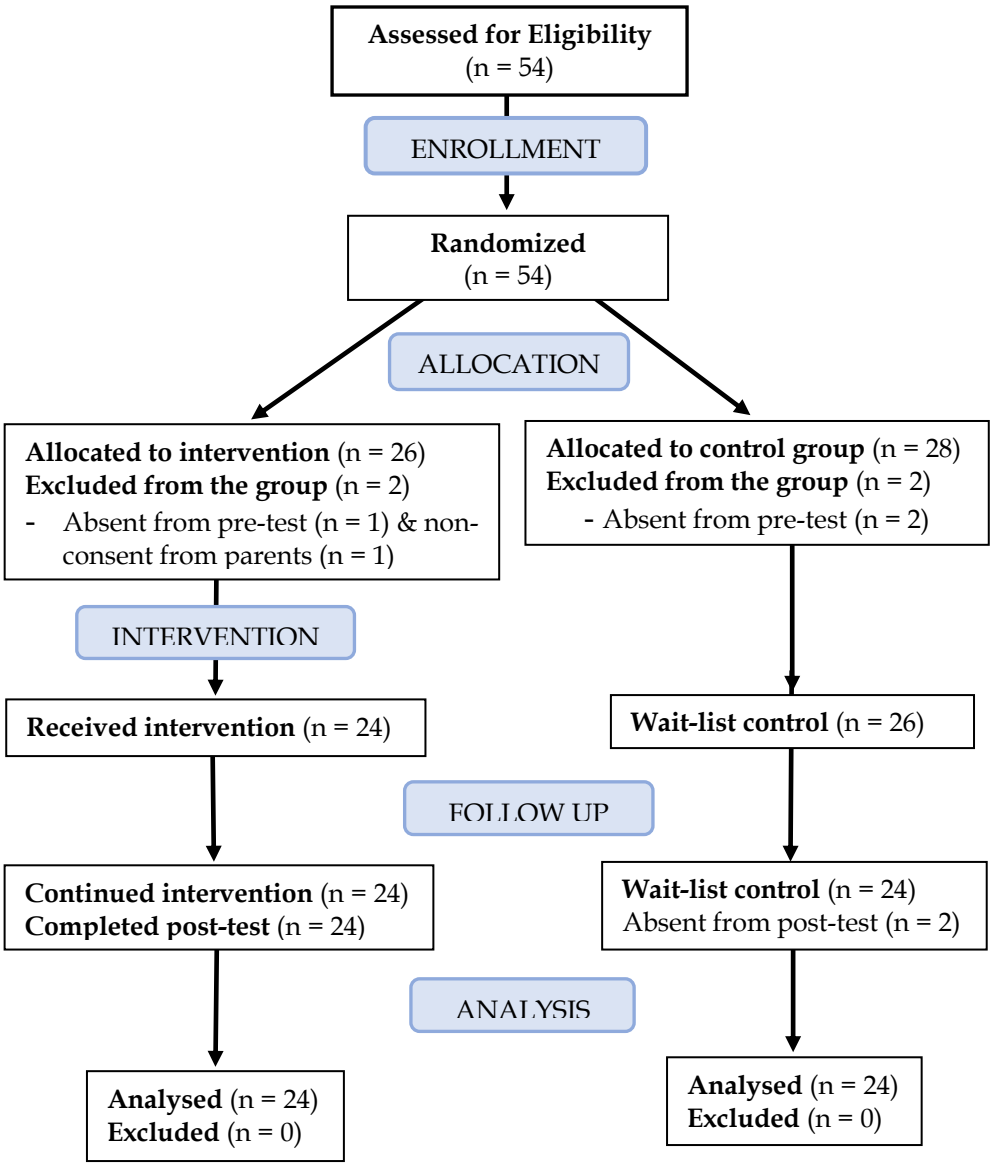

Figure 1: Flow chart

Intervention: IHMPP-A

The Integrated Holistic Movement Practices Programme for Adolescents (IHMPP-A), intended to enhance mental and cognitive well-being, consists of 12 modules, each spanning a week with three 60-minute sessions. The entire programme spans 12 weeks and comprises 36 sessions. The 12-week training, formulated to promote adolescents' overall well-being and delivered in school settings, comprises selected, validated and evidence-based yoga and mindfulness practices. Each module includes different yoga postures (*asanas*), breathing techniques (*pranayamas*), and mindfulness meditations.

The program follows the sequence listed below, every technique possessing different components (Table 1).

Table 1. Sequence of Techniques.

Sl. No.	Sequence of Techniques	Time
1	Conditioning/Preparatory Exercises	4 min
2	Flexibility/Loosening Practices	6 min
3	Yoga Postures/*Asanas*	18 min
4	Relaxation Technique	4 min
5	Breathing Techniques/*Pranayamas*	8 min
6	Mindfulness Meditation	8 min
7	Knowledge Sharing	4 min
8	Q&A/Clarifications	4 min
9	Connecting with Self & Universe	2 min
10	Reflection Exercise	2 min
	Total	60 min

Note: min = minutes.

Every module of the IHMPP-A comprised the ten components mentioned above, each of which varied in kind from module to module. The preparatory exercises included physical and mental conditioning with mindfulness-based practices that helped participants stay attentive and focused. Flexibility/loosening practices comprised warm-up exercises that incorporated diverse movements of the neck, shoulders, hands, hips, knees, and feet. The yogic postures/*Asanas* component of the programme included meditative postures, upward stretching postures, forward bending postures, backwards bending postures, sideways bending postures, etc. The IHMPP-A used the relaxation technique *Shavasana* (the corpse pose) in all 12 modules.

Every module of this integrated programme introduced learners to a different breathing technique and the following five were used as part of the pilot study: Equal Breathing, Intercostal Breathing, Clavicular Breathing, Diaphragmatic Breathing, and *Anuloma – Viloma*. Participants were also introduced to a different meditation in each module, such as: Breath Meditation, Body Scan, Senses Meditation, and Thoughts Meditation. As part of knowledge sharing, the first four modules covered the following value-based topics: *Ashtanga Yoga*, *Yama*, *Niyama*, *Triguna* and Yogic Diet.

Participants were given time to raise questions and clear their doubts in every module. Every module concluded with a mindfulness exercise. Further, students were given homework to reflect on and practice what they learned in the particular module. The first author (a certified yoga and mindfulness trainer cum practitioner) led the sessions with support from a trainer co-facilitator.

Measures

Comprehensive Inventory of Mindfulness Experiences – Adolescents (CHIME-A)

The Comprehensive Inventory of Mindfulness Experiences – Adolescents (CHIME-A) was used to measure mindfulness (Johnson et al., 2017). Composed of 25 items, the CHIME-A is organized into eight factors, namely, external awareness, internal awareness, acting with awareness, decentering and non-reactivity, openness to experience, relativity of thoughts, and insight (Johnson et al., 2017). The eight-factor structure showed good model fit, and its facets demonstrated good internal consistency (α = 0.65–0.77). CHIME-A appears to be a comprehensive tool for measuring mindfulness compared to other available instruments, given its eight dimensions (Magalhães & Limpo, 2022).

A preliminary psychometric assessment of 568 mid-adolescents (14-17 years) in Northeast India was conducted to evaluate the appropriateness of CHIME-A for use in the context (Unpublished work; Augustine & D'Souza, 2025). The inventory demonstrated good internal consistency (α = 0.95),

indicating excellent reliability and supporting its applicability among Indian adolescents.

Mental Health Continuum – Short Form (MHC-SF)
Mental Health was measured using the 14-item Mental Health Continuum – Short Form (MHC–SF). The scale assesses emotional, psychological, and social well-being, and has excellent internal consistency (α > .80) and discriminant validity in adolescents with good test-retest reliability. The psychometric properties of the scale have been validated and confirmed with adolescents in cultures and contexts across various countries, including India (Singh et al., 2015).

Cognitive Flexibility Inventory (CFI)
The Cognitive Flexibility Inventory (CFI), a widely used self-report measure, was employed to assess cognitive flexibility (Dennis & Vander Wal, 2010). CFI is a brief 20-item self-report measure with excellent internal consistency (α = 0.84 – 0.91).

Results
Descriptive statistics for mindfulness, mental health, and cognitive flexibility were initially assessed at pre- and post-test across the experimental and control groups (Table 2). There was no missing data among the 24 participants in each group, and the two groups were found to be generally equivalent and therefore comparable on all study variables at baseline.
The Shapiro-Wilk tests for all the variables in both groups at pre- and post-assessment points were non-significant (p > .05), indicating that the assumption of normality was met for each variable. The descriptive trend suggests improvement in all the variables for the experimental group and no significant change for the control group.

Table 2. Descriptive Statistics and Preliminary Analyses.

Variables	Group	Time	M	SD	*W*	*P*
Mindfulness	Experimental	Pre	65.29	1.92	.933	.114
		Post	67.37	1.49	.920	.059
	Control	Pre	65.16	1.88	.931	.103
		Post	65.20	1.81	.939	.158
Mental Health	Experimental	Pre	38.91	2.43	.923	.068
		Post	40.58	2.71	.955	.346
	Control	Pre	38.04	1.96	.927	.083
		Post	38.04	1.96	.927	.083
Cognitive Flexibility	Experimental	Pre	85.04	2.05	.959	.409
		Post	86.29	2.42	.943	.187
	Control	Pre	84.00	2.98	.934	.120
		Post	84.04	2.97	.942	.170

Note: M = mean; SD = standard deviation; W = Shapiro-Wilk statistic; p = p-value.

Pre-test inter-group analysis was conducted using independent-samples tests to determine baseline equivalence. The results (Table 3) indicate that there were no significant differences for mindfulness (t = 0.55, p = .586), mental health (t = 1.74, p = .089), and cognitive flexibility (t = 1.68, p = .100). The findings confirmed baseline equivalence and comparability between groups on all study variables.

Table 3. Baseline Equivalence between the Experimental and Control Groups.

Variables	Group	M	SD	t (p)
Mindfulness	Experimental	65.29	1.92	0.55 (.586)
	Control	65.16	1.88	
Mental Health	Experimental	38.91	2.43	1.74 (.089)
	Control	38.04	1.96	
Cognitive Flexibility	Experimental	85.04	2.05	1.68 (.100)
	Control	84.00	2.98	

Note: M = mean; SD = standard deviation; t = t-value; p = p-value.

The intra-group pre-test and post-test analyses of mindfulness, mental health, and cognitive flexibility (Table 4) showed a significant increase in mindfulness scores from pre-test (M = 65.29, SD = 1.92) to post-test (M = 67.38, SD = 1.50) for the experimental group with a large effect size (t = 10.48,

$p < .001$, $d = 1.20$). The results also indicated a significant improvement in the experimental group's mental health scores from pre-test (M = 38.92, SD = 2.43) to post-test (M = 40.58, SD = 2.72) with a medium effect size ($t = 7.49$, $p < .001$, $d = 0.65$). Similarly, cognitive flexibility scores in the experimental group significantly increased from pre-test (M = 85.04, SD = 2.10) to post-test (M = 86.29, SD = 2.42) with a medium effect size ($t = 5.15$, $p = < .001$, $d = 0.55$). In the control group, the scores did not differ significantly from pre-test to post-test, suggesting the intervention's effectiveness.

Table 4. Intra-group Pre-test and Post-test Analyses.

Variables	Group	Time	M	SD	t (p)	*d*
Mindfulness	Experimental	Pre	65.29	1.92	10.48 (< .001)	1.20
		Post	67.38	1.50		
	Control	Pre	65.17	1.88	0.25 (.802)	0.02
		Post	65.21	1.82		
Mental Health	Experimental	Pre	38.92	2.43	7.49 (< .001)	0.65
		Post	40.58	2.72		
	Control	Pre	38.04	1.97	0.00 (1.00)	0.00
		Post	38.04	1.97		
Cognitive Flexibility	Experimental	Pre	85.04	2.10	5.15 (< .001)	0.55
		Post	86.29	2.42		
	Control	Pre	84.00	2.98	0.24 (.814)	0.01
		Post	84.04	2.97		

Note: M = mean; SD = standard deviation; W = Shapiro-Wilk statistic; p = p-value.

A two-way mixed ANOVA was conducted to measure whether the pre-post effect differed by group for each outcome, namely mindfulness, mental health, and cognitive flexibility, with time (pre, post) as the within-subjects factor and Group (experimental, control) as the between-subjects factor. The analysis results (see Table 5) revealed that for mindfulness, there were significant main effects of time ($F[1, 46] = 71.30$, $p < .001$, $\eta p^2 = .608$), group ($F[1, 46] = 6.96$, $p = .011$, $\eta p^2 = .131$), along with a significant time × group interaction ($F[1, 46] = 65.70$, $p < .001$, $\eta p^2 = .588$). For mental health as well, the analysis indicated a significant main effect of time ($F[1, 46] = 36.4$, $p < .001$, $\eta p^2 = .441$), Group ($F[1, 46] = 7.98$, $p = .007$, $\eta p^2 = .148$), along with a significant time × group interaction ($F[1, 46] = 36.4$, $p < .001$, $\eta p^2 = .441$). The analysis further showed a significant main effect of time ($F[1, 46] = 10.44$, $p = .002$, $\eta p^2 = .185$), group ($F[1, 46] = 5.55$, $p = .023$, $\eta p^2 = .108$), and a significant time × group interaction ($F[1, 46] = 8.91$, $p = .005$, $\eta p^2 = .162$) for cognitive flexibility. Overall, the results showed that changes in mindfulness, mental health, and cognitive flexibility over time differed significantly across groups.

Table 5. Two-way Mixed ANOVA Results.

Outcome	Variables	*F(1,46)*	*p*	*ηp²*
Mindfulness	Time	71.3	<.001	0.608
	Group	6.96	0.011	0.131
	Time x Group	65.7	<.001	0.588
Mental Health	Time	36.4	<.001	0.441
	Group	7.98	0.007	0.148
	Time x Group	36.4	<.001	0.441
Cognitive Flexibility	Time	10.44	0.002	0.185
	Group	5.55	0.023	0.108
	Time x Group	8.91	0.005	0.162

Note: df = degrees of freedom; F = F-statistic; p = p-value; ηp^2 **=** partial eta-squared.

The post hoc assessments provided consistent evidence of the intervention's effect across mindfulness, mental health, and cognitive flexibility (see figure 1). The experimental and control groups

in each case were equivalent at baseline (p = .947, .317, and .344, respectively). The experimental group significantly improved across the three outcome variables from pretest to posttest (p < .001), while the control group did not show any significant change (p = .995, 1.00, and .998, respectively). Moreover, the experimental group scored significantly greater than the control group from pretest to posttest (p < .001, .003, and .030, respectively). The overall findings suggest that the intervention had a significant positive impact on adolescents' mindfulness, mental health, and cognitive flexibility.

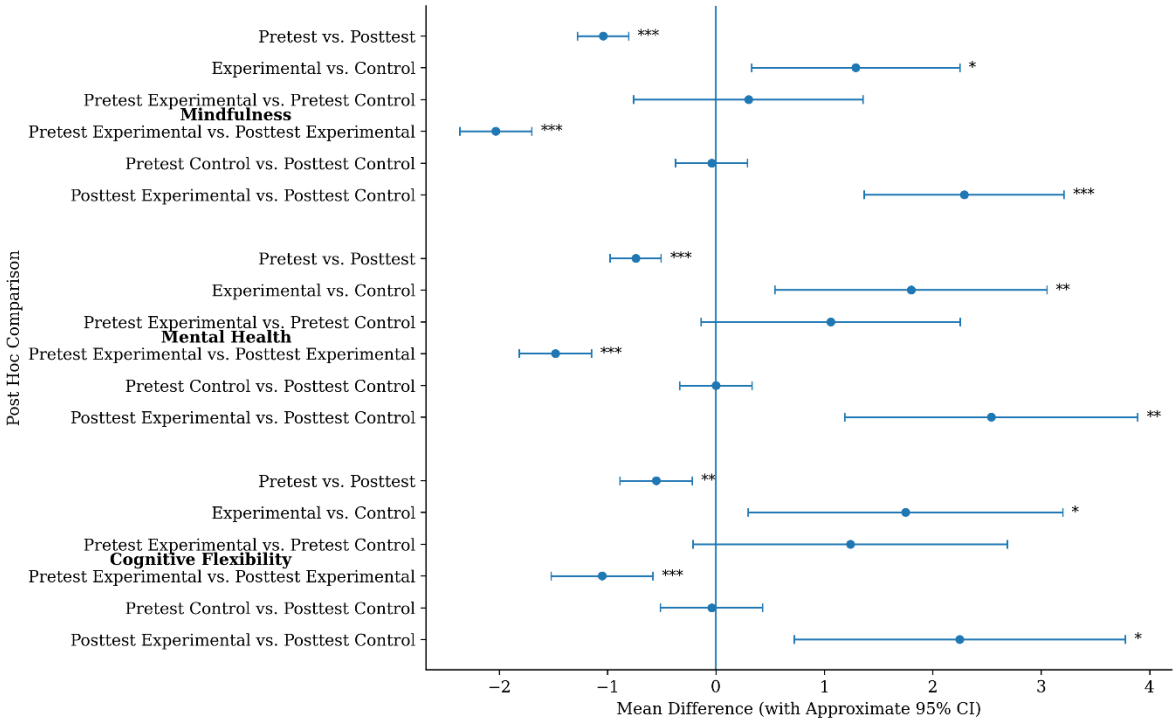

Figure 1. Post Hoc Comparisons for Mindfulness, Mental Health, and Cognitive Flexibility

Note. Points represent mean differences; horizontal lines represent approximate 95% confidence intervals computed as mean difference ± 1.96 x SE. Asterisks indicate statistical significance (*p < .05, **p < .01, *** p < .001). Negative pretest-posttest values indicate higher posttest scores.

The analysis results strongly support the intervention's effectiveness across the dependent variables of mindfulness, mental health, and cognitive flexibility. The significant Time x Group interactions for all three outcomes demonstrate that the improvements were specific to the experimental group and cannot be ascribed to an overall change over time.

Discussion

The present study examined the effect of the Integrated Holistic Movement Practices Programme for Adolescents (IHMPP-A) on their mindfulness, mental health, and cognitive flexibility, employing a quasi-experimental pre-post waitlist group design. The experimental group showed significant pre-post gains over the three outcome variables, whereas the waitlist group remained mostly stable. The intervention had a greater effect on mindfulness and mental health, indicating that the programme is specifically effective at augmenting present-moment awareness and psychological well-being. Cognitive flexibility also had a significant improvement, suggesting a moderate yet meaningful impact. The significant gains observed in the experimental group over time are a reliable indication of the intervention's effectiveness, given the baseline equivalence of the groups and the control group's stability across time.

This research signifies adolescence as a sensitive period of rapid neurobiological and psychosocial development, heightened learning and adaptation, and cognitive, emotional, and social changes with significant implications for intervention and prevention (Racine et al., 2021; Dahl et al., 2018; Blakemore & Mills, 2014). It further underscores the vital roles that context and exposure play in adolescent brain development, consistent with multilevel regulatory accounts (Galvan, 2021). In this developmental perspective, the study unfolds how

self-regulatory skills are consequently developed within multifaceted social environments and interoceptive systems (Casey et al., 2019). The IHMPP-A effects, from this perspective, echo the possibility of meaningful emergence of regulatory capabilities during the developmental and vulnerable adolescent period through attentional regulation, affect control and cognitive adaptability.

The study's theoretical underpinning in embodied cognition clearly explicates how a multi-component HMP intervention leverages physical, mental, and cognitive outcomes. Cognition, understood as emerging from sensorimotor engagement and interoceptive processes as per embodied cognition (Shapiro, 2011), HMPs combine physical movement and meditative practices to leverage physical, mental and cognitive changes (Schmalzl et al., 2014). Embedded in philosophies of holistic well-being, HMPs are operationalised through the core components of synchronized movements, breath control, and attentional regulation.

Yoga and mindfulness-based embodied approaches converge on the central trail of improved self-regulation. While mindfulness exercises are known for the beneficial effects of attention regulation, emotion control, and self-awareness (Tang et al., 201), yoga practices leverage 'top-down' and 'bottom-up' bidirectional integration through interoceptive and autonomic regulation, enhancing mental and cognitive well-being (Gard et al., 2014). Complementary evidence shows that mindfulness and interoceptive awareness are intertwined, plausibly implicating psychological well-being (Gibson, 2019; Price & Hooven, 2018).

Interpreting the findings of the present study through the embodied cognition lens, mindfulness improvements indicate enhanced attention and interoceptive awareness obtained through consistent practice of focused attention, ingrained in movement and breath. Mental health gains reflect self-regulation benefits, especially in emotion regulation, stress reduction, and responding adaptively in daily situations (Keyes, 2005; Tang et al., 2015). And cognitive flexibility benefits align with the theoretical perspective that cognitive functions are supported by interventions which reduce bottom-up influences and strengthen reflective control processes (Diamond, 2020; Zelano, 2020).

Intervention research in general provides an intricate background for discussing the present findings. Meta-analyses on MBIs suggest improvements in mental and cognitive outcomes, although the reported effects are only small to moderate and heterogeneous across results, samples and methods (Dunning et al., 2019; Klingbeil et al., 2017; Zoogman et al., 2015). And MBIs in school settings indicate promise in enhancing educational outcomes, but results differ by context, fidelity, facilitator experience, etc. (Mettler et al., 2023). Simultaneously, certain large-scale rigorous school-based trials report mindfulness training as not superior to teaching-as-usual, questioning 'what works, for whom, and under what conditions' (Kuyken et al., 2022).

The relatively robust pattern found in this present study, against the mixed background, points to the relevant design and programme content, instead of just 'mindfulness vs no mindfulness' interventions. First, IHMPP-A is movement-ingrained and aligned with embodied meditative practices than classroom-based mindfulness curricula (Schmalzl et al., 2014; Vergeer et al., 2021). Second, relevant adolescent evidence indicates that meditative movement and contemplative practices are effective in augmenting working memory and associated neural outcomes (Kang et al., 2020; Quach et al., 2016). Third, emerging school-based studies on yoga and mindfulness among adolescents report potential benefits for mental and cognitive outcomes, while noting challenges with delivery and fidelity (Bazzano et al., 2022; McCurdy et al., 2024). Studies further recommend integrating yoga and mindfulness programmes into school curricula to promote mental well-being among adolescents (Cerda et al., 2023). Finally, adolescents perceive yoga and mindfulness as acceptable when embedded in routine school settings in a developmentally and contextually sensitive manner (Sumner et al., 2025).

Theoretical and Practical Implications

Theoretically, the pattern of significant improvements in mindfulness, mental health, and cognitive flexibility is consistent with the study's proposed multi-level regulatory framework informed by embodied cognition. So to say, holistic practices that train attention and awareness through movement and breath influence multiple regulatory systems across physiological, mental, and executive control processes (Gard et al., 2014; Tang et al., 2015). Significantly, observed mental health outcomes are interpretable within the multi-dimensional model of mental health: mental health is not the absence of symptoms but the flourishing of emotional, psychological, and social well-being (Keyes, 2005).

The findings of this study may have a far-reaching impact given the substantial global burden of mental health challenges among adolescents. Interventions that can be integrated into existing school curricula

and leverage embodied engagement may strengthen everyday self-regulation, especially within constrained school resources. However, as the broader literature highlights, implementation requirements such as facilitator training, fidelity, engagement, and context must be addressed to ensure outcome benefits and generalizability.

Limitations and Future Directions

Although the study contributes to the evidence base on the effects of HMPs, several limitations must temper the interpretation. The study's findings are based on a short-term pre-post examination without a long-term follow-up. Not being able to infer the durability of gains is an issue here, as in several other school-based yoga and mindfulness studies. Although theoretically grounded, mechanistic interpretations remain empirically unverified without direct measurement of hypothesised mechanisms, such as interoceptive awareness, autonomic regulation, and emotion regulation processes.

Adequately powered randomised trials would benefit future research by enabling active comparators, measuring implementation fidelity, and multi-method assessment. Such designs will explicitly test whether embodied mechanisms proposed in yoga and mindfulness models mediate adolescent well-being outcomes. Further, future work must examine sociocultural moderators, given the strong evidence that context shapes adolescent development.

Conclusion

The present study contributes to the emerging evidence on the impact of HMPs on adolescents' mental and cognitive well-being. The findings indicate how engaging in HMPs is associated with positive developmental outcomes that extend beyond physical benefits to encompass psychological and executive spheres. The observed results show that integrated HMP interventions offer the potential to enhance adolescents' self-regulatory capabilities, mental well-being, and adaptive thinking.

The results pattern provides a sound basis for considering HMPs as an empirically relevant and pedagogically feasible intervention in school settings to promote student well-being. The study is significant in displaying that embodied holistic practices can yield measurable outcomes in educational contexts. The findings gather relevance in the context of adolescent mental health challenges globally, and the call for school-based developmentally responsible, scalable and preventive interventions.

However, methodological caution is needed when interpreting the results, especially regarding baseline differences, implementation fidelity, and contextual mediators. Randomised controlled trials, longitudinal follow-up, and mixed-method designs will benefit future studies to explore causal mechanisms, outcome durability, and adolescents' experience and internalisation of HMP processes. As a whole, IHMPP-A is a theoretically strong and practically sound intervention with considerable educational, psychological, and health scholarship.

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Declaration of Conflicting Interests

We declare that there are no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Statement of Informed Consent and Ethical Approval

Ethical approval for the study was obtained from the Institutional Review Board of CHRIST University, Bangalore (Ref. CU: RCEC/00654/06/24). Written informed consent was obtained from the school principal, the participants and their parents/guardians. The study was conducted in accordance with the principles as enunciated in the Declaration of Helsinki.

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