



Review Article

Effect of yoga and mindfulness on psychological correlates in young athletes: A meta-analysis



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ABSTRACT

Background: This meta-analysis planned to assess the impact of yoga and mindfulness practice in reducing stress and anxiety to improve athletes' sports performance.

Methods: Several databases were electronically searched for eligible articles till September 2022. Participants aged 18–45 yrs, male and female, and recreational athletes from different sports were included. Athletes' stress, competitive anxiety, and sports performance were measured. The mean difference or standardized mean difference with a 95% confidence interval was calculated in RevMan software 5.4. The fixed effect model was applied to test the statistical significance difference and heterogeneity ($p < 0.05$). The GRADE pro evidence was also created to assess the quality of evidence.

Results: Results were analyzed with pooled data from fifteen articles. Forest plots showed an overall significant effect of yoga and mindfulness on Mindfulness [$Z = 4.13$ ($p < 0.0001$)] [$I^2 = 48\%$], MD -2.6 , (95% CI, $-3.85, -1.37$)] and flow state [$Z = 9.49$ ($p < 0.00001$)] [$I^2 = 85\%$], SMD 3.13, (95% CI, 2.48, 3.77)]. The insignificant effects were noted on attention and awareness [$Z = 1.51$ ($p = 0.13$)] [$I^2 = 25\%$], SMD -0.26 , (95% CI, $-0.60, 0.80$)], and action and acceptance [$Z = 0.43$ ($p = 0.67$)] [$I^2 = 0\%$], MD 0.20, (95% CI, $-0.69, 1.08$)]. We also observed a significant effect for the comparison of stress [$Z = 6.56$ ($p < 0.00001$)] [$I^2 = 76\%$], SMD -0.74 , (95% CI, $-0.97, 0.52$)] and an insignificant effect for comparing anxiety [$Z = 1.62$ ($p = 0.11$)] [$I^2 = 14\%$], SMD -0.31 , (95% CI, $-0.69, 0.07$)].

Conclusion: The findings of this meta-analysis provides valuable insights to the beneficial or complementary effects of yoga and mindfulness on athletes' psychological health and sports performance.

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1. Introduction

Accumulating evidence from the past reflects that physical activity is very closely associated with athletes' psychological health [1]. Sports activities have many benefits, but the competitive nature can cause and exacerbate some psychological issues in athletes. A few personality traits help achieve success but may be associated with psychological problems in athletes. Athletic culture can also target athletes' psychological health and performance [2]. Data from the American College of Sports Medicine indicates that nearly

35% of elite athletes suffer from psychological issues (disordered eating, burnout, depression, or anxiety) [3]. Previous studies reported that almost 17.2%–31% of student-athletes had moderate to severe symptoms of stress and anxiety [4,5]. Another study in Canada noticed the prevalence of depressive and anxiety symptoms in athletes by 37.9% and 24.9% of the participants, respectively [6]. Several psychological strategies assist athletes in coping with their challenges and maintaining psychological health. These psychological strategies enhance athletes' performance in stressful and hostile situations [7]. Over the last decades, many performance enrichment activities have evolved in applied sport psychology. However, certain factors, such as psychological health, stress, and anxiety, affect the athletes' field performance [1,8]. Recently, mindfulness interventions have been introduced in the sports world to reduce stress and performance anxiety and enhance

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athletes' sports performance, which can help them achieve their targets as per the goal. Mindfulness techniques teach them to tolerate stress and change their relationship with anxiety. These techniques increase awareness and acceptance of internal states (emotions, thoughts) and adapt them to develop a nonjudgmental attitude toward their performance. Mindful sports performance enhancement by meditation emphasizes somatic awareness and the conservative movement [9]. These practices create core attention and build bridges between proper mindfulness practice and daily activities in their sports performance [10]. Mindfulness practice is not separate from yoga; even that combination enhances effectiveness [7]. Hatha yoga is potent in connecting the body with the mind by accepting the body's physical state and limits and enhancing mindful awareness [7]. Integrating mindfulness-based programs with yoga practice also yielded the most positive effects on psychological health [11]. Yoga consists of several components, such as physical postures, meditation practice, and breathing exercises outlined to balance physical and mental health [12]. The available literature on yoga and Mindfulness's effectiveness creates contradictory results due to inherent methodological shortcomings. This scenario directed to pool the data from available experimental studies and generate new findings for further experiment and research. This meta-analysis planned to assess the effectiveness of yoga and mindfulness practice in reducing stress and anxiety to improve athletes' sports performance.

2. Materials and methods

2.1. Data source

A systematic electronic search was conducted across the following databases to identify relevant studies up until September 2022: MEDLINE, PubMed, Embase, CENTRAL, CINAHL, Cochrane, Scopus, Google Scholar, Web of Science, ResearchGate, Clinical Key, Academia, and the International Clinical Trials

Registry Platform (ICTRP). No time, region, or publication date/type restrictions were applied. The only limitation was applied to the English language.

2.2. Search strategy

2.2.1. PubMed search history

(athlete*) OR (players[MeSH Terms]) OR (physical[MeSH Terms]) AND (health* OR adult*) AND Mindful* OR meditate* OR yoga OR (yoga[MeSH Terms]) OR (posture*) (sport* OR train* OR exercise* OR intervention* OR perform* OR capacity OR skill* OR (meditation[MeSH Terms]) OR (mindfulness[MeSH Terms]) AND (performance[MeSH Terms]) OR (sports performance)) OR (stress)) OR (anxiety)) OR (Acceptance)) OR (action)) OR (awareness)) OR (AQLQ score)) OR (flow [MeSH Terms]) Cochrane search strategy has been displayed in Table 1.

3. Study selection as per the PICO framework

3.1. Participants

3.1.1. Inclusion

Age group between 18 and 45 years, both gender-male and female, and recreational athletes from sports (Curling, Volleyball, Basketball, Swimming, Football, Cricket, Wrestling, Badminton, Skating, Kabaddi Tennis, and Hockey) were included.

Exclusion Criteria were a likely severe psychiatric disorder (schizophrenia, mania, bipolar disorders OCD), chronic illness (diabetes mellitus, hypertension, allergic asthma, tuberculosis.), endocrine or metabolic disorders (hypothyroidism or hyperthyroidism), substance abuse, disability, and history of using psychotropic drugs, and smoking, less than four hours of athletic training per week, previous experience with yoga or mindfulness training, or being younger than 18.

Table 1
Cochrane search record.

I.D.	Search	Hits
#1	players	3754
#2	MeSH descriptor: [Football] explode all trees	307
#3	Cricket	101
#4	MeSH descriptor: [Cricket Sport] explode all trees	5
#5	Volleyball	425
#6	MeSH descriptor: [Volleyball] explode all trees	88
#7	Basketball	761
#8	MeSH descriptor: [Basketball] explode all trees	207
#9	Yoga	4814
#10	MeSH descriptor: Yoga] explode all trees	843
#11	Pranayam	72
#12	Breathing exercise	5366
#13	MeSH descriptor: [Breathing Exercises] explode all trees	1011
#14	cognitive	87,940
#15	Mindful*	
#16	MeSH descriptor: [Mindfulness] explode all trees	11,786
#17	aggression	4025
#18	MeSH descriptor: [stress] explode all trees	1444
#19	Motivation	15,646
#20	MeSH descriptor: [performance] explode all trees	9377
#21	attention	38,069
#22	MeSH descriptor: Attention] explode all trees	5632
#23	Electroencephalogram	4045
#24	MeSH descriptor: [anxiety] explode all trees	5348
#25	Tiredness test	636
#26	Awareness	1
#27	MeSH descriptor: [acceptance] explode all trees	1553
#28	#1 OR #3 OR # 5 OR #7 OR #9 OR #11 OR #12 OR #14 OR #15 OR19 OR #21 OR #23 OR #25 OR #26	934,983

3.1.2. Intervention

Studies with yoga (pranayama, postures, and meditation) or mindfulness intervention were included.

3.1.3. Comparison

The comparison group included no intervention group or usual care.

3.2. Measured outcomes

3.2.1. Sport performance

Sports performance was assessed with the flow state, action, awareness, attention, and acceptance. The following questionnaires were used to determine the outcomes.

- Five Facet Mindfulness Questionnaire (FFMQ)**—The 39 items of the FFMQ measure dispositional Mindfulness using a 5-point Likert scale. Point – 1 for never or very rarely accurate) to point 5 (Very often or always true). The instrument has five subscales: observing, describing, nonjudging of inner experience, acting with awareness, and nonreactivity to inner experience [13].
- Acceptance and Action Questionnaire-II (AAQ-II)**—The AAQ-II is a seven-item measure of psychological inflexibility and experiential avoidance. The 7-point scale ranges from 1 to 7 (1 for never true to 7 for always true) [14].
- Mindfulness Attention Awareness Scale (MAAS)**- This tool consists of 15 items. It was designed to measure trait mindfulness, the aptness to be aware of internalized and environmental experiences. Responses were noted on a 6-point Likert scale from (1 for almost always to 6 for almost never. The higher scores reflected the athletes' tendency and proficiency in mindfulness practice. Internal consistency was good ($\alpha = 0.87$), and reliability was 0.81 [15].
- Short Flow State Scale (SFSS)** -The scale was used to evaluate the flow state after the end of an activity. The 5-point Likert scale scoring was used to measure the response. Lower scores indicate a lower flow state. The scale consists of several dimensions of flow state: action awareness, clear goal, clear feedback, challenge skill balance, focusing on the task with hands, sense of control, time conversion, loss of self-awareness, and enjoyable experience. The internal consistency coefficient was 0.73 [16].

3.3. Athletes stress

The Perceived Stress Scale (PSS) was applied to assess the stress level of athletes. This 10-item questionnaire measured global stress based on the subject's perception of stress in the past week. It was measured on a 7-point Likert-type scale from (0 for never to 6 very often. Internal consistency was $\alpha = 0.74$. The scale also measured participants' everyday stress experiences [17].

3.4. Competitive anxiety

Competitive State Anxiety Inventory-2 was used to measure the anxiety level of athletes. A 4-point Likert scoring system was adopted; in this scale, responses were "1" (not at all) and "4" (very strong). This tool indicates lower the value, the lower the athlete's anxiety level. This tool has 27 items: cognitive state anxiety, physical state anxiety, and state self-confidence. The internal consistency coefficient was 0.72 [18].

3.5. Study design

Only experimental trials (randomized controlled trials, quasi-experimental trials) were included for analysis.

3.6. Preferred reporting

This meta-analysis followed the PRISMA guidelines to measure the impact of yoga and mindfulness on physical athletes' stress, anxiety, and sports performance [19]. (Fig. 1).

3.7. Screening

The authors conducted a thorough search across various databases and then proceeded to screen the available articles by evaluating their titles and abstracts. Duplicate reports were also removed at this stage. After the first screening of the articles, files were moved from the Zotero library to Rayyan (<https://rayyan.qcri.org/>), free web-based software used to review articles. Two authors further independently screened the available articles related to the inclusion and exclusion criteria of the study. The third author resolved any discrepancy related to the inclusion of articles. In a condition of non-availability of full text and required estimable data, corresponding authors were contacted through emails. Consequently, selected articles were explored to get information on the study's participants, intervention, comparison, publication year, location, sample size, types of sample selection, and outcomes (Table 2).

3.8. Data extraction

A narrative synthesis noted the outcomes, variations on intervention, types, and outcomes measurement from the relevant searched articles. Data were extracted from the eligible articles and pooled into the Review manager (RevMan) software 5.4 to analyze the data and generate the results [35]. A fixed-effect model was applied to compute significant differences and statistical heterogeneity, considering the p-value <0.05. For calculating statistical heterogeneity as low, moderate, and high grades, I^2 statistics 25, 50, and 75% were considered, respectively [36].

For continuous variables, mean difference or standardized mean difference with a 95% confidence interval were calculated from the extracted data in the Review manager (RevMan) software 5.4. The GRADE pro evidence was also created to assess the quality of evidence [37]. Sub-group analysis was difficult to apply due to the limited article availability for each outcome. Sensitivity analyses were also performed for each outcome to minimize the heterogeneity in results.

3.9. Risk of bias assessment

Risk of bias assessment was done with the following subheads blinding (masking) of participants, researcher and outcomes, allocation concealment, randomization details, data outcome, and data reporting (Fig. 2). The authors independently evaluated the risk of bias, and any disagreements were resolved with the third author. Based on the assessment, a summary of the finding table was also created with GRADEpro GDT software (Table 3). Funnel plots representing publication bias in included articles (Figs. 3–5).

4. Results

4.1. The flow of the study

A total of 984 articles were identified after searching from several search engines. Seven hundred ninety duplicate articles were removed. Thirty-seven articles were removed due to different study designs—methodological reasons. Twenty-five articles were removed because they involved experimentation with individuals in the adolescent age group. Seven articles were either protocols or

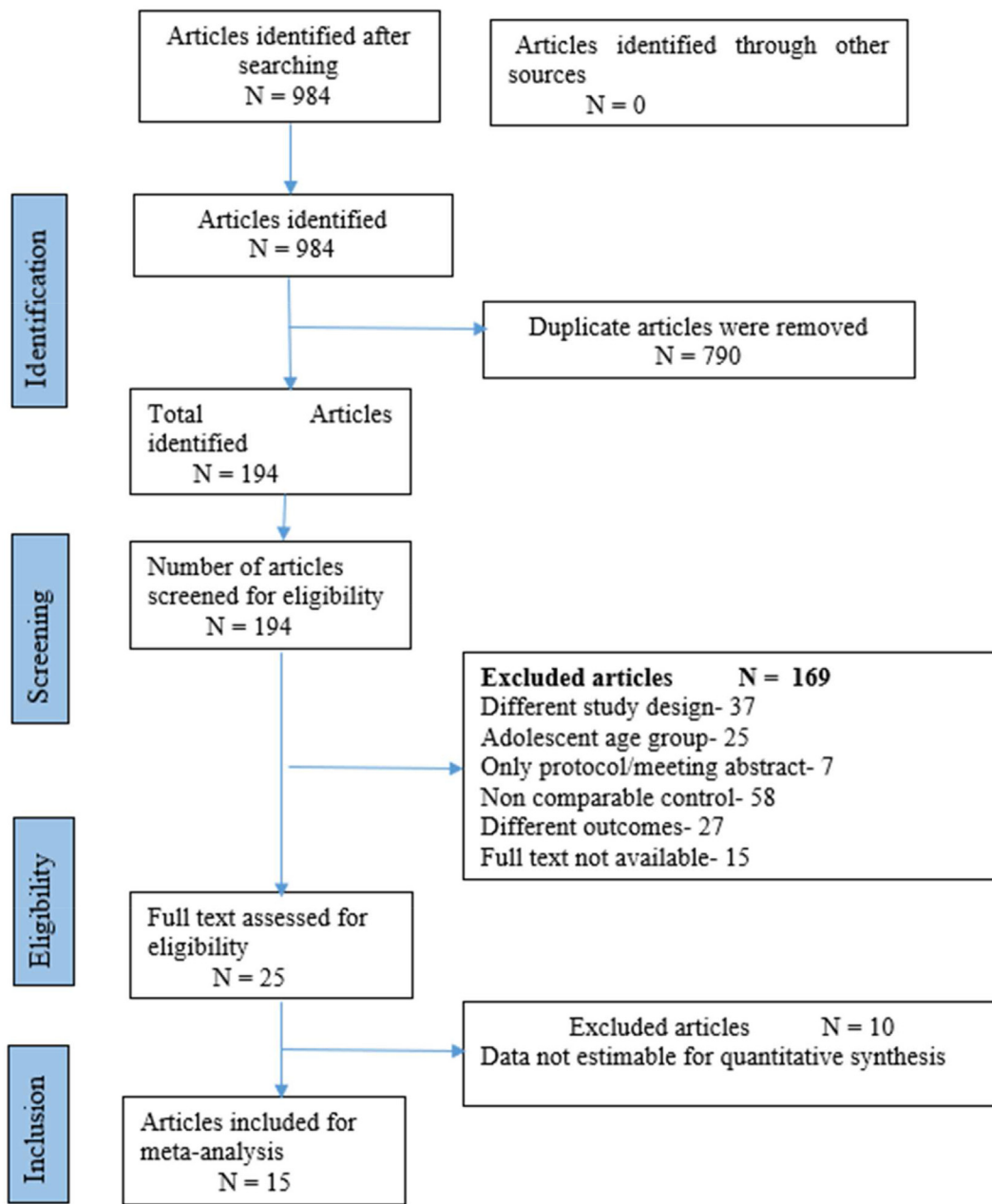


Fig. 1. Flow chart illustrating according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) process.

meeting abstract papers. Fifty-eight articles were removed because they had noncomparable control per the inclusion criteria. Twenty-seven articles had similar interventions and participants but different outcome analyses. In the present study, the full text of all selected articles was available except for fifteen articles, so the same articles were excluded. Fifteen articles were chosen for the meta-analysis; ten studies were not estimable for quantitative data synthesis, so only fifteen were included. PRISMA flow chart is presented in Fig. 1.

4.2. Characteristics of included studies

The total fifteen articles included in the meta-analysis were randomized controlled and quasi-experimental trials. Seven articles [Goodman (2014), Dehghani M (2018), Ning (2022), Liang (2021), MehraSafar (2019), Scott–Hamilton, (2016), and Saini

(2021)] were Randomized controlled trials. Eight articles [Harita (2022), Kusuma (2017), Chen (2019), Cherup (2019), Grilli (2022), Carmody (2008), Xu (2022), and Vidic (2018)] were quasi-experimental trials.

Four articles were conducted on the Chinese population, two on the Indonesian people, three articles on the United States, one in Canada, one on the Indian population, and one in Australia, two articles on Iran, and one article included African, American, Caucasian, and other population. All included studies have standard or usual care in the control group.

4.3. Sport performance

Sport performance of physical athletes was assessed with the flow state, action, awareness, attention, and acceptance. The following questionnaires were used to evaluate the outcomes.

Table 2
Study characteristics.

First author and year of the study	Study design	Setting	Participants' Intervention/ Control	Participant's Age Mean (S.D.)	Intervention	Comparison	Outcomes
Goodman 2014 [20]	RCT	Participants were African, American, Caucasian, and other	13/13	Intervention group; 20.23 (1.53)	90-min group intervention sessions immediately followed by 1-hr Hatha yoga sessions- 5 Weeks	Control group	Acceptance and Action Questionnaire Version-II (Experiential avoidance) Mindful Attention and Awareness Scale Perceived Stress Scale Action and Acceptance Questionnaire (AAQ)
Dehghani M, 2018 [21]	RCT	Iran	15/16	Intervention group; 23.44 (0.49) years/control group; 22.34 (0.34) years	Mindfulness-Acceptance-Commitment (MAC) for eight sessions	Control group	Five Facet Mindfulness Questionnaire Competitive State Anxiety Inventory Flow state scale Competitive State Anxiety Inventory Competitive State Anxiety Inventory
Ning, 2022 [22]	RCT	China	24/24	Intervention group; 22.34 (2.17) years	Psychological training mode (MAIC training)	Control group	Five Facet Mindfulness Questionnaire Competitive State Anxiety Inventory Flow state scale Competitive State Anxiety Inventory Competitive State Anxiety Inventory
Liang, 2021 [23]	RCT	China	14/10	Intervention group; 20.85 (1.46)/control group; 21 (1.16)	30-min -convenient progressive relaxation training (PRT)- 4 Weeks	Control group	Competitive State Anxiety Inventory Competitive State Anxiety Inventory
Mehrsafar, 2019 [24]	RCT	Iran	13/13	Intervention group:M = 24.6, (2.5) years, control group: 26.2, (2.3) years	An 8-week Mindfulness-based intervention	Control group	Competitive State Anxiety Inventory
Scott-Hamilton, 2016 [25]	RCT	Australia	27/20	Intervention group: 38.96, (12.4)/Control group:40.65, (10.88)	Eight-week mindfulness meditation intervention	Control group	Five facet mindfulness questionnaires
Saini, 2021 [26]	RCT	India	28/28	NA	Yogic intervention on (pranayama and meditation)	Control group	Perceived stress scale
Harita, 2022 [27]	Pre-post experimental trial	Indonesia	28	N.A.	Mindfulness Sports Performance Enhancement (MSPE) training- 6 weeks	N.A.	Competitive State Anxiety Inventory
Kusuma, 2017 [28]	Quasi-experimental	Indonesia	10/10	NA	Training for three days a week for six weeks in total, with 1 h in each practice for eight weeks	N.A.	Competitive State Anxiety Inventory
Chen, 2019 [29]	Pre-post experimental trial	China	21	26.38 (2.60)	Four weeks-Mindfulness training includes meditation, body scan, or yoga (Extended sitting and walking meditations).	N.A.	Competitive State Anxiety Inventory Mindful Attention and Awareness Scale Flow state scale Five Facet Mindfulness Questionnaire Perceived stress scale
Cherup, 2019 [30]	Pre-post	United States	17	19.59 (1.09)	MAC program, along with (Body scan, progressive muscle relaxation, breathing exercises, walking meditation, imagery, yoga-type stretching) 12 sessions	N.A.	Five Facet Mindfulness Questionnaire Perceived stress scale
Grilli, 2022 [31]	Pre-post experimental trial	Canada	13	19 (1.77)	Practiced yoga individually on average nearly once a week (yoga nidra, savasana)	N.A.	Five Facet Mindfulness Questionnaire Competitive State Anxiety Inventory Perceived stress scale Five Facet Mindfulness Questionnaire
Carmody, 2008 [32]	Pre-post experimental trial	United States	121	47.05 (10.26)	Mindfulness-Based Stress Reduction –8 weeks	N.A.	Perceived stress scale Five Facet Mindfulness Questionnaire

(continued on next page)

Table 2 (continued)

First author and year of the study	Study design	Setting	Participants' Intervention/Control	Participant's Age Mean (S.D.)	Intervention	Comparison	Outcomes
Xu, 2022 [33]	Quasi experimental trial	China	39/41	Intervention group: 17.7 (0.8) Control group: 16.4 (0.5)	Yoga intervention on functional movement patterns and Mindfulness- 12 weeks (Surya Namaskara, Standing Postures: Standing forward bend, Triangle, Extended triangle, Side angle, Extended side angle, Corpse pose, Spinal theme: Crow, Cat, Seal, Sphinx, Tadpole, Heart-melting pose, Finishing Postures: Wheel pose, Bowing pose, Eagle, Cow-faced pose, Reverse praying, Eye of the needle pose, Heart-melting pose, Twisted root, Open wing) Six-one hour mindfulness meditation-based intervention sessions	Control group	Mindful Attention and Awareness Scale
Vrdic, 2018 [34]	Pre-post experimental trial	United States	18	19.56 (1.19)		N.A.	Perceived stress scale

4.4. Five Facet Mindfulness Questionnaire (FFMQ)

The comparison of mindfulness effects in experimental and control groups through forest plot is illustrated in Fig. 6. It included six studies, such as Carmody (2008), Grilli (2022), Cherup (2019), Scott Hamilton (2016), Chen (2019), and Ning (2022). During sensitivity analysis, One study by Ning (2022) was removed from the final comparison. A total of 391 participants were included. Results showed an overall significant effect [Z = 4.13 (p < 0.0001)] for the comparison of Mindfulness in both groups. Heterogeneity [(I² = 48%), Chi² = 7.65, df = 4] was significantly moderate in included studies. The mean difference in both groups with the fixed effect model [MD -2.6, (95% CI, -3.85, -1.37)] favors the experimental group. Grade pro evidence also showed moderate evidence for intervention effectiveness compared to control. Table 3.

4.5. Mindfulness Attention Awareness Scale (MAAS)

A comparison of physical athletes' sports performance with Mindful Attention Awareness in experimental and control groups through a forest plot is given in Fig. 7. It included three studies, such as Goodman (2014), Deghani (2018), and Xu (2022). Due to low heterogeneity in the result, sensitivity analysis was not required. A total of 137 participants were included. Results showed an overall insignificant effect [Z = 1.51 (p = 0.13)] for both groups' attention and awareness comparison. Heterogeneity [(I² = 25%), Chi² = 2.66, df = 2] was significantly moderate in included studies. The standardized mean difference in both groups with the fixed effect model [SMD -0.26, (95% CI, -0.60, 0.80)] favors the experimental group. Grade pro evidence also showed low evidence for intervention effectiveness compared to control. Table 3.

4.6. Acceptance and Action Questionnaire-II (AAQ-II)

A comparison of athletes' sports performance with action and acceptance in experimental and control groups through forest plots is given in Fig. 8. It included two studies, Goodman (2014) and Deghani (2018) both of which were randomized controlled trials. A total of fifty-seven participants were included. Results showed an overall insignificant effect [Z = 0.43 (p = 0.67)] for comparing action and acceptance in both groups. Heterogeneity [(I² = 0%), Chi² = 0.09, df = 1] was significantly low in included studies. The mean difference with the fixed effect model [MD 0.20, (95% CI, -0.69, 1.08)] was inconsistent in both groups. Grade pro evidence also showed low evidence for intervention effectiveness compared to control. Table 3.

4.7. Short Flow State Scale (SFSS)

Fig. 9 compared athletes' sports performance with flow state in experimental and control groups through forest plots. It included two studies, Chen (2019) and Ning (2022). One study [Ning (2022)] was a randomized controlled trial, and another study [Chen (2019)] was a pre-post experimental trial. A total of ninety participants were included. Results showed an overall significant effect [Z = 9.49 (p < 0.00001)] for the comparison of flow state in both groups. Heterogeneity [(I² = 85%), Chi² = 6.71, df = 1] was significantly higher in included studies. Sensitivity analysis was not possible due to limited studies in the investigation. The standardized mean difference with the fixed effect model [SMD 3.13, (95% CI, 2.48, 3.77)] favors the experimental group over the control group. Grade pro evidence also showed low-level evidence for intervention effectiveness compared to control. Table 3.

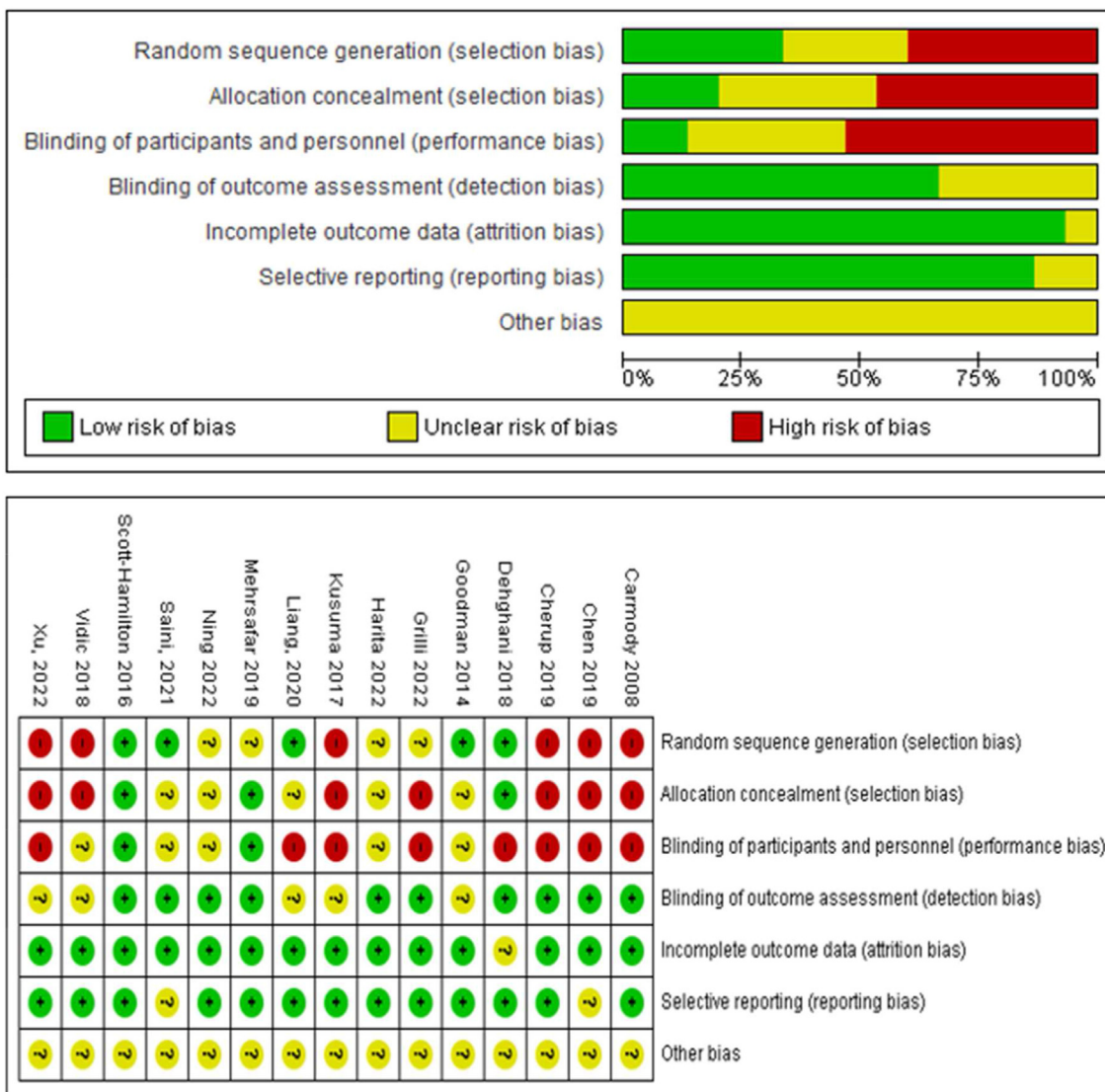


Fig. 2. Risk of bias graph including summary: review authors' judgments on the risk of bias for items presented as percentages across all included studies.

4.8. Athletes stress

4.8.1. Perceived stress scale

Fig. 10 compares stress in experimental and control groups through forest plots. It included five studies such as articles [Goodman (2014), Cherup (2019), Carmody (2008), Vidic (2018), and Saini (2021)]. During sensitivity analysis, one study by Saini (2021) was removed from the final comparison. A total of 338 participants were included. Results showed an overall significant effect [Z = 6.56 (p < 0.00001)] for the comparison of stress in both groups. Heterogeneity [(I² = 76%), Chi² = 12.32, df = 3] was significantly higher in included studies. Sensitivity analysis was not possible due to limited studies in the investigation. The standardized mean difference with the fixed effect model [SMD -0.74, (95% CI, -0.97, 0.52)] favors the experimental group over the control group. Grade pro evidence also showed low evidence for intervention effectiveness compared to control. Table 3.

4.9. Competitive anxiety

4.9.1. Competitive state anxiety inventory

Fig. 11 compared athletes' anxiety in experimental and control groups through forest plots. It included seven studies as articles [Ning (2022), Liang (2021), Mehrafsar (2019), Harita (2022), Kusuma (2017), Chen (2019), Grilli (2022)]. [Ning (2022), Liang (2021), and Mehrafsar (2019) were Randomized controlled trials. The other four were quasi-experimental trials. Mehrafsar (2019) was not estimable due to the non-availability of desired data. A total of 112 participants were included. Results showed an overall insignificant effect [Z = 1.62 (p = 0.11)] for comparing anxiety in both groups. Heterogeneity [(I² = 14%), Chi² = 3.50, df = 3, p = 0.32] was insignificant but low grade in included studies. During sensitivity analysis, two studies, Ning (2022) and Harita (2022), were removed from the final comparison. The standardized mean difference with the fixed effect model [SMD -0.31, (95% CI, -0.69, 0.07)] favors the experimental group over the control group. Grade

Table 3

Summary of findings							
Mindfulness and yoga compared to control for sports performance, stress, and anxiety							
Patient or population: Physical athletes, Setting: No limitation, Intervention: mindfulness and yoga, comparison: control							
Outcomes	Anticipated absolute effects* (95% CI)				Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)
	Risk with control	with Mindfulness and yoga	The risk	with Mindfulness and yoga			
Five facet mindfulness	The mean five-facet mindfulness was 0	MD 2.61 lower to 1.37 lower	2.61	lower	-	391 (5 studies)	⊕⊕⊕○ Moderate ^{a, b}
Five facet mindfulness	The mean five-facet mindfulness was 0	MD 2.61 lower to 1.37 lower	2.61	lower	-	391 (5 studies)	Moderate ^{a, b}
Attention awareness and	-	SMD 0.26 lower to 0.08 higher	0.26	lower	-	137 (3 studies)	⊕⊕○○ Low ^{a, b}
Action Acceptance and	The mean AAQ-2 was 0	MD 0.2 lower to 1.08 higher	0.2	higher	-	57 (2 studies)	⊕⊕○○ Low ^b
Flow state scale	-	SMD 3.13 lower to 3.77 higher	3.13	higher	-	90 (2 studies)	⊕⊕○○ Low ^{a, b, c}
Stress	-	SMD 0.07 lower to 0.25 higher	0.07	lower	-	282 (5 studies)	⊕⊕⊕○ Low ^{a, b, c}
Competitive Anxiety	-	SMD 0.31 lower to 0.07 higher	0.31	lower	-	112 (5 studies)	⊕⊕⊕○ Moderate ^a

*Explanations- *The risk in the intervention group with a 95% confidence interval. Which is based on the assumed risk in the comparator group. The relative effect of the intervention with 95% CI. CI: confidence interval; MD: mean difference; SMD: standardized mean difference*

a. Selection bias, b. Inconsistent, c. Heterogeneity

pro evidence also showed moderate evidence for intervention effectiveness compared to control. Table 3.

5. Discussion

The inception of yoga can be attributed to the ancient Indian philosophy. Various types of yoga (i.e., Iyengar, Viniyoga, Sivananda) emphasize the content of physical postures (asanas), breathing exercises (pranayama), meditation, and mindfulness practices that cultivate awareness and states of consciousness [38].

Yoga includes stretching and strength-building postures and affects the individual's physiological, metabolic, and psychological aspects. Yoga demonstrates efficacy in managing body weight, blood glucose levels, and total cholesterol even in individuals with diabetes and coronary artery disease [39]. Yoga and meditation can decrease stress and anxiety by affecting the limbic system and gamma-aminobutyric acid (GABA), a brain chemical [40].

To the best of our knowledge, the present study is the first meta-analysis that has synthesized the impact of yoga and mindfulness practice in reducing stress and anxiety to improve athletes' sports

performance in athletes. The findings derived from the combined data of fifteen experimental trials support the effectiveness of yoga intervention in reducing stress and anxiety and enhancing sports performance. Although the level of evidence was low for the stress outcomes, even moderate evidence was noted for the efficacy of yoga in reducing anxiety among athletes.

The summary of evidence for sports performance was reported as low to moderate in athletes. The present study has used four

scales - FFMQ, AAQ-II, MAAS, and SFSS to measure sports performance. All these scales measure observing, describing, nonjudging of inner experience, acting with awareness, and nonreactivity to inner experience [13], psychological inflexibility and experiential avoidance [14], the aptness to be aware of internalized and environmental incidents [15], flow state: challenge action awareness, skill balance, clear goal, focusing on the task with hands, loss of self-awareness, sense of control, clear feedback, time conversion, and

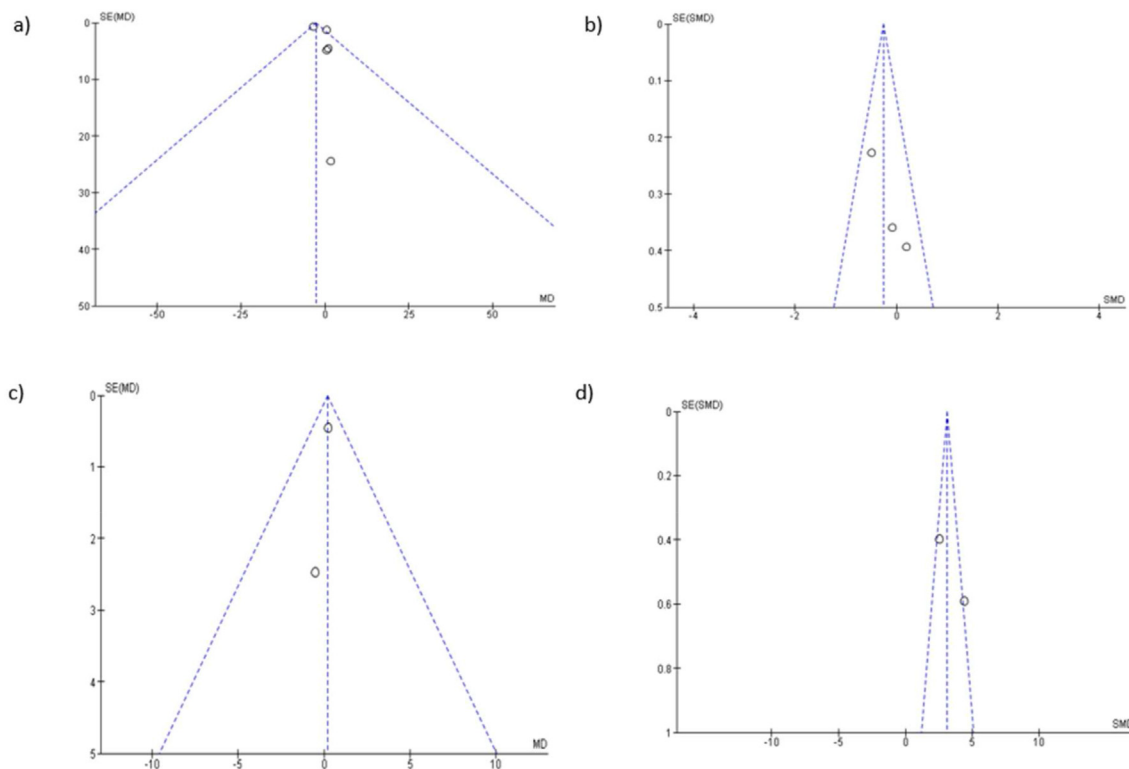


Fig. 3. Funnel plot of comparison: Sport performance, outcomes: (a) Five facet mindfulness, (b) MAAC, (c) AAQ-2, (d) flow state scale.

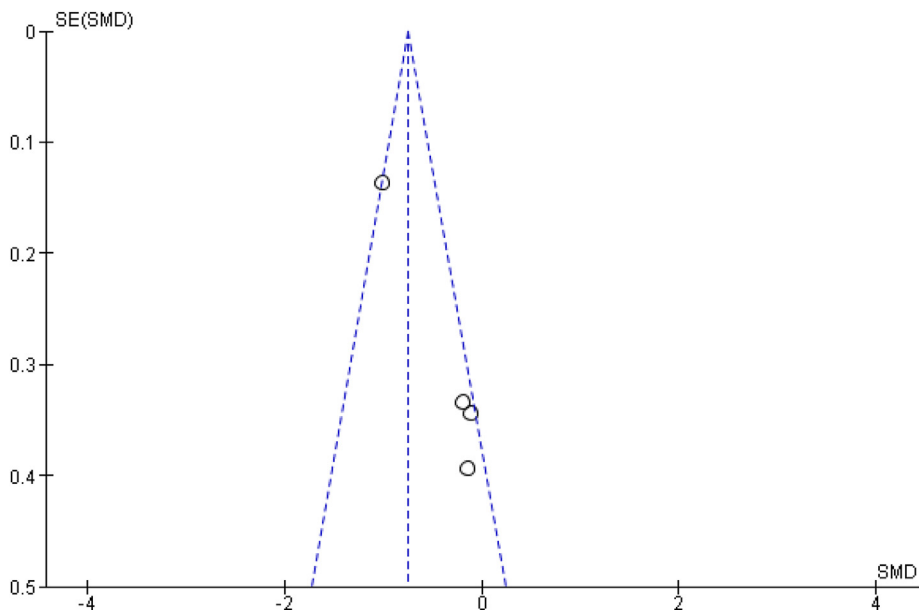


Fig. 4. Funnel plot of comparison of stress: Questionnaire- Perceived stress test.

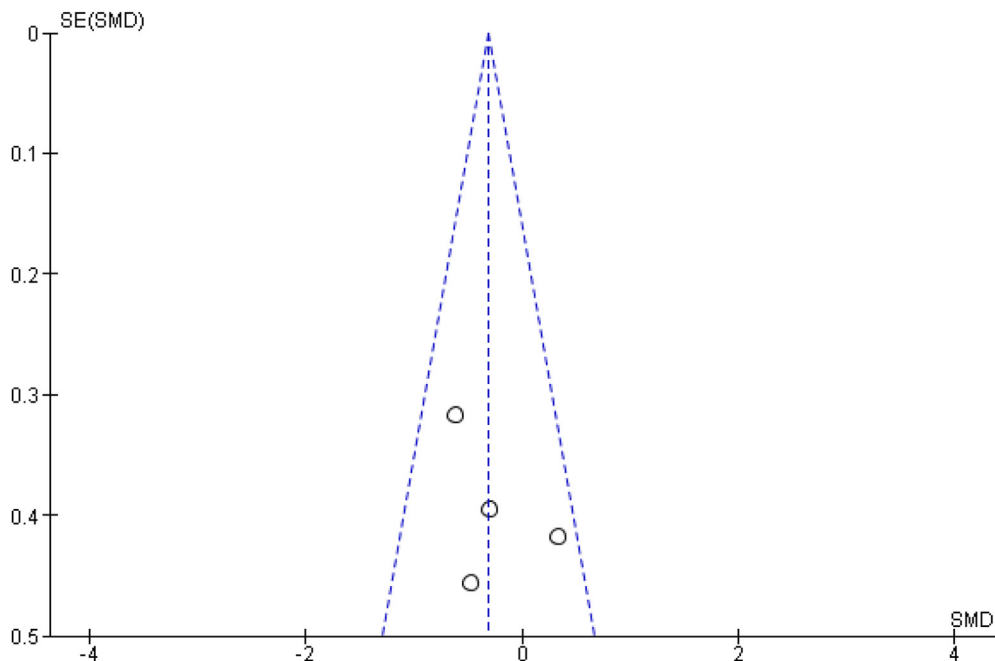


Fig. 5. Funnel plot of comparison of anxiety: Questionnaire- Competitive state anxiety Inventory.

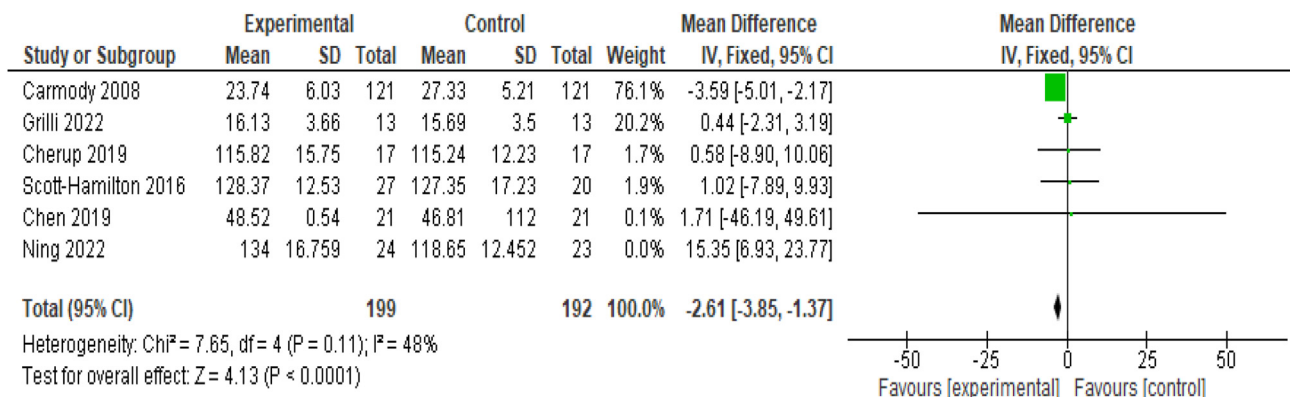


Fig. 6. Forest plot of comparison: Sport performance, outcome: Five facet mindfulness Questionnaire.

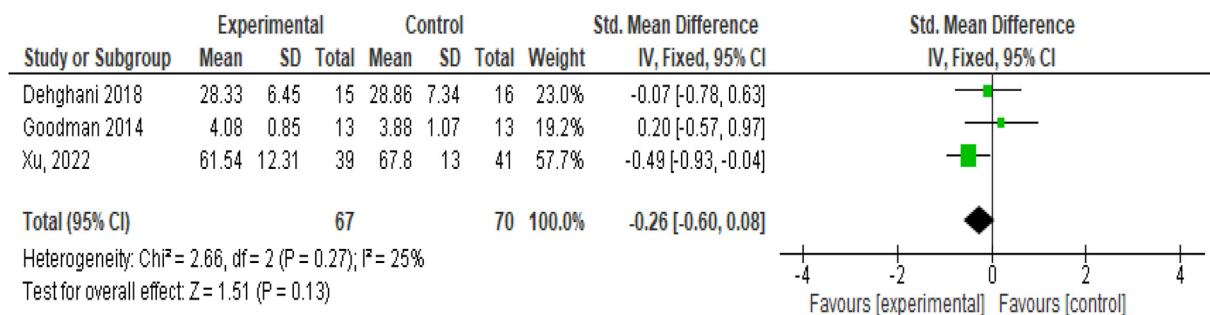


Fig. 7. Forest plot of comparison: 1 Sport performance, outcome: Mindful Attention Awareness Scale.

enjoyable experience [16]. Sport competitive anxiety can also influence an athlete’s performance in either a facilitative or debilitative fashion due to acute changes in the hormonal level [41]. Sport anxiety is collectively measured in terms of physical state anxiety, cognitive state anxiety, and state self-confidence [18].

Practicing yoga that connects the mind and body and regulates arousal could lighten the burden of stress and anxiety disorders [42]. The present study consistently reported significant results with several studies [20,22,30,31,42]. A meta-analysis of nine experimental trials observed that mindfulness practice constantly

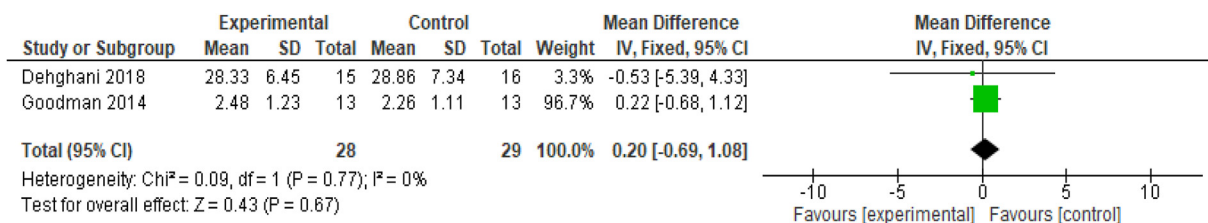


Fig. 8. Forest plot of comparison: 1 Sport performance, outcome: Acceptance and action questionnaire.

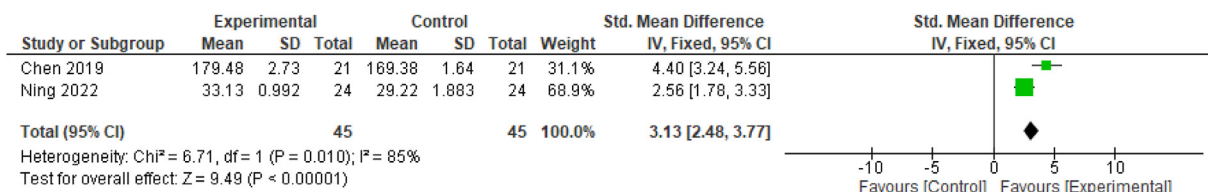


Fig. 9. Forest plot of comparison: 1 Sport performance, outcome: flow state scale.

regulates mindfulness scores. Although researchers have measured the flow, goal-directed energy, anxiety, shooting performance, and dart-throwing performance are quite different from the present study. Both physiological and psychological performance outcomes in shooting and dart throwing were affected from moderate to highly significant [43]. Another meta-analysis observed that mindfulness interventions improve several psychological health outcomes in athletes. Although significant effects were noted, but the included trials have other various types of interventions in the compared group, creating heterogeneity in the analysis [44]. According to a review, mindfulness practices also improved sports

performance and burnout [45,46]. Mindfulness intervention significantly affects athletes' performance, flow, and competitive anxiety [47,48].

Furthermore, mindfulness practices help individuals experience emotional and cognitive processes and change their behaviors mindfully. Mindfulness offers receptiveness to negative thoughts and coping with negative situations in sports and daily routines [1,20]. Few studies provided evidence of mindfulness practice's effects on specific performance indicators such as free-throw accuracy in basketball and table tennis rankings [49]. It was also noticed that eight weeks of Bikram yoga improved Mindfulness,

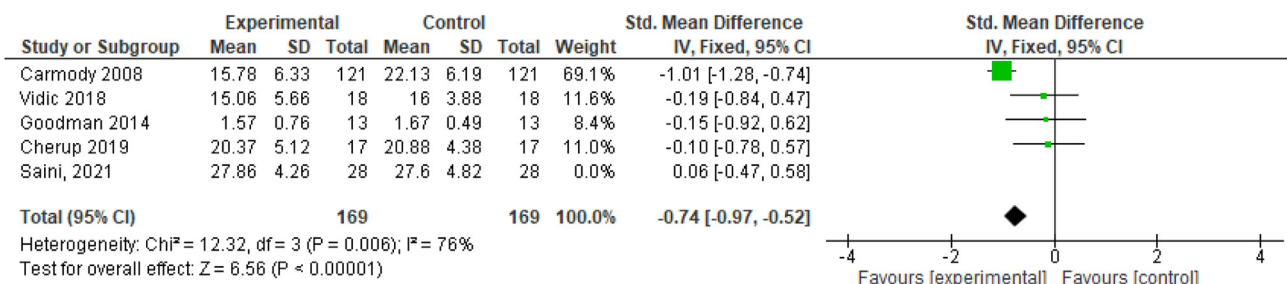


Fig. 10. Forest plot of comparison: Stress; Outcome- Perceived stress test.

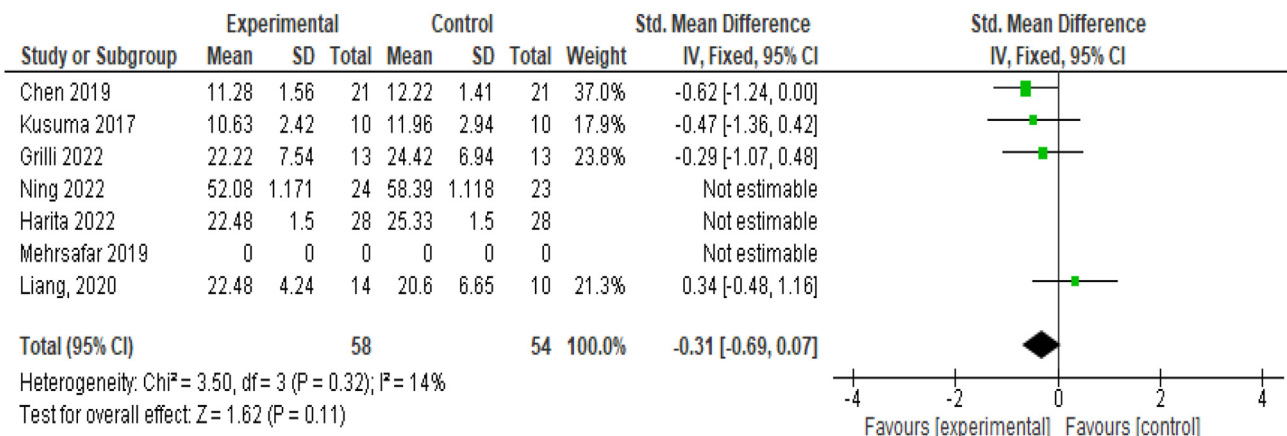


Fig. 11. Forest plot of comparison: Anxiety; outcome: Competitive state anxiety Inventory.

cardiorespiratory endurance, flexibility, and balance ($p < 0.01$). Mindfulness was also negatively correlated with stress in athletes ($r = -0.43, p < 0.01$) [50]. Mindfulness practice has also proven as a positive experience for athletes. It offered the same benefits as expected by the participants and noted participants' acceptability and recommendations for the future [51,52]. The literature shows that several reviews have been done regarding the beneficial effects of yoga and mindfulness in athletes, but reported outcomes were limited in those reviews with inherent methodological rigor. The present meta-analysis also noted sports performance along with competitive stress and anxiety in athletes as these factors affect their sports performance, making this study robust.

5.1. Methodology discussion (strength and weakness)

To the best of our knowledge, this is the first and most recent meta-analysis to evaluate the impact of yoga and mindfulness practice in reducing stress and anxiety to improve athletes' sports performance in athletes. A significant number of experimental studies were included to synthesize the results. Sensitivity analysis also strengthens the study's evidence. GradePro evidenced the summary as low effects of yoga and mindfulness in reducing athletes' stress and moderate evidence in lowering anxiety in athletes. The summary of evidence for sports performance was noted as low to moderate in athletes due to heterogeneity, limited studies for selected variables, limited internal validity across studies, and wide confidence interval.

5.2. Clinical implications

The findings of this meta-analysis contributed to the beneficial or complementary effects of yoga and mindfulness on athletes' psychological health and sports performance. However, evidence was noted as low to moderate for stress, anxiety, and sports performance. Conclusively, yoga may contribute as a complementary therapy to reduce athletes' stress and anxiety and improve sports performance as a standalone or in conjunction with other psychological or behavioral therapies.

6. Conclusion

This meta-analysis creates low to moderate evidence regarding yoga and mindfulness as a complementary therapy for managing stress and anxiety in athletes. However, results summarized moderate evidence on athletes' sports performance while practicing yoga and mindfulness. Based on the rationale or evidence, yoga and mindfulness can be considered beneficial complementary therapy contributing to athletes' psychological health and sports performance. A low to moderate degree of evidence suggested future research with powered trials with improved experimental designs to evaluate the impact of yoga on athlete stress, anxiety, and sports performance.

Author contribution

Conceptualization: Kanaujia S, Saraswati P; **Methodology:** Kanaujia S, Saraswati P, Yadav A, Singh S, Kataria N, Yadav P; **Formal analysis and investigation:** Kanaujia S, Saraswati P, Yadav A, Singh N, Singh S; **Writing - original draft preparation:** Kanaujia S, Saraswati P, Yadav A, Singh N, Singh S, Kataria N, Yadav P; **Writing - review and editing:** Saraswati P, Yadav A, Singh N, Singh S, Kataria N, Yadav P; **Visualization:** Kanaujia S, Saraswati P, Yadav A, Singh N, Singh S, Kataria N, Yadav P; **Supervision:** Kanaujia S, Saraswati P, **Project administration:** Yadav A, Singh N, Singh S, Kataria N, Yadav P.

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Conflict of interest

None.

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References

- [1] Birrer D, R othlin P, Morgan G. Mindfulness to enhance athletic performance: theoretical considerations and possible impact mechanisms. *Mindfulness* 2012;3.
- [2] Herring SA, Kibler W, Putukian M. Sideline preparedness for the team physician: a consensus statement-2012 update. *Med Sci Sports Exerc* 2012;44(12):2442–5.
- [3] Rice SM, Purcell R, De Silva S, Mawren D, McGorry PD, Parker AG. The Mental Health of Elite Athletes: A Narrative Systematic Review. *Sports Med* 2016;46(9):1333–53.
- [4] Drew B, Matthews J. The prevalence of depressive and anxiety symptoms in student-athletes and the relationship with resilience and help-seeking behavior. *J Clin Sport Psychol* 2019;13:421–39.
- [5] Salles JI, Silva C, Wolff A, Orwert L, Ribeiro P, Velasques B, et al. Anxiety, insomnia, and depression during COVID-19 lockdown in elite individual and team sport athletes. *Psicol Reflex o Cr tica* 2022;35(1):33.
- [6] Boudreault V, Labossiere S, Gauthier V, Brassard S, Couture S, Dionne F, et al. Symptoms of mental illness among university student-athletes during the second wave of the COVID-19 pandemic lockdown in Canada. *Front Sports Act Living* 2022;4:1017376. <https://doi.org/10.3389/fspor.2022.1017376>.
- [7] Kabat-Zinn J. University of Massachusetts Medical Center/Worcester. Stress Reduction Clinic. Full catastrophe living: using the wisdom of your body and mind to face stress, pain, and illness. New York: Delta; 1990.
- [8] Dhuri KD, Bodhe PV, Vaidya AB. Shirodhara: a psycho-physiological profile in healthy volunteers. *J Ayurveda Integr Med* 2013;4(1):40–4.
- [9] Thompson RW, Kaufman KA, De Petrillo IA, Glass CR, Arnkof DB. One-year follow-up of mindful sport performance enhancement (MSPE) with archers, golfers, and runners. *J Clin Sport Psychol* 2011;5(2):99–116.
- [10] Kaufman K, Glass CR, Pineau TR. Mindful sport performance enhancement (MSPE). *Mindfulness* 2016:153–85.
- [11] Santorelli SF, Kabat-Zinn J. Mindfulness-based stress reduction (MBSR) professional education and training: MBSR curriculum and supporting materials. Boston: Center for Mindfulness; 2009.
- [12] Ross A, Thomas S. The health benefits of yoga and exercise: a review of comparison studies. *J Alternative Compl Med* 2010;16(1):3–12.
- [13] Baer RA, Smith GT, Hopkins J, Krietemeyer J, Toney L. Using self-report assessment methods to explore facets of mindfulness. *Assessment* 2006;13(1):27–45.
- [14] Bond FW, Hayes SC, Baer RA, Carpenter KM, Guenole N, Orcutt HK, et al. Preliminary psychometric properties of the Acceptance and Action Questionnaire-II: a revised measure of psychological inflexibility and experiential avoidance. *Behav Ther* 2011;42(4):676–88.
- [15] Brown KW, Ryan RM. The benefits of being present: mindfulness and its role in psychological well-being. *J Pers Soc Psychol* 2003;84(4):822–48.
- [16] Nien CL. The preliminary analysis of validity and reliability of Flow State Scale. *Guo Li Ti Yu Xue Yuan Lun Cong* 2000;11(1):247–60.
- [17] Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav* 1983;24(4):385–96.
- [18] Cox RH, Martens MP, Russell WD. Measuring anxiety in athletics: the revised competitive state anxiety inventory-2. *J Sport Exerc Psychol* 2003;25(4):519–33.
- [19] PRISMA checklist. Accessed: Jun 17, 2022, <http://www.prismastatement.org/PRISMAstatement/Checklis; 2020>.
- [20] Goodman FR, Kashdan TB, Mallard TT, Schumann M. A brief mindfulness and yoga intervention with an entire NCAA Division I athletic team: an initial investigation. *Psychol Conscious: Theory, Res, Pract* 2014;1(4):339–56.
- [21] Dehghani M, Saf AD, Vosoughi A, Tebbenouri G, Zarnagh HG. Effectiveness of the mindfulness-acceptance-commitment-based approach on athletic performance and sports competition anxiety: a randomized clinical trial. *Electron Phys* 2018;10(5):6749–55.
- [22] Ning JH, Hao QW, Huang DC. Effects of "mindfulness acceptance insight commitment" training on flow state and mental health of College swimmers: a randomized controlled experimental study. *Front Psychol* 2022;13:799103.
- [23] Liang D, Chen S, Zhang W, Xu K, Li Y, Li D, et al. Investigation of a progressive relaxation training intervention on precompetition anxiety and sports performance among collegiate student-athletes. *Front Psychol* 2020;11:617541.

- [24] Mehrsafari AH, Strahler J, Gazerani P, Khabiri M, Sánchez JC, Moosakhani A, et al. The effects of mindfulness training on competition-induced anxiety and salivary stress markers in elite Wushu athletes: a pilot study. *Physiol Behav* 2019;210:112655.
- [25] Scott-Hamilton J, Schutte NS, Brown RF. Effects of a mindfulness intervention on sports-anxiety, pessimism, and flow in competitive cyclists. *Appl Psychol Health Well Being* 2016;8(1):85–103.
- [26] Saini HC, Singh DS, Rathore V. Effect of yoga on perceived stress level of College students, vol. 4; 2021.
- [27] Harita ANW, Suryanto S, Ardi R. Effect of mindfulness sports performance enhancement (MSPE) to reduce competitive state anxiety on karate athletes. *J SPORTIF: J Penelit Pembelajaran* 2022;8(2):169–88.
- [28] Kusuma DWY, Bin W. Effect of yoga program on mental health: competitive anxiety in semarang Badminton athletes. *KEMAS: J Kesehat Masyarakat* 2017 Jul 28;13(1):121–30.
- [29] Chen JH, Tsai PH, Lin YC, Chen CK, Chen CY. Mindfulness training enhances flow state and mental health among baseball players in Taiwan. *Psychol Res Behav Manag* 2019;12:15–21.
- [30] Cherup N, Vidic Z. Mindfulness with collegiate gymnasts: effects on flow, stress and overall mindfulness levels. *Int J Phys Educ, Fit Sports* 2019;8: 19–31.
- [31] Grilli Cadieux E, Richard V, Dupuis G. Effects of Bali yoga program for athletes (BYP-A) on psychological state related to the performance of circus artists. *Int J Yogic, Hum Mov Sports Sci* 2022;7:23–33.
- [32] Carmody J, Baer RA. Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well-being in a mindfulness-based stress reduction program. *J Behav Med* 2008;31(1): 23–33.
- [33] Xu D, Wu H, Ruan H, Yuan C, Gao J, Guo M. Effects of yoga interventions on functional movement patterns and mindfulness in collegiate athletes: a quasi-experimental study. *Int J Environ Res Publ Health* 2022;19: 14930.
- [34] Vidic Z, Martin M, Oxhandler R. Mindfulness meditation intervention with male collegiate soccer players: effect on stress and various aspects of life. *Sport J* 2018;24. Available from <https://thesportjournal.org/article/mindfulness-meditation-intervention-with-male-collegiate-soccer-players-effect-on-stress-and-various-aspects-of-life/>.
- [35] Copenhagen: The Nordic Cochrane Centre. The Cochrane collaboration: review manager (RevMan). <https://training.cochrane.org/online-learning/core-software-cochrane-reviews/revman>; 2014.
- [36] Schünemann H, Brozek J, Guyatt G, Oxman. A Handbook for grading the quality of evidence and the strength of recommendations using the GRADE approach. 2013.
- [37] Hamilton: McMaster University. GRADEpro 2014. Accessed: June 13, 2022, <https://www.gradepro.org/>.
- [38] Kirkwood G, Rampes H, Tuffrey V, Richardson J, Pilkington K. Yoga for anxiety: a systematic review of the research evidence. *Br J Sports Med* 2005;39(12): 884–91. discussion 891.
- [39] Ramos-Jiménez A, Hernández-Torres RP, Wall-Medrano A, Muñoz-Daw MD, Torres-Durán PV, Juárez-Oropeza MA. Cardiovascular and metabolic effects of intensive Hatha Yoga training in middle-aged and older women from northern Mexico. *Int J Yoga* 2009;2:49–54.
- [40] Akhtar P, Yardi S, Akhtar M. Effects of yoga on functional capacity and well being. *Int J Yoga* 2013;6(1):76–9.
- [41] MacDonald D, Wetherell MA. Competition stress leads to a blunting of the cortisol awakening response in elite rowers. *Front Psychol* 2019;10:1684.
- [42] Li AW, Goldsmith CA. The effects of yoga on anxiety and stress. *Alternative Med Rev* 2012;17(1):21–35.
- [43] Bühlmeier L, Birrer D, Röthlin P, Faude O, Donath L. Effects of mindfulness practice on performance-relevant parameters and performance outcomes in sports: a meta-analytical review. *Sports Med* 2017;47(11):2309–21.
- [44] Myall K, Montero-Marin J, Gorkczynski P, Kajej N, Syed Sheriff R, Bernard R, et al. Effect of mindfulness-based programmes on elite athlete mental health: a systematic review and meta-analysis. *Br J Sports Med* 2023;57(2):99–108.
- [45] Röthlin P, Birrer D, Horvath S, Grosse Holtforth M. Psychological skills training and a mindfulness-based intervention to enhance functional athletic performance: design of a randomized controlled trial using ambulatory assessment. *BMC Psychol* 2016;4(1):39.
- [46] Li C, Zhu Y, Zhang M, Gustafsson H, Chen T. Mindfulness and athlete burnout: a systematic review and meta-analysis. *Int J Environ Res Publ Health* 2019;16(3):449.
- [47] Noetel M, Ciarrochi J, Van Zanden B, Lonsdale C. Mindfulness and acceptance approaches to sporting performance enhancement: a systematic review. *Int Rev Sport Exerc Psychol* 2019;12(1):139–75.
- [48] Corbally L, Wilkinson M, Fothergill MA. Effects of mindfulness practice on performance and factors related to performance in long-distance running: a systematic review. *J Clin Sport Psychol* 2020;14:376–98.
- [49] Tebourski K, Bernier M, Ben Salha M, Souissi N, Fournier JF. Effects of mindfulness for performance programme on actual performance in ecological sport context: two studies in basketball and table tennis. *Int J Environ Res Publ Health* 2022;19(19):12950.
- [50] Hewett ZL, Ransdell LB, Gao Y, Petlichkoff LM, Lucas S. An examination of the effectiveness of an 8-week Bikram yoga program on mindfulness, perceived stress, and physical fitness. *J Exerc Sci Fit* 2011;9(2):87–92.
- [51] Mistretta EG, Glass CR, Spears CA, Perskaudas R, Kaufman KA, Hoyer D. Collegiate athletes' expectations and experiences with mindful sport performance enhancement. *J Clin Sport Psychol* 2017;11(3):201–21.
- [52] Khanal H, Khanal U. Benefits, barriers and determinants of practicing yoga: a cross sectional study from Kathmandu, Nepal. *J Ayurveda Integr Med* 2021;12(1):102–6.