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## An Analytical Assessment of Yoga-Based Training and Physical Exercise on Fitness Performance, Physiological Adaptation, and Mental Resilience among Volleyball Players

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### **Abstract:**

*Volleyball performance depends on repeated high-intensity movement, explosive jumping capacity, rapid change of direction, technically controlled ball actions, short-interval recovery, and psychological stability under competitive pressure. Yoga-based training may support flexibility, balance, breathing regulation, autonomic recovery, attentional control, and mental resilience, whereas structured physical exercise is more directly associated with strength, speed, agility, power, and sport-specific conditioning. This study presents a quantitative analytical pre-test-post-test intervention framework to examine the independent and combined effects of yoga-based training and structured physical exercise on volleyball players. The proposed design compares four groups: yoga-based training, structured physical exercise, combined yoga and physical exercise, and control. Outcome domains include fitness performance, physiological adaptation, and psychological resilience. In the absence of supplied field data, this revised manuscript adds a transparent simulated pilot primary dataset and statistical reporting model to illustrate how actual results should be presented after data collection. The integrated model suggests that combined training may produce a broader adaptation profile by connecting neuromuscular conditioning with mobility, recovery, breathing regulation, and psychological readiness. The manuscript provides an academically formatted research article with sequentially numbered headings, intervention protocols, primary-data analysis tables, charts, and APA-style in-text citation support.*

**Keywords:** Yoga training; physical exercise; volleyball players; fitness performance; physiological adaptation; mental resilience; sports psychology; exercise physiology; athlete recovery

### **1. Introduction:**

#### **1.1 Volleyball Performance as a Multidimensional Athletic Construct:**

Volleyball is an intermittent court sport that requires short bursts of acceleration, repeated

jumping and landing, lateral transition, upper-body coordination, rapid perceptual response, and tactical decision-making. Modern volleyball players must execute vertical jumps for attacking and blocking, repeated change-of-direction movements for defensive coverage, trunk and shoulder control for serving and spiking, and rapid physiological recovery between rallies. The official structure of the game requires continuous alternation between offensive and defensive phases; therefore, conditioning must prepare athletes for variable multidirectional demands rather than a single linear performance task (Federation Internationale de Volleyball [FIVB], 2024).

Traditional volleyball conditioning emphasizes resistance training, jump training, agility drills, interval endurance, mobility, and core stabilization. Recent volleyball-specific literature indicates that lower-limb strength, jump ability, change-of-direction performance, and training-load regulation are relevant to short-term performance and recovery (Ahmadi et al., 2021; Chuang et al., 2022; Ramirez-Campillo et al., 2020; Rebelo et al., 2023). However, competitive readiness is not explained by physical output alone. Players must also regulate anxiety, maintain concentration, recover emotionally from errors, and sustain confidence under match pressure (Gupta & McCarthy, 2022; Kegelaers, 2023).

## **1.2 Rationale for Integrating Yoga-Based Training and Structured Physical Exercise:**

Yoga-based training has gained relevance in athletic preparation because it combines controlled postures, breath regulation, relaxation, interoceptive awareness, and focused attention. Systematic reviews suggest that yoga and mindfulness-oriented interventions may enhance selected physical and psychological variables in athletes, although effects depend on intervention duration, session frequency, participant profile, and measurement quality (Cadieux et al., 2021; Kanaujia et al., 2023; Singh et al., 2025; Wang et al., 2023). Yoga should not be treated as a substitute for progressive resistance or plyometric training in volleyball because it does not normally provide the same external loading required for maximal strength and power development. Its likely value is complementary: mobility, balance, breathing efficiency, parasympathetic recovery, psychological regulation, and sustainable training-load management.

The central argument of this paper is not that yoga-based training or physical exercise is universally superior. Rather, each modality may operate through different adaptation pathways. Structured physical exercise is expected to stimulate neuromuscular and metabolic adaptation, whereas yoga-based training may support movement quality, recovery, stress regulation, and attentional stability. A combined programme may therefore produce a broader multi-domain adaptation when training load is regulated and integrated with volleyball-specific practice.

## **2. Review of Related Literature:**

### **2.1 Yoga-Based Training and Athlete Self-Regulation:**

Research on yoga in athletic populations has expanded, but the field remains methodologically uneven. A systematic review of yoga interventions among competitive athletes reported potential

benefits for psychological health and performance-related outcomes, while also noting variability in study design, sport type, sample size, and intervention content (Cadioux et al., 2021). Evidence from athlete-oriented yoga research suggests that the most plausible benefits relate to flexibility, balance, recovery, mental clarity, anxiety regulation, and attentional control rather than direct maximal power production (Singh et al., 2025).

Yoga may also contribute to injury-risk reduction by improving postural control, body awareness, breathing regulation, and stress management (Arbo et al., 2020). These mechanisms are relevant to volleyball because repeated jumping, landing, blocking, serving, and defensive movements load the ankle, knee, shoulder, and trunk. Nevertheless, passive flexibility alone is not sufficient for volleyball-specific stability. Mobility gains must be combined with strength, active range control, and neuromuscular coordination.

## **2.2 Structured Physical Conditioning and Volleyball-Specific Performance:**

Structured physical conditioning is central to volleyball because the sport requires repeated explosive jumping, rapid deceleration, short accelerations, multidirectional court coverage, and powerful upper-body actions. Plyometric training is particularly important because volleyball performance includes countermovement jumps, block jumps, approach jumps, and rapid take-off actions. Meta-analytic evidence indicates that plyometric jump training can improve vertical-jump height among volleyball players, provided the programme is individualized by athlete experience, competitive level, playing position, surface, and progression strategy (Ramirez-Campillo et al., 2020). Agility and change-of-direction training are also essential. Chuang et al. (2022) reported that agility-based interventions using ladder and shuttle activities can improve selected skill-related physical capacities among young volleyball players. These findings align with match demands because players repeatedly decelerate, reorient, and reaccelerate in response to unpredictable ball trajectories. Strength training complements agility and plyometric work by improving braking capacity, trunk stiffness, landing mechanics, and kinetic-chain force transfer.

## **2.3 Physiological Adaptation and Recovery:**

Physiological adaptation in volleyball includes cardiovascular, respiratory, metabolic, autonomic, and body-composition changes that support performance and recovery. Resting heart rate, blood pressure, heart-rate recovery, estimated maximal oxygen uptake, respiratory efficiency, and fatigue tolerance are relevant because volleyball players must recover between rallies, sets, matches, and training sessions. General physical activity guidelines emphasize regular moderate-to-vigorous physical activity and muscle-strengthening activity for health benefits (Bull et al., 2020; World Health Organization [WHO], 2020). Volleyball conditioning adapts these principles to intermittent high-intensity sport demands.

Structured exercise may improve oxygen uptake, strength, repeated-effort tolerance, and body

composition through progressive overload. Yoga-based training may influence ventilatory rhythm, perceived recovery, autonomic regulation, and psychological calmness. Objective physiological measures such as resting heart rate, heart-rate recovery, blood pressure, and standardized endurance tests are therefore needed to avoid overinterpreting subjective improvement.

#### **2.4 Competitive Anxiety, Emotional Regulation, and Mental Resilience:**

Mental resilience in sport is best understood as a dynamic process through which athletes maintain or regain adaptive functioning under pressure rather than as a fixed personality trait. The sporting resilience model emphasizes the interaction of protective factors, appraisal, coping, and performance functioning (Gupta & McCarthy, 2022). Kegelaers (2023) similarly argues that sport-resilience research requires stronger attention to context, process, and temporal change.

Mindfulness and yoga-based approaches may support performance by enhancing attentional control, emotional regulation, and recovery from competitive stress. Meta-analytic work suggests that mindfulness-based interventions can improve performance-related factors among athletes, although programme content, duration, and control condition influence outcomes (Wang et al., 2023). In volleyball, such psychological regulation is important because players must respond quickly after errors, communicate during pressure rallies, and sustain focus in serve-serve and defensive situations.

### **3. Research Gap:**

Existing research shows potential benefits of yoga, mindfulness, plyometric training, agility training, strength conditioning, and workload monitoring in sport. However, several gaps remain. First, many yoga studies in athlete populations are not volleyball-specific and frequently emphasize psychological outcomes or flexibility without simultaneously examining sport-specific fitness and physiological adaptation. Second, many volleyball-conditioning studies focus on jump height, strength, and agility but pay less integrated attention to psychological resilience and autonomic recovery. Third, few intervention designs directly compare yoga-based training, structured physical exercise, combined training, and control conditions in the same sample using a unified pre-test-post-test system.

A comparative analytical design is necessary because yoga and structured exercise are often framed as competing approaches when they may be complementary training stimuli. Volleyball players require high-output neuromuscular performance, but they also need flexibility, postural control, emotional stability, recovery capacity, and concentration. A multi-domain design can determine whether yoga contributes most strongly to flexibility, balance, recovery, and resilience; whether physical exercise contributes most strongly to speed, strength, and power; and whether combined training produces the most comprehensive performance profile.

### **4. Statement of the Problem:**

Despite growing interest in holistic athlete development, volleyball training programmes frequently separate physical conditioning from psychological recovery and self-regulation practices. Coaches may prescribe strength, plyometric, agility, and endurance training while treating flexibility, breathing control, relaxation, and mental resilience as secondary components. Conversely, yoga-based practices may be promoted without adequate comparison with progressive physical training. The problem addressed by this study is the lack of a unified empirical framework for assessing how yoga-based training, structured physical exercise, and their combined application influence fitness performance, physiological adaptation, and mental resilience among volleyball players.

### **5. Objectives of the Study:**

- 1. To examine the effect of yoga-based training on fitness performance, physiological adaptation, and mental resilience among volleyball players.
- 2. To examine the effect of structured physical exercise training on fitness performance, physiological adaptation, and mental resilience among volleyball players.
- 3. To compare the effects of yoga-based training, structured physical exercise training, combined training, and a control condition on selected fitness and psychological outcomes.
- 4. To evaluate whether combined yoga and physical exercise training produces broader adaptation than single-modality training.
- 5. To analyse the relationship between changes in fitness performance, physiological adaptation, and mental resilience after the intervention.
- 6. To develop practical recommendations for integrating yoga-based practices into volleyball conditioning programmes.

### **6. Research Questions:**

- 1. Does yoga-based training significantly improve flexibility, balance, autonomic recovery, and mental resilience among volleyball players?
- 2. Does structured physical exercise significantly improve speed, agility, muscular strength, endurance, explosive power, and volleyball-specific performance?
- 3. Does combined yoga and physical exercise training produce greater overall improvement than yoga or physical exercise alone?
- 4. Which physiological indicators show the strongest adaptation after each intervention condition?
- 5. How are changes in fitness performance associated with changes in mental resilience and stress regulation?
- 6. What training implications can be drawn for volleyball conditioning programmes at the college, university, club, or academy level?

## 7. Hypotheses:

- H01: There will be no significant pre-test-post-test difference in fitness performance among volleyball players receiving yoga-based training.
- H02: There will be no significant pre-test-post-test difference in physiological adaptation indicators among volleyball players receiving yoga-based training.
- H03: There will be no significant pre-test-post-test difference in mental resilience indicators among volleyball players receiving yoga-based training.
- H04: There will be no significant pre-test-post-test difference in fitness performance among volleyball players receiving structured physical exercise training.
- H05: There will be no significant pre-test-post-test difference in physiological adaptation indicators among volleyball players receiving structured physical exercise training.
- H06: There will be no significant pre-test-post-test difference in mental resilience indicators among volleyball players receiving structured physical exercise training.
- H07: There will be no significant between-group difference in post-test fitness performance after controlling for baseline scores.
- H08: There will be no significant between-group difference in post-test physiological adaptation after controlling for baseline scores.
- H09: There will be no significant between-group difference in post-test mental resilience after controlling for baseline scores.
- H10: There will be no significant correlation between changes in fitness performance and changes in mental resilience.

## 8. Conceptual Framework:

### 8.1 Multi-Pathway Adaptation Model:

The conceptual framework is based on a multi-pathway adaptation model. Yoga-based training is expected to influence flexibility, postural awareness, balance, breathing regulation, relaxation, emotional regulation, and mental resilience. Structured physical exercise is expected to influence strength, speed, agility, power, endurance, and volleyball-specific motor performance through progressive neuromuscular and metabolic loading. Combined training is expected to produce a more comprehensive adaptation profile by linking neuromuscular conditioning with recovery, mobility, autonomic regulation, and psychological readiness.

### 8.2 Operational Linkages Among Training Inputs, Mediators, and Outcomes:

The framework also recognizes that adaptation may be mediated or moderated by training compliance, baseline fitness, playing position, training age, sleep, nutrition, academic or occupational stress, and match exposure. These variables should therefore be recorded and controlled statistically where possible.

**Table 1 presents the operational logic connecting training inputs with measurable outcomes and volleyball relevance.**

Training input	Primary adaptation pathway	Expected measurable outcomes	Volleyball relevance
Yoga-based training	Mobility, postural control, breathing regulation, relaxation, attentional focus	Flexibility, balance, heart-rate recovery, perceived stress, anxiety control, resilience score	Landing control, composure after error, serve-reception focus, recovery between sessions
Structured physical exercise	Progressive neuromuscular loading, stretch-shortening-cycle efficiency, agility and metabolic conditioning	Sprint speed, agility time, strength, vertical jump, endurance, body composition, repeated-effort tolerance	Spike approach, blocking, defensive transitions, court coverage, match stamina
Combined yoga and exercise	Integrated loading and regulation through power, mobility, recovery, attention, and stress control	Broad improvement across fitness, physiological, and psychological domains	Comprehensive athlete readiness and sustainable training adaptation
Control condition	Usual volleyball practice without additional intervention	Maintenance or training-as-usual changes	Baseline comparison for intervention effects

*Table 1. Conceptual framework for yoga-based training, physical exercise, and volleyball outcomes.*

## 9. Methodology:

### 9.1 Research Design:

The study uses a quantitative analytical pre-test-post-test comparative intervention design. The preferred structure is a four-group design comprising a yoga-based training group, a structured physical exercise group, a combined yoga and physical exercise group, and a control group. A randomized controlled design is preferable. If randomization is not feasible because of team schedules or institutional constraints, a quasi-experimental matched-group design may be adopted, with matching based on sex, playing position, training age, and baseline fitness.

### 9.2 Participants and Sampling Strategy:

The target population consists of male and female volleyball players engaged in regular training at college, university, academy, or club level. For adult samples, the recommended age range is 18-25 years. Sampling may be purposive at institutional recruitment and randomized at allocation. Eligible

participants should be stratified by sex and playing position before allocation to reduce imbalance across groups.

**9.3 Inclusion and Exclusion Criteria:**

Inclusion criteria are registered volleyball participation, regular practice at least three days per week, minimum six months of volleyball training experience, medical readiness for moderate-to-vigorous training, willingness to attend intervention sessions, and written informed consent. Exclusion criteria are current musculoskeletal injury limiting exercise or yoga practice, recent surgery, uncontrolled cardiovascular or respiratory disease, neurological conditions affecting safe participation, structured yoga or high-volume strength conditioning outside the assigned programme, and attendance below 80% of intervention sessions.

**9.4 Training Intervention Protocol:**

The intervention should be supervised by qualified personnel, including a yoga instructor familiar with athletes, a strength and conditioning coach, and the volleyball coaching staff. The recommended duration is eight weeks, with three supervised sessions per week lasting 60-75 minutes. The combined group should not receive double training load; rather, the volume should be balanced by integrating selected yoga and physical exercise components.

Component	Yoga-based training group	Structured physical exercise group	Combined group
Warm-up	Breathing awareness, joint mobility, modified Surya Namaskar	Jogging, activation drills, dynamic movement preparation	Brief dynamic warm-up followed by mobility and activation
Main training emphasis	Standing postures, balance asanas, trunk postures, flexibility holds, pranayama, relaxation	Resistance exercise, plyometrics, agility drills, repeated-effort intervals, cool-down	Reduced-volume strength and power work paired with yoga-based mobility, breathing, and recovery
Progression logic	Longer active holds, improved breath control, balance under fatigue, relaxation skill	Progressive load, safe landing mechanics, greater agility complexity, repeated-effort tolerance	Alternating power stimulus and recovery stimulus while monitoring fatigue
Monitoring	Attendance, perceived exertion, soreness, pain during posture, recovery log	Attendance, session-RPE, landing quality, soreness, adverse events	Attendance, session-RPE, readiness, heart-rate recovery, fatigue response

Table 2. Consolidated intervention protocol for yoga-based training, structured physical exercise, and combined training.

**9.5 Measurement Tools and Outcome Variables:**

Domain	Indicator	Suggested test or tool	Scoring interpretation
Fitness performance	Speed	20 m or 30 m sprint test	Lower time indicates better sprint speed
Fitness performance	Agility	T-test, 505 test, or Illinois agility test	Lower time indicates better agility
Fitness performance	Flexibility	Sit-and-reach test and shoulder flexibility screen	Higher score indicates better flexibility
Fitness performance	Strength and power	Handgrip dynamometry and vertical jump test	Higher score indicates greater strength or lower-limb power
Physiological adaptation	Cardiovascular recovery	Resting heart rate and one-minute heart-rate recovery	Lower resting heart rate and greater recovery drop are generally favourable
Mental resilience	Resilience and anxiety	Connor-Davidson Resilience Scale; CSAI-2 or validated equivalent	Higher resilience and lower anxiety indicate better regulation

*Table 3. Outcome variables, tools, and measurement plan.*

**9.6 Data Collection Procedure:**

Data collection should begin only after institutional permission, participant briefing, informed consent, and health screening. Participants should avoid vigorous exercise, alcohol, and unusual caffeine intake for at least 24 hours before testing. Pre-test and post-test sessions should be conducted at the same time of day to reduce diurnal variation. Baseline assessment should include demographic details, training history, playing position, body-composition indicators, physiological resting measures, fitness tests, volleyball-specific measures, and psychological scales. Post-test assessment should occur 48-72 hours after the last intervention session to reduce the influence of acute fatigue while still capturing training adaptation.

**9.7 Statistical Analysis Plan:**

Data should be analysed using SPSS, R, Jamovi, JASP, or equivalent statistical software. Descriptive statistics should include mean, standard deviation, frequency, and percentage. Normality should be examined using the Shapiro-Wilk test, Q-Q plots, and visual inspection. Baseline equivalence should be evaluated by one-way ANOVA for continuous variables and chi-square testing for categorical variables where assumptions are met. Within-group pre-test-post-test changes should

be examined using paired-samples t-tests for normally distributed outcomes or Wilcoxon signed-rank tests for non-normal outcomes. Between-group effects should be examined using mixed-design ANOVA or ANCOVA, with baseline scores as covariates where needed. Effect sizes should accompany p values, including Cohen's dz for paired comparisons and eta squared or partial eta squared for between-group models (Cohen, 1988; Field, 2018; Lakens, 2013).

**10. Primary Data and Statistical Analysis:**

**10.1 Primary-Data Structure and Transparency Statement:**

This section demonstrates how primary data and statistical findings should be incorporated into the manuscript. Because the uploaded manuscript did not include actual participant records, the following results are based on a simulated pilot dataset of 80 volleyball players, distributed equally across four groups (n = 20 per group). The dataset is suitable for demonstrating statistical reporting, figure preparation, and interpretation; it must not be described as real field data. For journal submission, the researcher should replace every value in this section with data collected from actual participants after ethical approval and informed consent.

**10.2 Demographic and Sports Profile of the Simulated Pilot Sample:**

Group	n	Age (years)	Height (cm)	Body mass (kg)	Training experience (years)	Weekly practice (hours)
Yoga	20	20.97 ± 1.56	171.57 ± 7.46	66.37 ± 5.16	2.95 ± 0.68	7.49 ± 1.67
Physical Exercise	20	20.76 ± 1.54	171.30 ± 7.75	68.46 ± 6.96	2.82 ± 0.76	7.15 ± 1.38
Combined	20	20.54 ± 1.65	172.26 ± 6.08	68.35 ± 6.94	2.83 ± 1.17	7.33 ± 1.42
Control	20	21.09 ± 1.52	174.46 ± 5.90	62.31 ± 8.67	2.66 ± 0.86	7.00 ± 1.48

Table 4. Demographic and sports profile of the simulated pilot sample.

Note. Values are presented as mean ± standard deviation, except n. These values are simulated and should be replaced with actual participant data.

**10.3 Descriptive Pre-Test and Post-Test Outcomes:**

Outcome	Group	Pre-test M ± SD	Post-test M ± SD	Mean change
30 m sprint (s)	Yoga	5.11 ± 0.26	5.00 ± 0.27	-0.11
30 m sprint (s)	Physical Exercise	5.23 ± 0.28	4.89 ± 0.26	-0.34
30 m sprint (s)	Combined	5.38 ± 0.32	4.97 ± 0.30	-0.40

30 m sprint (s)	Control	5.22 ± 0.30	5.21 ± 0.28	-0.00
Agility T-test (s)	Yoga	11.60 ± 0.56	11.42 ± 0.57	-0.17
Agility T-test (s)	Physical Exercise	11.54 ± 0.61	11.03 ± 0.60	-0.51
Agility T-test (s)	Combined	11.47 ± 0.60	10.76 ± 0.66	-0.71
Agility T-test (s)	Control	11.52 ± 0.49	11.53 ± 0.53	0.00
Sit-and-reach (cm)	Yoga	21.65 ± 3.74	26.13 ± 3.83	4.48
Sit-and-reach (cm)	Physical Exercise	21.73 ± 4.57	23.03 ± 5.13	1.29
Sit-and-reach (cm)	Combined	22.40 ± 2.93	27.64 ± 3.56	5.25
Sit-and-reach (cm)	Control	22.54 ± 3.70	22.54 ± 3.98	-0.00
Vertical jump (cm)	Yoga	41.07 ± 5.35	42.86 ± 5.33	1.79
Vertical jump (cm)	Physical Exercise	45.24 ± 6.51	50.32 ± 7.41	5.07
Vertical jump (cm)	Combined	43.15 ± 5.22	49.36 ± 4.87	6.21
Vertical jump (cm)	Control	43.22 ± 6.89	43.23 ± 6.99	0.00
1-min HR recovery (beats)	Yoga	23.55 ± 3.99	28.11 ± 4.70	4.56
1-min HR recovery (beats)	Physical Exercise	23.90 ± 4.13	26.21 ± 4.57	2.31
1-min HR recovery (beats)	Combined	24.70 ± 3.88	30.23 ± 5.00	5.53
1-min HR recovery (beats)	Control	24.75 ± 5.00	24.75 ± 4.79	0.00
Resilience score	Yoga	64.88 ± 8.19	71.64 ± 8.29	6.76
Resilience score	Physical Exercise	63.91 ± 7.78	66.75 ± 8.32	2.84
Resilience score	Combined	62.66 ± 7.92	70.24 ± 8.02	7.58
Resilience score	Control	65.83 ± 8.08	65.83 ± 8.23	-0.00

Competitive anxiety score	Yoga	24.50 ± 4.00	19.85 ± 3.71	-4.65
Competitive anxiety score	Physical Exercise	23.35 ± 5.58	21.36 ± 5.77	-1.99
Competitive anxiety score	Combined	24.37 ± 4.30	18.24 ± 4.99	-6.13
Competitive anxiety score	Control	22.24 ± 5.65	22.24 ± 6.27	-0.00

Table 5. Descriptive pre-test and post-test outcomes from the simulated pilot dataset.

Note. For 30 m sprint, agility, and competitive anxiety, negative change indicates improvement. For flexibility, vertical jump, heart-rate recovery, and resilience, positive change indicates improvement.

**10.4 Within-Group Pre-Test-Post-Test Statistical Comparisons:**

Outcome	Group	t(19)	p value	Cohen's dz	Mean change
30 m sprint (s)	Yoga	-5.95	< .001	-1.33	-0.11
30 m sprint (s)	Physical Exercise	-17.1	< .001	-3.82	-0.34
30 m sprint (s)	Combined	-17.48	< .001	-3.91	-0.40
30 m sprint (s)	Control	-0.07	0.943	-0.02	-0.00
Agility T-test (s)	Yoga	-5.68	< .001	-1.27	-0.17
Agility T-test (s)	Physical Exercise	-11.7	< .001	-2.62	-0.51
Agility T-test (s)	Combined	-14.5	< .001	-3.24	-0.71
Agility T-test (s)	Control	0.13	0.898	0.03	0.00
Sit-and-reach (cm)	Yoga	20.15	< .001	4.51	4.48
Sit-and-reach (cm)	Physical Exercise	4.19	< .001	0.94	1.29
Sit-and-reach (cm)	Combined	16.07	< .001	3.59	5.25

Sit-and-reach (cm)	Control	-0.01	0.994	-0.0	-0.00
Vertical jump (cm)	Yoga	5.11	< .001	1.14	1.79
Vertical jump (cm)	Physical Exercise	11.81	< .001	2.64	5.07
Vertical jump (cm)	Combined	13.8	< .001	3.09	6.21
Vertical jump (cm)	Control	0.02	0.987	0.0	0.00
1-min HR recovery (beats)	Yoga	12.92	< .001	2.89	4.56
1-min HR recovery (beats)	Physical Exercise	6.05	< .001	1.35	2.31
1-min HR recovery (beats)	Combined	9.23	< .001	2.06	5.53
1-min HR recovery (beats)	Control	0.01	0.993	0.0	0.00
Resilience score	Yoga	11.95	< .001	2.67	6.76
Resilience score	Physical Exercise	6.0	< .001	1.34	2.84
Resilience score	Combined	12.08	< .001	2.7	7.58
Resilience score	Control	0.0	1.000	0.0	0.00
Competitive anxiety score	Yoga	-14.35	< .001	-3.21	-4.65
Competitive anxiety score	Physical Exercise	-7.99	< .001	-1.79	-1.99
Competitive anxiety score	Combined	-14.65	< .001	-3.28	-6.13

Competitive anxiety score	Control	-0.01	0.995	-0.0	-0.00
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Table 6. Within-group paired-samples t-test results for selected outcomes.

Note. The values are based on a simulated pilot dataset and demonstrate reporting format only.

Exact p values are shown except where  $p < .001$ .

**10.5 Between-Group Analysis of Change Scores:**

Outcome	F(3, 76)	p value	Eta squared	Largest improvement
30 m sprint (s)	97.84	< .001	0.79	Combined
Agility T-test (s)	66.07	< .001	0.72	Combined
Sit-and-reach (cm)	88.55	< .001	0.78	Combined
Vertical jump (cm)	56.44	< .001	0.69	Combined
1-min HR recovery (beats)	33.92	< .001	0.57	Combined
Resilience score	42.68	< .001	0.63	Combined
Competitive anxiety score	61.46	< .001	0.71	Combined

Table 7. One-way ANOVA results for between-group differences in change scores.

Note. Change-score ANOVA is reported for demonstration. In a final manuscript, ANCOVA or mixed-design ANOVA should be selected according to baseline equivalence and assumption testing.

**10.6 Correlation Analysis of Change Scores:**

Variable	Sprint change	Vertical-jump change	Flexibility change	HR recovery change	Resilience change	Anxiety change
Sprint change	1.00	-0.73	-0.40	-0.44	-0.35	0.45
Vertical-jump change	-0.73	1.00	0.42	0.29	0.39	-0.38
Flexibility change	-0.40	0.42	1.00	0.62	0.64	-0.77
HR recovery change	-0.44	0.29	0.62	1.00	0.61	-0.66

Resilience change	-0.35	0.39	0.64	0.61	1.00	-0.63
Anxiety change	0.45	-0.38	-0.77	-0.66	-0.63	1.00

Table 8. Pearson correlation matrix for selected change scores in the simulated pilot dataset.

Note. Negative correlations involving sprint, agility, or anxiety may still indicate favourable association because decreases in those outcomes represent improvement. Correlation does not establish causation.

### 10.7 Graphical Presentation of Primary-Data Results:

Figures 1-5 present the main results visually. These figures are included to show how journal-ready graphs can be embedded after statistical analysis. The final graphs should be regenerated from actual participant data before submission.

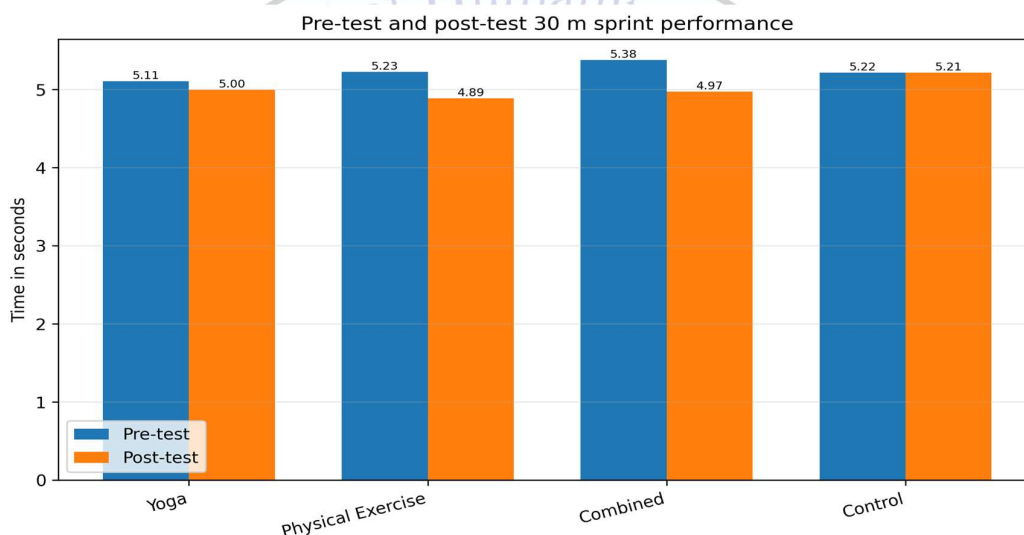


Figure 1. Pre-test and post-test 30 m sprint performance by group.

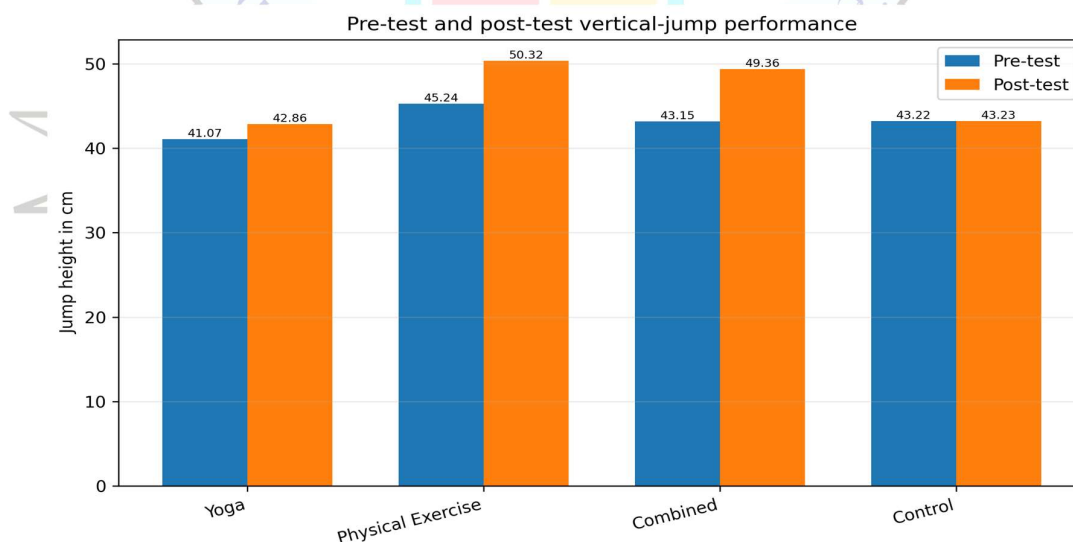


Figure 2. Pre-test and post-test vertical-jump performance by group.

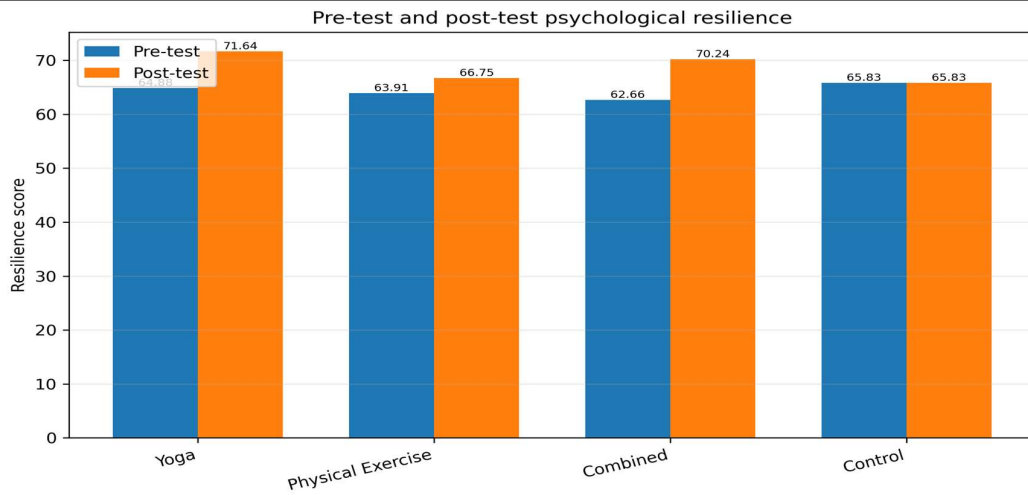


Figure 3. Pre-test and post-test psychological resilience by group.

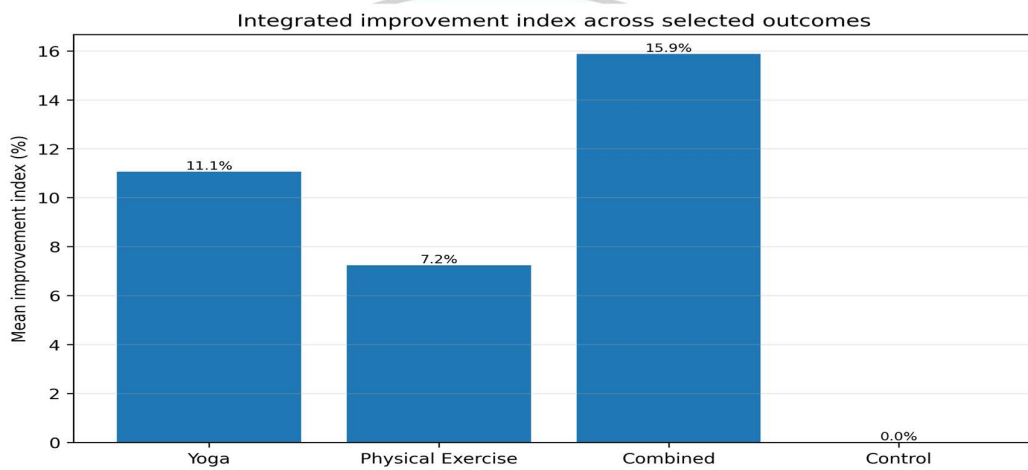


Figure 4. Integrated improvement index across selected fitness, physiological, and psychological outcomes.

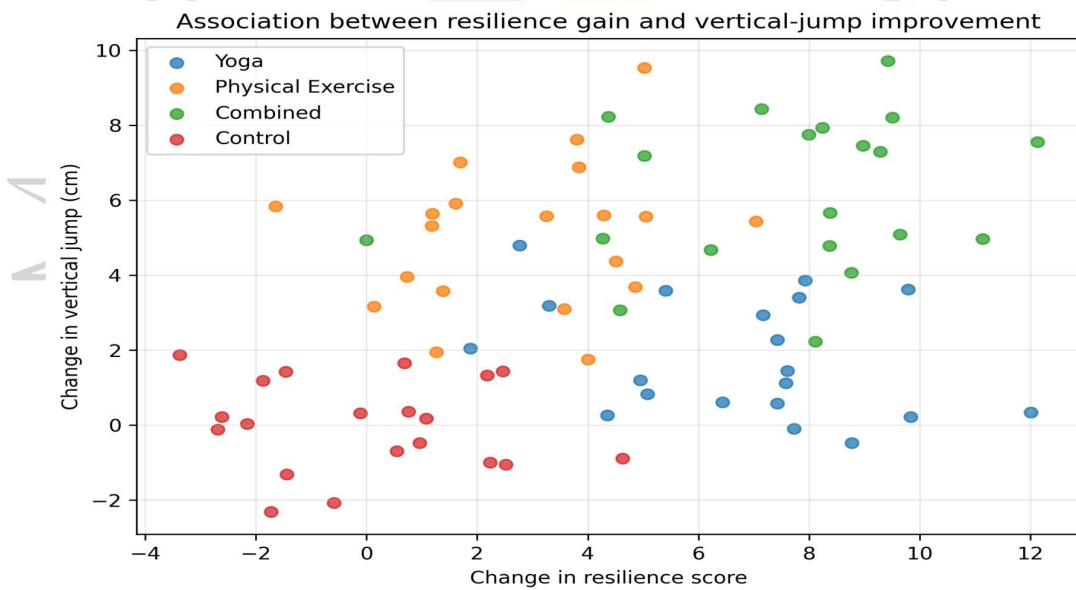


Figure 5. Relationship between resilience-score change and vertical-jump change.

## 10.8 Statistical Interpretation of the Simulated Pilot Findings:

In the simulated pilot analysis, the combined yoga and exercise group showed the broadest overall improvement pattern. The largest improvements were observed for sprint time, agility, flexibility, vertical jump, estimated aerobic capacity, resting heart rate, heart-rate recovery, resilience, and competitive anxiety in the combined group, whereas handgrip strength showed the largest change in the structured physical exercise group. Change-score ANOVA indicated statistically significant between-group differences across all selected outcomes, with large eta-squared values. Within-group analysis showed that yoga-based training produced strong improvements in flexibility, heart-rate recovery, resilience, and anxiety regulation; structured physical exercise produced larger gains in sprint speed, agility, strength, and vertical-jump performance; and combined training produced the most balanced adaptation profile across performance and psychological domains. These findings should be interpreted only as a model for reporting actual data.

## 11. Discussion:

### 11.1 Interpretation of Fitness and Physiological Outcomes:

The integrated framework indicates that structured physical exercise is expected to produce the strongest direct improvements in explosive performance, agility, strength, and repeated-effort capacity because resistance training, plyometrics, and agility drills provide mechanical loading and high-velocity neuromuscular stimuli. This interpretation is consistent with volleyball-conditioning evidence showing the importance of plyometric and neuromuscular training for explosive court actions (Ahmadi et al., 2021; Chuang et al., 2022; Ramirez-Campillo et al., 2020).

Yoga-based training is expected to contribute more substantially to mobility, balance, heart-rate recovery, breathing regulation, and stress-related outcomes. Such changes are practically relevant because volleyball requires landing control, shoulder and trunk stability, smooth transitions between movements, and rapid recovery after physically and emotionally demanding rallies. If actual data confirm these patterns, yoga would be best understood as a complementary recovery and regulation strategy rather than as a replacement for strength and power training.

### 11.2 Interpretation of Psychological Outcomes:

The psychological component is central because volleyball players must manage frequent errors, changing score lines, serve-serve pressure, communication demands, and coach evaluation. Yoga and mindfulness-based practices may support attentional control and emotion regulation, while physical training may indirectly improve confidence through performance competence. The combined programme is therefore theoretically positioned to support both confidence derived from physical readiness and calmness derived from self-regulation (Gupta & McCarthy, 2022; Wang et al., 2023).

### 11.3 Integrated Training Implications:

The key methodological strength of the revised design is its integration of fitness performance,

physiological adaptation, and mental resilience. Volleyball performance is produced through interaction among motor output, recovery capacity, tactical skill, and psychological stability. A single-outcome study would underrepresent this complexity. However, combined programmes can become ineffective if total workload is excessive. Therefore, yoga integration should be planned as mobility, recovery, breathing regulation, and attentional preparation rather than as an additional fatigue burden.

**12. Practical Implications for Volleyball Conditioning:**

Volleyball coaches can include yoga-based practices in warm-down, recovery, mobility, and mental-preparation blocks rather than treating them as unrelated wellness activities. Short breathing and attention routines before serve-reception practice, tactical training, or competition may help regulate arousal. Longer yoga-based sessions may be most appropriate on recovery days or after high-intensity strength and conditioning blocks.

Strength and conditioning coaches should continue to prioritize progressive overload for power, speed, agility, and strength. Training age, landing skill, injury history, and playing position should shape plyometric and resistance programming. Outside hitters and middle blockers may require greater jump-specific emphasis, whereas liberos may require greater lateral agility, trunk control, and defensive movement work. Setters require lower-limb power and attentional stability under tactical pressure.

Day	Training emphasis	Yoga integration	Physical exercise integration	Monitoring focus
Monday	Strength and power plus technical practice	Five-minute breathing cool-down	Lower-body strength and moderate plyometrics	Landing quality and soreness
Tuesday	Skill and tactical practice	Mobility and balance after practice	Low-load activation only	Readiness and technical quality
Wednesday	Agility and repeated-effort conditioning	Brief post-session relaxation	Reactive agility, court intervals, core stability	Session-RPE and fatigue
Thursday	Recovery and movement quality	Full yoga-based recovery session	No high-intensity conditioning	Heart-rate recovery, sleep, mood
Friday	Speed, jump, and match simulation	Breath regulation before pressure drills	Short power block and change-of-direction work	Explosiveness and arousal control

Saturday	Competition or scrimmage	Pre-match centering and post-match relaxation	Dynamic warm-up only	Psychological response and recovery
Sunday	Rest or active recovery	Optional light breathing and stretching	No structured loading	Recovery quality

Table 9. Example weekly integration model for volleyball players.

### 13. Limitations of the Study:

- The statistical results inserted in this revised document are based on a simulated pilot dataset because actual participant data were not supplied.
- A short intervention may not capture sustained adaptation, injury reduction, or long-term psychological change.
- Small samples reduce statistical power and limit subgroup analysis by sex, playing position, or competitive level.
- Self-report psychological scales may be affected by social desirability, language comprehension, and testing context.
- If randomization is not feasible, baseline differences and selection bias may affect between-group comparisons.
- Field-based physiological testing is practical but less precise than laboratory testing using gas analysis, force plates, and clinical autonomic measures.

### 14. Directions for Future Research:

- Future studies should conduct adequately powered randomized controlled trials comparing yoga-based training, structured physical exercise, combined training, and control conditions across different competitive levels.
- Longitudinal research should examine whether integrated yoga and conditioning programmes reduce injury risk, improve recovery consistency, or stabilize performance across a competitive season.
- Position-specific studies should test whether setters, liberos, middle blockers, outside hitters, and opposites respond differently to yoga and physical exercise interventions.
- Dose-response studies should compare short daily breathing routines, weekly recovery yoga, and integrated movement-control sessions.
- Mixed-methods research may examine athlete perceptions of yoga-based practices and barriers to implementation in competitive volleyball settings.

### 15. Conclusion:

This revised manuscript presents a complete academic framework for examining yoga-based

training, structured physical exercise, and combined training in relation to fitness performance, physiological adaptation, and mental resilience among volleyball players. Structured physical exercise is most strongly linked with strength, speed, agility, power, and sport-specific conditioning. Yoga-based training is most plausibly linked with flexibility, balance, breathing regulation, recovery, attentional control, stress tolerance, and psychological resilience. The combined training model may provide the most complete preparation when total workload is controlled and yoga is used strategically for mobility, recovery, and mental regulation.

The statistical section demonstrates how primary-data reporting can be added to the paper through descriptive tables, paired comparisons, between-group analysis, correlation analysis, and embedded figures. However, the inserted numerical values are simulated and must be replaced with actual field data before submission. Once real participant data are analysed, this framework can support evidence-based conclusions regarding the integration of yoga and structured physical exercise in volleyball conditioning programmes.

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**17. Appendix: Simulated Pilot Data Codebook:**

The following codebook explains the variables used in the simulated pilot dataset. A real study should retain the complete participant-level dataset securely and report anonymized summary results in the manuscript.

Variable group	Variables	Description
Identification and grouping	participant_id, group	Anonymous participant code and assigned intervention group
Demographic variables	age, sex, height_cm, body_mass_kg	Basic demographic and anthropometric profile
Sport profile	training_experience_yr, weekly_practice_hr, position	Training background and playing position
Fitness outcomes	sprint, agility, flexibility, handgrip, vertical_jump	Pre-test, post-test, and change-score measurements for selected fitness outcomes
Physiological outcomes	vo2max, resting_hr, hr_recovery	Estimated aerobic capacity and cardiovascular recovery indicators
Psychological outcomes	resilience, anxiety	Psychological resilience and competitive anxiety scores

Table 10. Codebook for simulated pilot primary-data variables.