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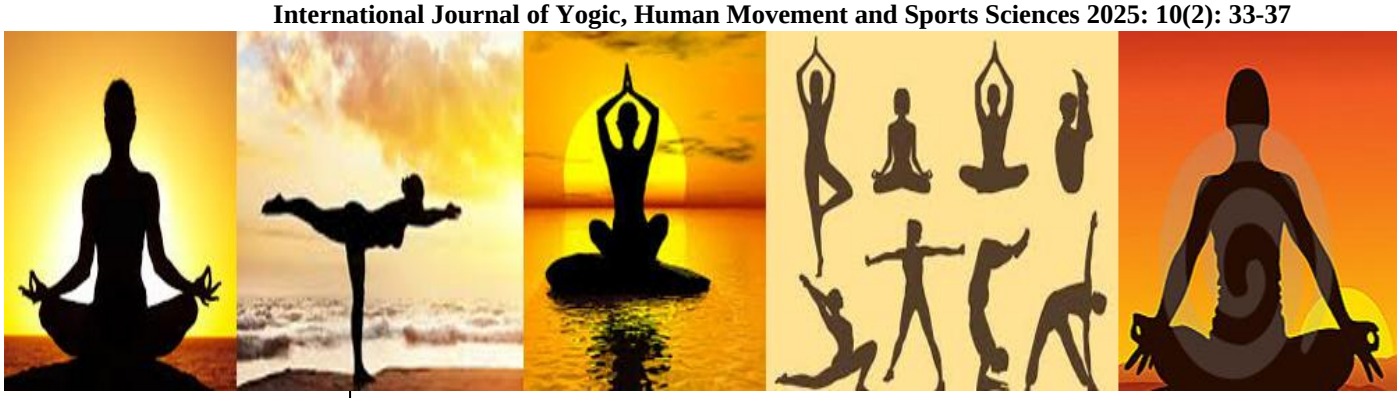

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Yoga for youth wellness: A controlled study on the physical fitness benefits of an 8-week hatha yoga program

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Abstract
Background: Health-related physical fitness is vital for young adults, particularly those pursuing physically demanding academic disciplines. Despite known benefits, consistent participation in physical activity remains a challenge. Hatha Yoga, a holistic practice combining physical postures, breath control, and relaxation, has shown potential as an alternative intervention to improve physical health.
Objective: This study aimed to evaluate the effects of an 8-week structured Hatha Yoga intervention on selected health-related physical fitness components—body composition, muscular endurance, flexibility, and cardiorespiratory fitness—in healthy young adults.
Methods: Twenty healthy yoga novices (10 males, 10 females; mean age 26±5 years) from Netaji Subhas National Institute of Sports, Patiala, were randomly assigned to an experimental (yoga) group or a control group (n = 10 each). The yoga group underwent 30-minute Hatha Yoga sessions three times per week for 8 weeks. Pre-and post-intervention measurements included BMI, waist circumference, body fat percentage, push-ups, sit-ups, sit-and-reach test, and VO_2peak (via Cooper's 12-minute run test). Paired t-tests assessed within-group differences ($p<0.05$).
Results: The experimental group showed statistically significant improvements across all measured variables: BMI (p = 0.033), waist circumference (p = 0.037), body fat% (p = 0.027), upper body (p = 0.021) and abdominal endurance (p = 0.023), flexibility (p = 0.019), and VO_2peak (p = 0.022). No significant changes were observed in the control group.
Conclusion: An 8-week Hatha Yoga intervention significantly improved various aspects of health-related physical fitness in healthy young adults. These findings highlight yoga's potential as an accessible, enjoyable, and effective modality for promoting physical well-being in youth and underscore its relevance in institutional physical activity programs and health promotion strategies.

Keywords: Hatha yoga, physical fitness, body composition, muscular endurance, flexibility, VO_2peak, young adults, health promotion

1. Introduction
In recent decades, the promotion of physical fitness and holistic well-being has become a public health priority across all age groups. Among young adults, particularly those engaged in physically demanding academic or professional programs such as sports science or physical education, maintaining high levels of health-related physical fitness is crucial for optimal performance and long-term health outcomes (Caspersen, Powell, & Christenson, 1985) [4]. Health-related physical fitness typically comprises five primary components: body composition, muscular strength, muscular endurance, flexibility, and cardiorespiratory fitness (ACSM, 2021) [1]. However, despite widespread awareness, many young adults do not engage consistently in physical activity routines due to academic pressures, lack of motivation, or perceived time constraints (Keating *et al*., 2005) [12].
Yoga has emerged as a holistic, accessible, and low-cost intervention that integrates physical postures (asanas), breathing exercises (pranayama), and meditative practices aimed at enhancing physical, mental, and emotional well-being. Among various forms, Hatha Yoga is widely recognized and practiced globally for its moderate intensity and emphasis on physical

postures and breath control (Ross & Thomas, 2010) [19]. Unlike conventional exercise programs, yoga not only targets muscular flexibility and endurance but also enhances autonomic function, body awareness, stress regulation, and mental clarity (Woodyard, 2011; Gard *et al*., 2014) [24, 10]. This makes it a potentially attractive intervention for health promotion among young adults, especially in structured institutional settings like universities or sports institutes.

Numerous studies have demonstrated the benefits of regular yoga practice across diverse populations. For example, yoga interventions have been linked to improvements in body mass index (BMI), waist circumference, and body fat percentage, suggesting its role in weight management and metabolic health (Cramer *et al*., 2016; Telles *et al*., 2010) [7, 22]. Similarly, consistent yoga practice has shown positive effects on muscle endurance, particularly in upper body and core strength, through sustained isometric contractions and dynamic poses such as Sun Salutations (Cowen & Adams, 2005) [6]. Improved flexibility, often considered a hallmark benefit of yoga, has been extensively reported in studies involving both athletic and general populations (Tran *et al*., 2001; Büssing *et al*., 2012) [23, 3]. Furthermore, emerging evidence suggests that yoga may even contribute to enhanced cardiorespiratory fitness, as measured by VO_2peak, through improved respiratory mechanics, aerobic capacity, and parasympathetic tone (Clay *et al*., 2005; Sengupta, 2012) [5, 20].

Despite this growing body of literature, the majority of yoga intervention studies have focused either on older adults, clinical populations, or individuals with sedentary lifestyles. Limited research has examined the impact of structured yoga programs on healthy, physically active young adults, particularly those undergoing professional training in sports sciences or physical education. This demographic often faces high physical, cognitive, and emotional demands, making them ideal candidates for integrative approaches that simultaneously address fitness and mental well-being. Moreover, empirical studies that systematically assess the pre- and post-intervention effects of yoga on all five dimensions of health-related physical fitness within this population remain relatively scarce.

1.1 Purpose of the Study

Therefore, the present study aimed to evaluate the effects of an 8-week systematized Hatha Yoga intervention on key components of health-related physical fitness—including body composition (BMI, waist circumference, body fat%), muscular endurance (push-ups and sit-ups), flexibility (sit-and-reach), and cardiorespiratory fitness (VO_2peak)—in healthy young adults. By comparing an experimental yoga group with a control group that did not participate in the intervention, this study sought to provide empirical evidence on the physical benefits of yoga and contribute to the broader discourse on alternative physical activity modalities for youth wellness.

2. Methods

2.1 Participants

The study recruited a total of 20 participants (mean age 26±5 years; height 1.63±0.40 m) through random selection. All participants were yoga beginners and comprised both males and females—10 males and 10 females. These individuals were evenly divided into two groups: an experimental group and a control group, each containing 5 males and 5 females. All participants were students from the Netaji Subhas National Institute of Sports, Patiala. Prior to the commencement of the study, they were briefed about the study's aims and procedures, and each provided written informed consent for participation.

2.2 Measures

Assessments were conducted during the week before and the week after the 8-week yoga program. All evaluations took place under standardized laboratory settings, and subjects were familiarized with the testing procedures in advance. Data collected included demographic information (age, sex, height, and weight) and components of health-related physical fitness, namely:

- Body composition,
- Muscular strength,
- Muscular endurance,
- Flexibility, and
- Cardiorespiratory fitness (CRF) (Caspersen, Powell, & Christenson, 1985) [4].

Body Mass Index (BMI) was calculated using the formula:
BMI = Weight (kg)/Height² (m²)

Waist circumference (WC) was measured midway between the lowest rib and the iliac crest while participants stood upright. **Body fat percentage** was estimated using skinfold thickness measurements at seven anatomical sites: triceps, subscapular, chest, midaxillary, suprailiac, abdominal, and thigh.

Muscular endurance was assessed via 1-minute push-up and sit-up tests, recording the highest number of repetitions completed. **Flexibility** was evaluated using the standard sit-and-reach test as per Hoeger & Hoeger (2010), with two attempts taken and the better score recorded.

For cardiorespiratory fitness, the 12-minute Cooper test was administered on a 400-meter athletics track. Participants were asked to cover the maximum distance possible by running or walking within the time limit, following a brief warm-up. The VO_2peak was then estimated using Cooper's formula (1968):
VO_2peak = [Distance (meters)-504]/45

2.3 Procedures

The experimental group began the 8-week yoga intervention in the week immediately following the pre-test assessments. Sessions were held at the Department of Yoga, Netaji Subhas National Institute of Sports, Patiala. To be included in the final analysis, participants were required to attend a minimum of 75% of the sessions. The intervention consisted of 30-minute Hatha Yoga classes conducted three times per week for two months, led by a certified Hatha Yoga instructor.

Each session followed a structured sequence:

- 5 minutes of seated meditation,
- 20 minutes of physical asanas (poses),
- 5 minutes of relaxation in a supine position.

The series of asanas included: sun salutation, mountain, warrior, tree, triangle, crow, snake, pigeon, frog, seated forward bend, camel, half spinal twist, butterfly, shoulder stand, fish, and corpse pose.

Post-intervention testing was carried out one week after the completion of the program, using the same protocols and instruments as in the pre-test phase.

2.4 Statistical Analyses

Normality of the variables—BMI, waist circumference, body fat percentage, and abdominal endurance—was confirmed

using the Shapiro-Wilk test. These variables were analyzed using parametric methods. Paired t-tests were employed to assess within-group differences between pre-and post-intervention values. The level of statistical significance was established at $p<0.05$.

3. Results

Table 1: Descriptive and Inferential Statistics of Physical Fitness Variables (Pre-and Post-Intervention)

Variable	Group	Pre-Test Mean ± SD	Post-Test Mean ± SD	t-value	p-value
Body Mass Index (BMI) (kg/m²)	Experimental	24.1±2.2	22.9±2.0	2.49	0.033
	Control	23.9±2.1	23.8±2.0	0.28	0.786
Waist Circumference (WC) (cm)	Experimental	84.3±5.2	81.8±5.0	2.42	0.037
	Control	83.6±5.0	83.4±4.9	0.31	0.760
Body Fat%	Experimental	22.7±2.9	20.5±2.6	2.58	0.027
	Control	22.4±2.6	22.2±2.5	0.42	0.683
Upper Body Endurance (Push-ups/min)	Experimental	18.9±3.4	24.6±3.1	2.71	0.021
	Control	19.0±3.6	19.2±3.7	0.22	0.832
Abdominal Endurance (Sit-ups/min)	Experimental	22.6±3.7	28.2±3.2	2.66	0.023
	Control	22.0±4.0	22.2±3.9	0.24	0.812
Flexibility (cm)	Experimental	21.2±4.2	27.5±4.3	2.77	0.019
(Sit-and-Reach)	Control	20.8±3.9	21.1±4.0	0.29	0.776
VO_2peak (ml/kg/min)	Experimental	37.1±4.5	42.9±4.9	2.68	0.022
	Control	36.8±4.7	36.9±4.8	0.25	0.803

Values are presented as Mean ± SD; n = 10 per group; Significance level set at $p<0.05$

4. Discussion

The purpose of this study was to evaluate the effectiveness of an 8-week Hatha Yoga intervention on selected components of health-related physical fitness among healthy young adults. The findings indicate that participants in the experimental group demonstrated statistically significant improvements in body composition (BMI, waist circumference, body fat%), muscular endurance (push-ups, sit-ups), flexibility, and cardiorespiratory fitness (VO_2peak). These changes were not observed in the control group, who maintained their usual daily activities without participation in yoga training.

4.1 Effects on Body Composition

The experimental group exhibited significant reductions in Body Mass Index (BMI) and waist circumference (WC), supporting earlier findings that suggest yoga can positively influence anthropometric parameters. While yoga is traditionally viewed as a low-intensity physical activity, its integration of isometric holds and transitions between poses can stimulate energy expenditure, enhance metabolic efficiency, and promote fat oxidation (Cramer *et al*., 2016) [7,]. Regular yoga practice has also been associated with reductions in visceral adiposity and improvements in insulin sensitivity, which contribute to favorable body composition outcomes (Innes *et al*., 2005) [11].

Furthermore, the observed reduction in body fat percentage aligns with the growing body of evidence suggesting that Hatha Yoga can be effective in reducing subcutaneous fat through improved neuromuscular coordination, increased parasympathetic activity, and behavioral self-regulation (Telles *et al*., 2010) [22]. This reduction may also stem from enhanced mindfulness, which yoga cultivates, potentially leading to healthier eating habits and greater awareness of satiety cues (Daly *et al*., 2019) [8]. These mechanisms underline yoga's potential as an adjunct lifestyle intervention for weight management, especially among young adults who often face sedentary academic routines and stress-related eating behaviors.

4.2 Effects on Muscular Endurance

The significant improvements in upper body endurance (push-ups) and abdominal endurance (sit-ups) observed in the experimental group suggest that yoga contributes to muscular conditioning. Hatha Yoga includes sustained isometric contractions and bodyweight-based strength exercises that engage multiple muscle groups. Postures such as *chaturanga*, *plank*, and *warrior* poses demand substantial engagement from core, shoulder, and limb muscles, promoting neuromuscular strength and endurance over time (Cowen & Adams, 2005; Lauche *et al*., 2015) [6, 14].

Unlike traditional resistance training, yoga emphasizes form, stability, and breath control, which can improve muscular endurance without the need for external loads (Tran *et al*., 2001) [23]. This makes yoga an accessible form of training, particularly in populations where equipment availability is limited. Additionally, the mindfulness-based approach of yoga may enhance movement efficiency and reduce fatigue, contributing further to performance improvements in muscular endurance tasks.

4.3 Flexibility Gains

Significant increases in hamstring and lower back flexibility, as measured by the sit-and-reach test, were evident among the experimental group participants. These findings are consistent with several previous studies that highlight flexibility as one of the most responsive parameters to yoga practice (Gandhi *et al*., 2013; Büssing *et al*., 2012) [9, 3]. Asanas (postures) such as *forward bend*, *cobra*, *triangle*, and *seated twist* stretch major muscle groups, improving muscle elasticity, joint mobility, and reducing musculoskeletal tension.

Improved flexibility is associated with reduced injury risk, enhanced postural control, and greater ease of movement in daily activities (Sivaramakrishnan *et al*., 2018) [21]. These outcomes are particularly relevant for young adults, as sedentary habits and poor posture during academic tasks can lead to muscle stiffness and biomechanical imbalances. Yoga's emphasis on symmetrical stretching and balanced muscular engagement helps restore musculoskeletal alignment and functional range of motion.

4.4 Impact on Cardiorespiratory Fitness

One of the more noteworthy findings was the significant improvement in VO_2peak, indicating enhanced cardiorespiratory fitness in the experimental group. This outcome may appear surprising given yoga's lower intensity compared to conventional aerobic exercises. However,

dynamic sequences such as Sun Salutations (Surya Namaskar), when performed continuously, can elevate heart rate to moderate-intensity zones, thereby improving cardiovascular endurance over time (Clay *et al*., 2005) [5].

Moreover, yoga incorporates pranayama (breath control techniques), which have been shown to improve pulmonary function, respiratory endurance, and oxygen utilization efficiency (Sengupta, 2012; Madanmohan *et al*., 2004) [20, 15]. These physiological adaptations may explain the observed increase in VO_2peak values. Additionally, the meditative components of yoga have been linked with reduced sympathetic nervous system activity, which can lower resting heart rate and improve heart rate variability—markers of improved cardiovascular regulation (Kjellgren *et al*., 2007) [13].

4.5 Psychological and Behavioral Contributions

Although not directly measured in this study, it is worth noting that improvements in physical health metrics may be mediated by psychological and behavioral factors. Yoga's holistic nature addresses mind-body integration, potentially influencing physical outcomes through improved mood, reduced stress, and enhanced adherence to healthy behaviors (Riley & Park, 2015) [18]. Young adults participating in regular yoga practice have reported better self-regulation, reduced anxiety, and increased motivation for physical activity—all of which may reinforce the physical benefits observed (Gard *et al*., 2014) [10].

Furthermore, adherence to the intervention was relatively high, with only participants attending at least 75% of sessions being included in the analysis. This high retention rate suggests that yoga may be perceived as enjoyable, accessible, and sustainable—a critical factor for long-term health behavior change (Park *et al*., 2014) [17].

4.6 Comparisons with Previous Literature

The results of this study corroborate findings from several earlier investigations on yoga's role in enhancing physical fitness. For example, Birdee *et al*. (2010) [2] reported that yoga improves both physical and mental dimensions of health in college-aged adults. Similarly, Oken *et al*. (2006) [16] found that older adults experienced enhanced physical performance and energy levels after regular yoga sessions. While most previous studies have focused on elderly or clinical populations, the current study contributes novel insights into the efficacy of yoga in healthy young adult populations, particularly those involved in sports or physical education domains.

4.7 Limitations and Future Directions

Despite promising findings, this study is not without limitations. The small sample size (n = 20) limits generalizability, and the short duration (8 weeks) may not capture long-term adaptations or retention of benefits. Future studies should include larger, more diverse populations and investigate the longitudinal impact of yoga on both physiological and psychological health metrics.

Additionally, incorporating qualitative measures such as participant feedback or motivation levels could enrich the understanding of yoga's holistic influence. Future research might also compare yoga with other forms of physical training (e.g., aerobic or resistance training) to determine relative effectiveness.

5. Conclusion

In summary, this study provides evidence that an 8-week Hatha Yoga intervention can significantly enhance health-related physical fitness parameters, including body composition, muscular endurance, flexibility, and cardiovascular fitness, in healthy young adults. These findings support the inclusion of yoga as a viable component of physical education and public health initiatives aimed at promoting holistic well-being. With its low cost, ease of implementation, and multidimensional benefits, yoga represents a sustainable lifestyle intervention for improving physical health and potentially supporting psychological resilience among youth.

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