Original Article

Impact of Yoga on Hematological and Physiological Parameters in Tribal Female College Students

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ABSTRACT

Background: Out of 243 million adolescents living in India, 9% belong to the Scheduled Tribes (ST) residing in underserved rural areas. Despite known disparities, limited research has examined the health and nutritional status of tribal adolescent girls. Although previous studies have shown the beneficial effects of yoga on physiological functions in general populations, there is a lack of evidence regarding its impact on haematological health in tribal college-going females. **Methodology:** Sixty tribal female college students aged 18–23 years were recruited and randomly assigned to a yoga group (n = 30; mean age ± SD = 19.07 ± 1.11) and a control group (n = 30; mean age ± SD = 19.37 ± 1.18). The yoga group participated in a 1-hour yoga session a day for 12 weeks, while the control group continued their routine. Outcome measures included haematological and physiological parameters. **Results:** Statistical analysis revealed significant improvements in the yoga group compared to the control group in haemoglobin (Hb) ($p = 0.001$), platelet count ($p = 0.009$), Red Blood Cells (RBC) count ($p = 0.001$), white blood cells (WBC) count ($p = 0.003$), Body Mass Index (BMI) ($p = 0.002$), and breath-holding time (BHT) ($p = 0.003$). Changes in blood pressure (BP) were not statistically significant. **Conclusion:** A three-month structured yoga program was effective in improving haematological profiles, BMI, and respiratory endurance in tribal female college students, suggesting the potential of yoga as a cost-effective health promotion strategy in underserved populations.

Key words: Yoga, Complete Blood Count, Health Status

The largest adolescent population in the world belongs to India, with over 243 million individuals aged 10–19 years [1]. Female adolescents from Scheduled Tribe (ST) communities face multiple health and social disadvantages due to their intersecting vulnerabilities related to gender, poverty, and socio-cultural marginalization. National surveys and reviews indicate that Indian adolescents, particularly girls, are at increased risk of malnutrition, anaemia, mental health issues, and early marriage [2]. Tribal populations in India comprise about 9% of the total population (over 104 million people). Although they are spread across the country, they are predominantly concentrated in Central, Eastern, and North-Eastern regions [3].

These communities have historically been socioeconomically disadvantaged, with limited access to healthcare and nutrition, resulting in a high prevalence of anaemia. These micronutrient deficiencies are also associated with irregular menstruation, low haemoglobin (Hb) levels, and delayed menarche in young women [4]. Several studies have highlighted the benefits of Yoga in enhancing cardiovascular, respiratory, and haematological health in both clinical and non-clinical populations. Short-term practices of pranayama and meditation have been found to improve cardiovascular parameters across age groups [5], while Bhramari pranayama and Omh chanting enhance pulmonary function [6].

Sudarshan Kriya Yoga, Hatha Yoga, and other traditional yogic practices have demonstrated positive effects on Hb levels, lipid profiles, stress biomarkers, and emotional well-being in college students and healthy individuals [7-10]. Moreover, Yoga has been shown to reduce stress, promote resilience, and support general health among students [11,12]. Despite this growing evidence, no study to date has specifically examined the impact of yoga practices on the haematological and physiological health of tribal female college students, a population at critical risk for anaemia, low physical fitness, and psychosocial stressors. Given the accessibility, affordability, and cultural acceptability of Yoga in India, it offers a valuable, community-based strategy to improve the health profile of this marginalized group. This study aims to bridge the existing research gap by assessing the impact of a structured Yoga intervention on selected haematological (e.g., Hb) and physiological parameters (e.g., blood pressure (BP), Body Mass Index (BMI), pulse rate) in tribal female college students. By targeting a population that is both nutritionally vulnerable and

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underrepresented in wellness-based interventions, the study has the potential to contribute meaningfully to evidence-based strategies for adolescent health promotion in tribal settings.

MATERIALS AND METHODS

This two-group pre–post experimental study was conducted at the Government Adivasi/Tribal College Girls' Hostel in Jawhar, Palghar District, Maharashtra. A total of 60 female tribal college students aged between 18 and 23 years were recruited and randomly (computer-generated randomisation) assigned to an experimental group or a control group. Since this was a preliminary exploratory study conducted based on feasibility and participant availability, a formal sample size calculation was not performed. Participants were selected based on the following eligibility criteria: unmarried tribal girls enrolled in undergraduate programs, residing in the hostel, familiar with the Marathi language, and in normal physical and mental health. Those females with ongoing medication, chronic illness, psychiatric disorders, or who did not reside in the hostel during the intervention period were excluded from the study. Written informed consent was obtained from all participants.

Intervention

The experimental group received a daily 1-hour integrated yoga intervention for a duration of 3 months (90 days), conducted by a certified yoga instructor. The intervention included loosening exercises, breathing awareness, *Surya Namaskara*, selected *asanas*, *pranayama*, and relaxation techniques. Sessions were conducted six days a week in the morning. The control group continued with their routine academic and hostel activities without any structured intervention.

Outcome Measures

Haematological Parameters

Venous blood samples were collected from all participants at baseline (Day 1) and post-intervention (Day 90) and analysed for complete blood count CBC), including: White Blood Cell (WBC) count, Red Blood Cell (RBC) count, Hb, Platelet count

Physiological Parameters

BP was measured in mmHg using a standard sphygmomanometer. Pulse Rate was assessed using a pulse oximeter. BMI and Breath Holding Time were measured as the duration (in seconds) a participant could sustain a humming sound ("mmm") during exhalation.

Data Collection and Analysis

All data were collected at baseline and after 90 days of the intervention. Data were entered into Microsoft Excel and analysed using SPSS version 20.1. Normality of data distribution was assessed using the Shapiro–Wilk test. As the data were not normally distributed, non-parametric tests were applied: Mann–Whitney U test for between-group comparisons and Wilcoxon signed-rank test for within-group (pre–post) comparisons. A p-value < 0.05 was considered statistically significant.

RESULTS

Participant Characteristics

A total of 60 tribal female college students were included in the study, with 30 participants each in the experimental (yoga) and control groups. The mean age of the yoga group was 19.36 ± 2.9 years, while the control group had a mean age of 19.06 ± 2.9 years. All participants completed the 3-month intervention period and post-assessment.

Haematological Parameters

Table 1 summarizes the changes in CBC parameters following the 3-month intervention. The yoga group demonstrated significant improvements in Hb, RBC count, platelet count, and WBC count compared to the control group. Hb and RBC levels showed notable increases following yoga practice, indicating possible improvement in hematological status. Platelet count also improved significantly after the intervention. WBC count increased in the yoga group by 17.68% compared to 3.86% in the control group ($p = 0.003$); however, this finding should be interpreted cautiously, as changes in WBC may reflect immune modulation, transient physiological adaptation, stress response, or normal biological variability rather than solely a beneficial effect. In contrast, the control group showed minimal or non-significant changes in most hematological parameters.

Physiological Parameters

Table 2 presents the changes in physiological parameters following the intervention. Participants in the yoga group showed significant improvement in pulse rate and breath-holding time (BHT), suggesting enhanced autonomic regulation and respiratory efficiency. Pulse rate decreased by 7.86% in the yoga group, while BHT improved by 16.26% following the intervention. BMI showed a modest reduction with a significant between-group difference ($p = 0.002$). Although systolic and diastolic BP showed trends toward improvement in the yoga group, the between-group differences were not statistically significant. Overall, the findings indicate favourable physiological adaptations associated with regular integrated yoga practice.

DISCUSSION

The present study evaluated the effects of a 3-month integrated yoga intervention on CBC and physiological parameters among tribal female college students. The findings demonstrated significant improvements in selected haematological parameters, particularly Hb levels, along with favourable changes in physiological variables in the yoga group compared to the control group. These findings suggest that yoga may serve as a feasible, low-cost, and non-pharmacological approach for promoting physiological well-being among underserved adolescent populations. The observed

improvements in pulse rate, BMI, and respiratory parameters are consistent with earlier studies reporting beneficial effects of yoga on autonomic regulation, cardiopulmonary efficiency, and haematological health [13–20].

Table 1. CBC Comparison – Pre and Post Intervention

Variables	Group N=60	PRE	POST	% Changes	ES	Within Gps (Wilcoxon-sign rank) Sig- P value	Sig- P values Between Gps (Mann-Whitney)	
		Mean/SD	Mean/SD			Pre/Post	Pre /pre	Post /post
Hb	Yoga N=30	10.40±1.32	11.50±1.07	10.57	0.91	0.001*	0.094	0.001
	Control N=30	10.10±1.26	10.17±1.02	0.69	0.06	0.564		
Platelets	Yoga N=30	2.33±0.47	3.07±0.58	31.75	1.40	0.001*	0.788	0.009
	Control N=30	2.37±0.49	2.63±0.66	10.97	0.44	0.087		
RBC	Yoga N=30	4.60±0.56	5.17±0.64	12.39	0.94	0.001	0.379	0.001
	Control N=30	4.47±0.50	4.53±0.62	1.34	0.10	0.617		
WBC	Yoga N=30	6220.00 ±1049.926	7320.00 ±1028.692	17.68	1.05	0.001	0.313	0.003
	Control N=30	6210.00 ±600.775	6450.00 922.422	3.86	0.30	0.245		

ES: Effect size, Hb- Haemoglobin, RBC- Red Blood Cells, WBC- White Blood cells; *-p<0.05.

Table 2. Changes in Physiological Parameters – Pre and Post Intervention

Variables	Group N=60	PRE	POST	% Changes	ES	Within Group changes (Wilcoxon-sign rank) P value	P values Between-group changes (Mann-Whitney U-test)	
		Mean/SD	Mean/SD			Pre/Post	Pre /Pre	Post /Post
BMI	Yoga N=30	16.67 ±2.83	16.57 ±2.28	0.59	0.03	0.593	0.002	0.002
	Control N=30	18.57 ±1.87	18.50 ±1.85	0.37	0.03	0.317		
Systolic BP	Yoga N=30	120.00 ±5.87	119.33 ±5.83	0.55	0.11	0.157	1.000	0.867
	Control N=30	120.00 ±6.94	119.67 ±7.18	0.27	0.04	0.564		
Diastolic BP	Yoga N=30	78.67 ±8.60	78.00 ±5.50	0.85	0.09	0.564	0.925	0.534
	Control N=30	78.98 ±7.30	79.33 ±7.84	0.82	0.04	0.317		
Pulse rate	Yoga N=30	83.43 ±9.00	76.87 ±8.63	7.86	0.74	0.001	0.001	0.928
	Control N=30	75.93 ±4.50	76.27 ±3.62	0.44	0.08	0.493		
BHT	Yoga N=30	11.50 ±2.76	13.37 ±2.91	16.26	0.65	0.001	0.087	0.003
	Control N=30	10.37 ±1.49	11.20 ±1.82	8.00	0.49	0.001		

ES: Effect size, BMI- Body Mass Index, BP- Blood Pressure, BHT- Breath Holding Time.

Previous research involving yoga, pranayama, meditation, and integrated yoga therapy has shown improvements in Hb concentration, blood indices, respiratory endurance, and cardiovascular parameters, supporting the findings of the present study. Although systolic and diastolic BP did not show statistically significant between-group differences, the trend toward improvement in the yoga group may indicate early cardiovascular adaptation. A major strength of the study was its practical implementation within the regular college schedule, which supported participant adherence and feasibility. Additionally, this is among the first studies conducted among tribal female college students in Jawhar, a population with limited prior exposure to yoga-based interventions. However, the limitations of the study were: the sample size was relatively small, participants were recruited from a single institution, and the intervention duration was limited. Since the study was conducted as part of an institutional academic activity, as a preliminary field-based educational/yoga intervention study, formal IEC approval and CTRI registration were not obtained before the commencement. Potential confounding factors such as dietary intake, menstrual status, and habitual physical activity levels were not systematically monitored or controlled during the study period, which may have influenced haematological and physiological outcomes. Furthermore, psychological and cognitive parameters were not assessed, and continuous supervision outside scheduled sessions could not be ensured. Future studies should include larger multi-centric samples, longer intervention periods, and a comprehensive assessment of lifestyle-related variables to better understand the multidimensional effects of yoga in underserved populations.

CONCLUSION

The present study suggests that a three-month integrated yoga intervention demonstrated beneficial effects on selected hematological and physiological parameters among tribal female college students. The findings suggest that yoga may serve as a feasible, low-cost, and culturally acceptable approach for promoting health and well-being in underserved populations. Further large-scale studies with rigorous methodology are required to confirm and extend these findings.

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