

Role of Sports in Modulating Blood Parameters among Undergraduate Allied Health Students in Tripura

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ABSTRACT

Regular engagement in sports is known to influence hematological and immunological responses, yet sex-specific effects among undergraduate allied health students remain underexplored. This study investigated the impact of sports participation on blood parameters and leukocyte distribution in male and female undergraduate allied health students in Tripura. A total of 88 students (44 boys, 44 girls) were assessed for anthropometric, physiological, and hematological parameters before and after participation in sports activity. Packed cell volume (PCV), hemoglobin (Hb), total red blood cell (TRBC) count, Total leukocyte count (TLC), and Differential leukocyte count (DLC) were estimated. Data were expressed as mean $\pm$ SE and analyzed using paired *t*-tests, with significance set at $p < 0.05$. Boys exhibited greater height, body mass, and aerobic performance compared to girls. Post sports activity, RBC counts increased significantly in both sexes, with a higher percentage rise in boys ($3.15 \pm 0.55\%$) than girls ($2.75 \pm 0.40\%$). Girls demonstrated significant increases in Hb and hematocrit, while boys showed stable Hb levels. WBC counts rose in both groups, more prominently in girls ($+43.75\%$), indicating a stronger stress-induced leukocytosis. Subtype analysis revealed greater lymphocyte mobilization in girls, whereas boys displayed stronger neutrophil responses. Eosinophil and monocyte percentages declined in both groups. Sports participation induces significant hematological and immunological changes in allied health students, with clear sex-specific patterns. While boys exhibited stronger erythrocyte and neutrophil responses, girls showed greater lymphocyte, hematocrit, and hemoglobin adaptations. These findings highlight the role of sports in modulating blood parameters and support its integration into student health promotion strategies.

Keywords- Allied health students, Blood parameters, Immune response, Sports.

I. INTRODUCTION

Sports and physical activity are integral components of a healthy lifestyle, exerting a profound influence on multiple physiological systems, including the cardiovascular, respiratory, and hematopoietic systems. Studies have shown that consistent exercise improves heart and lung function, enhances oxygen utilization, and supports immune health, which collectively contribute to better physical and mental well-being [1]. Among young

adults, particularly undergraduate students, sports participation plays an essential role not only in maintaining fitness but also in mitigating the adverse effects of academic stress and sedentary habits.

Blood parameters such as hemoglobin concentration, hematocrit, red blood cell (RBC) indices, white blood cell (WBC) counts, are essential indicators of how the body adapts to physical exercise and training. Research indicates that regular sports participation can stimulate the production of red blood cells, improve

oxygen transport efficiency, and influence immune cell distribution as part of the physiological adaptations to sustained physical activity [2]. Moreover, sports may induce transient or long-term changes in immune cell dynamics, reflecting both acute stress responses and chronic adaptation to training load [3].

In the context of allied healthcare students, who often experience academic pressure, irregular sleep, and fluctuating dietary habits, the role of sports in modulating blood parameters becomes particularly relevant. These students represent a unique population where lifestyle behaviors and academic stress can influence hematological and overall health outcomes. Participation in sports could serve as a protective factor, counterbalancing stress-induced physiological alterations and supporting immune and cardiovascular resilience [4].

While exercise physiology has been extensively studied globally, few studies have focused on how sports participation influences blood parameters among students in specific regions like Tripura, India. With anemia and other nutrition-related health problems still highly prevalent among Indian adolescents and young adults, examining the impact of physical activity on hematological health can help guide regional health policies and preventive strategies [5].

Therefore, this study aims to evaluate the role of sports in modulating blood parameters among undergraduate allied health students in Tripura. The findings may contribute to developing evidence-based recommendations for incorporating structured sports and physical activity programs into academic institutions to promote student health and resilience.

II. METHODOLOGY

Study Design and Setting: This cross-sectional study was carried out between January 2025 and April 2025 in a professional paramedical college located in West Tripura, India. Participants were recruited through random sampling. A structured proforma explaining the study objectives and procedures was distributed, and informed written consent was obtained prior to anthropometric assessments and venous blood collection.

Participants and Eligibility Criteria: A total of 96 undergraduate allied health students were enrolled, of which 88 met the eligibility criteria after screening. Inclusion criteria were: age between 18–21 years, male and female paramedical students, and voluntary participation with signed informed consent. Exclusion criteria included: history of chronic illness (e.g., tuberculosis, hypertension), acute infections (e.g., rhinitis, upper respiratory tract infection), recent surgery,

ongoing long-term medication (e.g., hormones, vitamins, hematinic, antitubercular therapy), and history of alcohol or tobacco use within the past 12 months.

Anthropometric and Physiological Measurements: Anthropometric parameters recorded included height, weight, and body mass index (BMI), calculated as weight (kg)/height (m²) in accordance with WHO standards (WHO, 1995). Physiological assessments included heart rate, measured manually at the radial artery, and blood pressure, recorded in triplicate using a mercury sphygmomanometer following 5 minutes of rest, with mean values documented [6].

Blood Sample Collection and Hematological Analysis: Venous blood samples (2 mL) were collected aseptically between 9:00-10:00 AM and 2:00-3:00 PM in K₂EDTA vials. All hematological parameters were conducted using an automated hematology analyzer (Horiba Yumizen H500, HORIBA Medical, France), which provides a complete blood count (CBC) and 6-part leukocyte differential with high precision and minimal sample requirement.

Parameters Evaluated: The primary blood parameters evaluated included hemoglobin (Hb), hematocrit (HCT), Total red blood cell count (TRBC), and differential leukocyte percentages (neutrophils, lymphocytes, monocytes, eosinophils and basophils). Secondary parameters included vital signs and anthropometric measures (BMI, blood pressure, and heart rate).

Statistical Analysis: All data were analyzed using IBM SPSS Statistics, version 24.0 (Chicago, IL). Results are expressed as mean $\pm$ standard error (SE). Paired-sample t-tests were applied to compare within-group changes, while independent-sample t-tests were employed to assess between-group differences in hematological and physiological parameters. A p-value <0.05 was considered statistically significant.

III. RESULT

Table 1 presents the physical and physiological characteristics of the participants (n = 88; 44 boys, 44 girls) along with their endurance performance outcomes. Boys were significantly taller (173.1 ± 1.2 cm) and heavier (69.4 ± 1.3 kg) than girls (160.2 ± 1.1 cm; 56.8 ± 1.1 kg), resulting in a higher BMI (23.1 ± 0.4 vs. 22.1 ± 0.5 kg·m⁻²).

Systolic and diastolic blood pressures were higher in boys (120.1 ± 1.4 mmHg and 74.6 ± 1.0 mmHg) than in girls (111.8 ± 1.2 mmHg and 68.7 ± 0.9 mmHg, respectively).

Table 1. Physical and physiological characteristics of the participants

Groups	Height (cm)	Weight (kg)	BMI (kg/m ²)	SBP (mmHg)	DBP (mmHg)
Boys (44)	$173.1 \pm 1.2^{\#}$	$69.4 \pm 1.3^{\#}$	$23.1 \pm 0.4^{\#}$	$120.1 \pm 1.4^{\#}$	$74.6 \pm 1.0^{\#}$
Girls (44)	160.2 ± 1.1	56.8 ± 1.1	22.1 ± 0.5	111.8 ± 1.2	68.7 ± 0.9

Table 2 summarizes hematological changes before and after exercise in male and female participants. Both groups showed an increase in red blood cell (RBC) count post-exercise, with boys exhibiting a greater percentage rise ($+3.15 \pm 0.55\%$) than girls ($+2.75 \pm 0.40\%$), indicating a stronger erythrocyte mobilization in males.

White blood cell (WBC) counts rose markedly in both sexes, consistent with an acute exercise-induced leukocytosis. Girls demonstrated a more pronounced increase ($+43.75 \pm 4.50\%$) compared to boys ($+28.72 \pm 2.15\%$), suggesting heightened immune reactivity or stress response in females.

Table 2: Changes in hematological parameters following exercise

Variable	Sex	Before Exercise	After Exercise	Percentage Change (%)
Red blood cell ($\times 10^{12}/L$)	Girls	4.72 ± 0.08	$4.85 \pm 0.07^*$	$+2.75 \pm 0.40^*$
	Boys	$5.08 \pm 0.09^\#$	$5.24 \pm 0.08^{*\#}$	$+3.15 \pm 0.55^{*\#}$
White blood cell ($/\mu L$)	Girls	7950 ± 280	$11,420 \pm 410^{***}$	$+43.75 \pm 4.50^{***}$
	Boys	8250 ± 240	$10,620 \pm 360^{**}$	$+28.72 \pm 2.15^{**}$
Hematocrit (%)	Girls	35.8 ± 0.35	$37.9 \pm 0.45^*$	$+5.87 \pm 1.25^*$
	Boys	$39.7 \pm 0.60^\#$	$40.0 \pm 0.55^\#$	$+0.75 \pm 0.40$
Hemoglobin (g/dL)	Girls	12.10 ± 0.15	$12.55 \pm 0.20^*$	$+3.72 \pm 1.60^*$
	Boys	$13.25 \pm 0.18^\#$	$13.20 \pm 0.17^\#$	$-0.38 \pm 0.45^\#$

Values expressed as mean $\pm$ SE. Negative values indicate a decrease. $^*P < 0.001$ = significant within-group change from pre-exercise; $^\#P < 0.001$ = significant between groups at the same time point.

Hematocrit levels rose significantly in girls (from $35.8 \pm 0.35\%$ to $37.9 \pm 0.45\%$; $+5.87 \pm 1.25\%$), whereas boys showed only a marginal change ($+0.75 \pm 0.40\%$). Similarly, hemoglobin concentration increased significantly in girls ($+3.72 \pm 1.60\%$), but slightly declined in boys ($-0.38 \pm 0.45\%$), possibly due to sex-specific differences in plasma volume shifts during exertion.

Overall, exercise induced significant hematological alterations in both sexes, with girls showing more robust relative changes in WBC, hematocrit, and hemoglobin, while boys demonstrated greater increases in RBC counts. These findings suggest that sex-specific physiological adaptation occur in response s to acute physical stress.

Table 3. Changes in absolute and relative leukocyte counts following exercise

Variable	Sex	Absolute Before	Absolute After	% Change (Absolute)	Relative Before (%)	Relative After (%)	% Change (Relative)
Lymphocyte	Girls	$2620 \pm 155^\#$	$3820 \pm 165^{***\#\#}$	$+45.80 \pm 6.25^\#$	$29.8 \pm 1.20^{\#\#}$	$34.9 \pm 1.30^{**\#\#}$	$+17.11 \pm 3.85^\#$
	Boys	1925 ± 145	$2680 \pm 175^{***}$	$+39.23 \pm 2.05$	22.2 ± 1.15	$25.3 \pm 1.28^{***}$	$+13.96 \pm 0.65$
Monocyte	Girls	210 ± 12	$238 \pm 10^*$	$+13.65 \pm 4.20$	2.45 ± 0.10	$2.18 \pm 0.06^{**}$	-11.02 ± 3.10
	Boys	$255 \pm 15^\#$	$290 \pm 12^{***\#\#}$	$+14.12 \pm 2.55$	$2.85 \pm 0.14^\#$	$2.70 \pm 0.12^{**\#\#}$	-5.26 ± 2.05
Neutrophil	Girls	4950 ± 210	$6090 \pm 275^{***}$	$+23.03 \pm 2.25$	60.4 ± 1.45	$55.8 \pm 1.50^{**}$	-7.61 ± 1.80
	Boys	5620 ± 135	$7485 \pm 185^{***\#\#}$	$+33.20 \pm 1.30^{\#\#}$	$66.3 \pm 1.30^\#$	$71.5 \pm 1.38^{***\#\#}$	$+7.84 \pm 0.75^{\#\#}$
Eosinophil	Girls	660 ± 90	$795 \pm 110^*$	$+12.80 \pm 6.50$	7.25 ± 0.82	6.45 ± 1.00	-20.31 ± 6.85
	Boys	640 ± 42	$755 \pm 55^{***}$	$+17.97 \pm 1.42$	8.65 ± 0.44	$4.85 \pm 0.25^{***}$	$-43.94 \pm 2.65^{\#\#}$
Basophil	Girls	16.0 ± 0.85	$19.6 \pm 0.55^{**}$	$+29.10 \pm 5.80$	0.18 ± 0.006	0.19 ± 0.010	$+4.55 \pm 3.60$
	Boys	15.5 ± 0.52	$17.9 \pm 0.65^{***}$	$+15.48 \pm 3.75$	0.18 ± 0.005	0.176 ± 0.007	-2.22 ± 2.85

Values are expressed as Mean $\pm$ SE. Negative values indicate a decrease. $^*P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$ = Significant within-group change (pre vs post). $^\#P < 0.05$, $^{\#\#}P < 0.01$, $^{\#\#\#}P < 0.001$ = Significant between-group difference at the same time point.

Table 3 outlines the changes in absolute and relative leukocyte counts following exercise in male and female students. Both groups exhibited a marked increase in lymphocyte counts, with girls showing a stronger absolute rise ($+45.80 \pm 6.25\%$) than boys ($+39.23 \pm 2.05\%$). Relative lymphocyte percentages also increased

in both sexes, with girls maintaining higher overall proportions, suggesting a stronger adaptive immune activation in females.

Monocyte counts rose modestly in both groups, with boys showing a slightly greater absolute increase ($+14.12 \pm 2.55\%$) compared to girls ($+13.65 \pm 4.20\%$).

However, the relative monocyte percentage decreased post-exercise in both sexes, reflecting a redistribution effect.

Neutrophil counts increased substantially in both groups, but the rise was more pronounced in boys ($+33.20 \pm 1.30\%$) compared to girls ($+23.03 \pm 2.25\%$). This was also reflected in relative percentages: boys demonstrated a significant increase ($+7.84 \pm 0.75\%$), while girls showed a decline ($-7.61 \pm 1.80\%$), indicating a sex-specific divergence in innate immune mobilization.

Eosinophil counts rose slightly in both groups, but the relative percentage decreased, more sharply in boys ($-43.94 \pm 2.65\%$) compared to girls ($-20.31 \pm 6.85\%$). Basophil counts increased modestly in both sexes, though their relative proportions remained largely unchanged.

Overall, exercise induced pronounced leukocyte redistribution, with females demonstrating stronger lymphocyte responses and males showing greater neutrophil mobilization. These findings highlight sex-specific immune adaptations to acute physical exertion.

IV. DISCUSSION

The present study investigated the role of sports and exercise in modulating blood parameters among undergraduate allied health students in Tripura, with a focus on sex-specific responses. The findings demonstrate that both male and female students exhibited significant hematological and immunological adaptations following exercise, though the magnitude and direction of changes differed between sexes.

Anthropometric and physiological data (Table 1) revealed that male students had higher body height, body mass, and aerobic performance compared to females, consistent with prior evidence that sex-based differences in muscle mass, hemoglobin levels, and aerobic capacity contribute to superior endurance performance in men [7,8]. Girls, however, presented higher pre-exercise heart rates, suggesting differences in baseline cardiovascular conditioning.

Exercise elicited significant increases in red blood cell count and white blood cell count in both groups (Table 2). While boys demonstrated a relatively greater erythrocyte response, girls showed more pronounced increases in hematocrit and hemoglobin. This may reflect sex-specific plasma volume shifts during exercise, with females being more susceptible to hemoconcentration effects [9]. The increase in WBC counts aligns with previous reports that acute physical activity mobilizes leukocytes into circulation as part of a transient stress and immune response [10].

Leukocyte subtype analysis (Table 3) further highlights differential immune adaptations. Females showed stronger lymphocyte mobilization, whereas males exhibited greater neutrophil activation, suggesting that exercise may preferentially enhance adaptive immunity in females and innate immune mobilization in males. These

patterns are consistent with earlier studies reporting that sex hormones influence leukocyte trafficking and cytokine responses [11]. The decline in relative eosinophil percentages and stable basophil counts in both sexes indicates redistribution rather than absolute suppression of these cell types, corroborating established exercise immunology models [12].

Overall, these findings suggest that sports participation induces measurable hematological and immunological shifts in young adults, with distinct sex-based patterns. Such adaptations may contribute to improved oxygen transport, immune surveillance, and exercise tolerance, supporting the health-promoting role of regular sports engagement in allied health students.

V. CONCLUSION

This study demonstrates that engagement in sports and exercise induces significant but sex-specific alterations in blood parameters among undergraduate allied health students. Males exhibited stronger erythrocyte and neutrophil responses, while females showed greater lymphocyte, hematocrit, and hemoglobin changes. These differences may be attributed to underlying physiological and hormonal influences on exercise-induced hematological and immunological responses.

The findings underscore the importance of incorporating regular sports and physical activity into the academic curriculum of healthcare students, both for enhancing physical performance and supporting immune function. Future studies with larger cohorts and longitudinal follow-up are recommended to establish causal relationships and explore the long-term health benefits of sports participation in this population.

REFERENCES

- [1] Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2006). Health benefits of physical activity: The evidence. *CMAJ*, 174(6), 801–809. <https://doi.org/10.1503/cmaj.051351>
- [2] Okon, I. A., Beshel, J. A., Owu, D. U., Orie, N. N., Edet, A. E., & Edet, L. I. (2025). Moderate aerobic exercise improves haematological indices without altering cardio-metabolic enzyme activities in sedentary healthy young adults. *BMC Sports Science, Medicine and Rehabilitation*, 17, 32. <https://doi.org/10.1186/s13102-025-01080-y><https://doi.org/10.1152/japplphysiol.00889.2018>
- [3] Nieman, D. C., & Wentz, L. M. (2019). The compelling link between physical activity and the body's defense system. *Journal of Sport and Health Science*, 8(3), 201–217. <https://doi.org/10.1016/j.jshs.2018.09.009>
- [4] Nath, S. K., & H. Pallathadka. (2025). Hematological Changes Associated with Examination Stress: Insights from a Pilot Study

- Among Undergraduate Allied Healthcare Students in Tripura. *World Journal of Biology Pharmacy and Health Sciences*, 2025, 23(02), 411-418. <https://doi.org/10.30574/wjbphs.2025.23.2.0781>
- [5] Nath, S. K., A. S. Das, & W. Wankhar. (2024). Prevalence of Non-Communicable Diseases Among Tea Garden Workers in West Tripura, India. *International Journal of Creative Research Thoughts*, 12(6), 472–480. <http://doi.org/10.1729/Journal.40345>
- [6] Nath, S. K., A. M. Dutta., S. Datta., S. Chattopadhyay., & A. S. Das. (2018). Nutritional and Health Status of the Tea Garden Workers of West Tripura District, Tripura, India. *International Journal of Research and Analytical Reviews*, 5(4), 700-706. <http://doi.org/10.1729/Journal.18631>
- [7] Cheuvront, S. N., Carter, R., & Sawka, M. N. (2003). Fluid balance and endurance exercise performance. *Current Sports Medicine Reports*, 2(4), 202–208. DOI: 10.1249/00149619-200308000-00006
- [8] Joyner, M. J. (2017). Physiological limits to endurance exercise performance: Influence of sex. *Journal of Physiology*, 595(9), 2949–2954. Article <https://doi.org/10.1113/JP272268>
- [9] Sawka, M. N., Convertino, V. A., Eichner, E. R., Schnieder, S. M., & Young, A. J. (2000). Blood volume: Importance and adaptations to exercise training, environmental stresses, and trauma/sickness. *Medicine & Science in Sports & Exercise*, 32(2), 332–348. <https://doi.org/10.1097/00005768-200002000-00012>
- [10] Nieman, D. C. (2001). Exercise immunology: nutritional countermeasures. *Canadian Journal of Applied Physiology, Annals of Nutrition and Metabolism*, 26(S1), S45-55. <https://doi.org/10.1139/h2001-041>
- [11] Gubbels Bupp, M. R. (2015). Sex, the aging immune system, and chronic disease. *Cell Immunology*, 294(2), 102–110. <https://doi.org/10.1016/j.cellimm.2015.02.002>
- [12] Pedersen, B. K., & Hoffman-Goetz, L. (2000). Exercise and the immune system: Regulation, integration, and adaptation. *Physiological Reviews*, 80(3), 1055–1081. <https://doi.org/10.1152/physrev.2000.80.3.1055>