

Research Article

Effect of Intense Physical Exercise in Sports Personnel on Hematological Parameters - A Prospective Analytical Study

Nusrath N¹, Shahanuma Shaik², Md K Faheem N^{3*}, Sushma C⁴, Indrani G⁵

¹Associate Professor, Dept. of General Medicine, Govt. Medical College, Nandyal.

²Associate Professor, Dept. of Pathology, Govt. Medical College, Nandyal.

^{3*}Associate Professor, Dept. of Pathology, Govt. Medical College, Kadapa.

⁴Associate Professor, Dept. of Pathology, S.V. Medical College, Tirupati.

⁵Professor & Head, Dept. of Pathology, S.V. Medical College, Tirupati.

Corresponding Author: Md K Faheem N

Associate Professor, Dept. of Pathology, Govt. Medical College, Kadapa.

Email: faheemkhader@gmail.com

Received: 06.06.26, Revised: 09.07.26, Accepted: 10.08.26

ABSTRACT

Introduction: Hematological parameters alter in high intensity physical exercises in a common manner. It might be due to various factors like - altered blood flow, hormonal changes, complex neurological signals etc., The changes in all the organs and organ systems are evident in them and blood being one of the most vital tissue of the body which carries oxygen and aids in defence mechanism, definitely shows variable changes in these individuals. Physical and physiological changes in virtually all organs and structures within the human body can occur during physical activity

Aim: To evaluate hematological profile in athletes and sportspersons who are involved in intense physical performance or activity

Objectives: To assess the demographic details of athletes, sportspersons with intense physical performance depending with relation to the type of sport, duration of intense physical activity (8-12 hrs of activity per week) from past one year of period and alterations in hematological parameters accordingly..

Materials and Methods: It is a cross-sectional prospective study conducted in a tertiary care hospital from a period of May 2025 to April 2026. Only the male individuals (to exclude statistical bias in comparison to females) were classified into four different groups based on sport played viz., Athletes (A), Cricket players (B), Volley ball (C) and Basket ball (D) players with total of 267 individuals attending out-patient departments and are undergoing complete Blood Picture (CBP) with Peripheral smear has been performed with automated cell counter and manual technique using Leishman's stain respectively. The slides were evaluated under microscope (100x) oil immersion. All findings were tabulated and statistical analysis was performed using Microsoft Excel and R software.

Results: Hematological alterations was observed more commonly in young adult age group between 18-25 years. There is remarkable depression in Hemoglobin, RBC, Hematocrit, MCV and MCH in Group D. RDW is raised and showed significant increase in both Group C and Group D individuals.

Conclusion: The most affected players were the athletes who practice for a long duration and in imminent stress. The hematological conditions of all the players should be evaluated periodically at different times. This step will be a beneficial bench mark for trainers to tailor the training program for different individuals practicing different sports.

Keywords: Hematological Parameters, High Intensity Exercise, Physical Activity, Sports Persons.

INTRODUCTION

Persons with active and intense physical performances during sports need extra calories which are to be supported by all the tissues of the human body. The changes in all the organs and organ systems are evident

in them and blood being one of the most vital tissue of the body which carries oxygen and aids in defence mechanism, definitely shows variable changes in these individuals. Taking into consideration the present scenario, it is

evident that, there is significant lacking of studies related to hematological parameters in stressed individual's viz., sportspersons.

Physical and physiological changes in virtually all organs and structures within the human body can occur during physical activity. Changes that occur in the individual can be observed by using the right experimental techniques, and what needs to be done in this direction can be determined. It is possible to achieve physiological adaptation to the different athlete training environments in the context of the data decided on the basis of the research ^(1,2)

In the relatively stable population, hematological parameters are determined by many factors. Those factors include education, age, sex, ethnicity, diet, and altitude ⁽²⁾. Each or all these factors may affect hematocrit (Hct), hemoglobin (Hb), and red blood cell (RBC) counts positively or negatively. In particular, the resistance training often decreases all three ⁽³⁾.

Hematological and biochemical parameters can differ by type, intensity, exercise duration, feeding status, and supplementation. The intense activity of 90 minutes to 2 hours of daily physical activity with 8 to 12 hours per week can be considered as intense physical activity in sportspersons ^(4,5).

The energy consumption and metabolism arising from long term workouts and competitions and metabolites expand in the body. Increased metabolites cause a gradual decline in muscle and nervous system function that leads to exhausting chemical, physiological, psychological and environmental factors in this exhaustion ⁽⁵⁾. The produced blood metabolites are lactic and pyruvic acid arising from the digestion of carbohydrates, urea, uric acid, phosphates, creatinine and creatinine as a result of the metabolism of proteins, acetone and ketone bodies as a consequence of fat metabolism. Besides, the chemical causes of fatigue are decrease in blood sugar, hypoglycemia and decrease in the amount of oxygen ^(6,7).

This study focusses to find out the probable hematological changes which may occur during intense physical performance in athletes and sportspersons which may or may not affect the health of the individual and aids to find out any alarming alerts which may give early signal of any factual changes that needs correction for the betterment of the

performance as well as well-being of the individuals. Thus, we herewith undertake the study to evaluate the positive and negative hematological effects on individuals who are undergoing intense physical training.

Aim & Objectives

Aim:

- To evaluate hematological profile in athletes and sportspersons who are involved in intense physical performance or activity

Objectives:

- To assess the demographic details of athletes, sportspersons with intense physical performance depending with relation to the type of sport, duration of intense physical activity (8-12 hrs of activity per week) from past one year of period.
- To evaluate the hematological profile (Hemoglobin, Red blood cell count, White blood cell count, Platelet count, Hematocrit, Red cell indices, Differential White blood cell count) in individuals with respect to demographic detail, type of sport, duration of intense physical activity.

MATERIAL AND METHOD

1. Study Design: Prospective analytical study

2. Study Setting: Clinical Pathology Laboratory, Central Lab, Dept. of Pathology, Sri Venkateswara Ramnarayan Ruia Government General Hospital/S.V.Medical College, Tirupati, Andhra Pradesh.

3. Study Period: A Period of one year from May 2025 to April 2026.

4. Study Subjects/units: The study subjects/individuals will be – athletes, sportspersons and people who are between the age group of 18-35 years, only male population (to avoid bias in normal values in female population) and involved in intense physical activity for 8 – 12 hours per week from past one year of time period, attending clinical pathology lab for investigations to attain physical fitness certificates based on the investigations.

5a. Inclusion Criteria:

- All male athletes and sportspersons who are involved in physical activity for at least 8-12 hours per week from past one year of period.
- The individual should be an actively performing male individuals of age group between 18 to 35 years.

5b. Exclusion Criteria:

- Already enrolled individuals in study; if attending lab in repetition.
- Individuals with pre-existing hematological disorders
- Individuals who have not given consent

Ethical Consideration: As a statutory requirement, the study is registered with institutional scientific committee with approval no: 272/SRC/2024 dated 22/07/2024 and permission obtained from Institutional ethics committee with respect to Lr.No.300/20245 on 03/08/2024. Relevant informed and written consent was obtained from all the participants of the study.

Statistical Analysis: The details were tabulated in Microsoft Excel software and basic statistical analysis likely – Mean, Standard deviation, p-value calculation was carried out. All categorical variables were designated as frequency and percentages. All the continuous variables are expressed as mean and standard deviation. One way ANOVA test was performed for comparative analysis of hematological parameters in individuals with altered body mass index and normal body mass index using R programming language for statistical computing and data visualization (freeware) stable release version 4.4.2 (2024). The p value of <0.05 was considered statistically significant.

6. Sample Size:

Convenient sampling method is chosen for the study and all the individuals who are athletes, sportspersons and are involved in intense physical activity are taken into consideration for studying the hematological profile at Clinical Pathology, Hematology division. However, taking into consideration the study performed by Banfi et al.,⁽⁸⁾ the prevalence of anemia which happens to be the common hematological manifestation in sports persons and athletes was found to be 6%. Thus, taking this into consideration

$$\text{Sample size} = Z^2 \times P(100-P) / E^2$$

Z = Z transformation score for given confidence interval (1.96)

P = Sports persons and athletes who are diagnosed with anemia as a common hematological manifestation (6)

E = Margin of error acceptable (3)

$$\text{Sample size} = (1.96)^2 \times 6(100-6) / 3^2 = 240.6$$

Therefore, at least 240 individuals are to be

examined to obtain an outcome in a span of quarter year in the present study.

7. Type Of Sampling: Convenient sampling

METHODOLOGY

Data Collection:-

Consent (oral, informed and written) was obtained from the individual and data related to age, sex, type of sport being played, number of hours being spent in active intense physical activity i.e., 8-12 hours of physical activity per week, practiced from past one year of period was be noted. All the data was recorded as per the information provided by the participant only. Other relevant data like clinical condition if any, details of past history of illness if any like covid, other infectious diseases, medical or surgical ailments if any treated for were noted in order to evaluate.

The blood sample was collected under aseptic precautions by venipuncture technique preferably from left cubital vein. Two (2 ml) milli liters of venous blood is collected using vacutainer in capped EDTA tube (Ethylene Diamine Tetra Acetic acid tube). The tube was subjected for mixing in a roller platform for 5 minutes and was analysed in Erba Transasia Elite 580, five part automated hematology analyser.

- Hemoglobin (g/dl); RBC (cells/cu.mm); WBC (cells/cu.mm); Platelets (cells/cu.mm); Hematocrit (%); Red cell indices viz., Mean Corpuscular Volume (MCV in femtoliters), Mean Corpuscular Hemoglobin (MCH in picograms); Mean Corpuscular Hemoglobin Concentration (MCHC in percentage) were analysed and noted in respective tabular columns.
- All the tabulated units based on numerical values and variables were analyzed and statistical calculations were performed using MS Excel (Microsoft Office Professional Copyrighted Version 2010); R Software/programming language. The continuous descriptive variables were calculated as Mean and Standard deviation; Categorical variables were shown as percentages. Chi square test was used as a tool for measuring association of different variables.

RESULTS

The cumulative findings of the research have showed that high intensity interval training (HIIT) was commonly practiced in individuals preferably male between 18-25 years,

whereas less commonly seen in males between 26-35 years of age. Overall male predominance was observed in HIIT group. (Table no. 1).

Individual sport event practiced by the participant was observed and time of practice also was taken into consideration – the participants were divided into four major groups based on the sport practiced namely, Cricket, Volley Ball, Basket Ball & Athletics as male individuals. (Table no. 2). There is significant depression in the mean RBC count, hemoglobin percentage, hematocrit, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) in contrast with elevation of red cell distribution width (RDW) in athletics and basket ball group when compared against the players of cricket and volley ball group of individuals. MCV; MCH & MCHC have revealed no statistically significant

difference in athletics (Table no. 2).

It is observed that there is no statistically significant difference in total leucocyte count and platelet count when compared between all four groups of participants. Differential leucocyte count analysis showed statistically significant difference in all the cells in athletics and basket ball playing individuals compared to players of cricket and volley ball playing individuals. (Table no. 3).

Peripheral blood evaluation revealed a different picture – where 12 (4.49%) of athletics group of individuals show anemia and 26 (9.73%) cricket playing group show anemia. Most common type of anemia noticed was dimorphic anemia 42 (15.73%) in both cricket and volley ball playing individuals followed by normocytic normochromic picture – 18 (6.74%) and 15 (5.61%) show microcytic hypochromic type of anemia

Table No: 1. Distribution of Individuals Based On Age With Respect To Sport

Sl.no	Sex	Type of sport	Age in years				Total (%)
			18-20	21-25	26-30	31-35	
1.	Male	Athletics	15	8	12	4	39 (14.6)
2.		Cricket	28	35	30	15	108 (40.4)
3.		Basket Ball	15	26	18	5	64 (23.9)
4.		Volley Ball	16	18	14	8	56 (20.9)
			74 (27.7)	87 (32.5)	74 (27.7)	32 (11.9)	267 (100)

Table No. 2: Comparative Analysis of Red Blood Cell (RBC) Parameters among Study Groups

Red blood cell parameters	Athletics (n=39) Mean +/- Standard Deviation (SD)	Cricket (n=108) Mean +/- Standard Deviation (SD)	Basket Ball (n=64) Mean +/- Standard Deviation (SD)	Volley Ball (n=56) Mean +/- Standard Deviation (SD)	P value P1 = p value of athletics p2 = p value of cricket and others (cumulative)
RBC (in million/cu.mm)	2.9+/-0.75	3.2+/-0.55	4.8+/-0.83	3.7+/-0.75	p1=0.0001 p2=0.0001
Hemoglobin (gm %)	8.7+/-1.72	10.2+/-1.72	13.24+/-1.82	12.27+/-1.58	p1=0.0001 p2=0.0001
Hematocrit (%)	25.24+/-5.82	35.82+/-7.26	44.24+/-4.28	42.85+/-3.82	p1=0.0001 p2=0.0001
MCV (femtolitres)	82.64+/-6.24	83.26+/-3.88	84.23+/-7.88	80.58+/-6.98	p1=0.022 p2=0.124
MCH (picograms)	25.37+/-3.14	26.36+/-2.16	30.18+/-1.82	27.186+/-1.52	p1=0.029 p2=0.251
MCHC (g/dl)	28.12+/-3.12	29.54+/-2.11	30.24+/-1.56	28.28+/-1.32	p1=0.036 p2=0.328
RDW (%)	12.98+/-0.8	13.28+/-0.58	11.94+/-0.58	10.82+/-0.46	p1=0.0001 p2=0.0001

Table No. 3: Comparative Analysis of White Blood Cell (WBC) and Platelet Observations among Study Groups

WBC & Platelets	Athletics (n=39) Mean +/- Standard Deviation (SD)	Cricket (n=108) Mean +/- Standard Deviation (SD)	Basket Ball (n=64) Mean +/- Standard Deviation (SD)	Volley Ball (n=56) Mean +/- Standard Deviation (SD)	P value P1 = p value of athletics p2 = p value of cricket and others (cumulative)
WBC – Total leucocyte count (X 1000 cells/cu.mm)	6.84+/-2.21	7.14+/-2.46	7.86+/-2.66	7.24+/-2.32	p1=0.62 p2=0.91
Platelets (lakhs/cu.mm)	1.98+/-0.81	2.24+/-1.14	264+/-1.05	232+/-0.84	p1=0.092 p2=0.51

DISCUSSION

Alterations of hematological parameters in normal individuals pose a diagnostic challenge in normal individuals in India and all the developing and under developed countries of the world. Deficiency of one or more nutrients required for haemopoiesis results in below normal average concentration of hemoglobin which in turn leads to nutritional anemia.⁽⁹⁾

The literature regarding hematological alterations in athletes and sports personnel is minimal and no recorded evidences are present related to the normal levels of hematological parameters in the above mentioned individuals.⁽¹⁰⁾ Therefore, it is considered that the periodic evaluation of hematological parameters of people practicing intense exercises and players involved in daily sport activities is to be carried out without fail for the need of better evaluation and progress as well as to take care of the fitness and health of the individuals. The evaluation during training periods and at rest, may be beneficial in terms of supporting and improving the training programs, increasing performance, or preventing possible adverse events in the future. ⁽¹¹⁾It can also be assumed that, the changes in the hematological parameters of sports persons after acute exercise offer essential break-through for further research and essential updates. Therefore, it can be assumed that the data obtained from this study shall contribute to the development of sports and lead research and development of sports medicine too.⁽¹²⁾

Normally, the exercise performance boost is affected by several factors, including the nervous system, hormones, and a variety of proteins, that significantly control the muscle tissue, resulting in effective oxygen and energy usage and hematological factors, such as improved oxygen-transporting capacity in

the blood circulation. From this point of view, it is considered that the existing hematological conditions of paralympic athletes or the hematological changes that occur as a result of exercise may affect their performance and even lead to particular health problems.⁽¹⁰⁾

In a study conducted by Ayhan et al.,⁽¹³⁾ (2017) the results showed Red Blood Cell RBC, Hemoglobin HGB, Hematocrit HCT, Mean Erythrocyte Volume MCV, Mean Hemoglobin MCH, Erythrocyte Hemoglobin Concentration MCHC, Platelet count shows statistically significant values ($p > 0.05$). White Blood Cell WBC values were found to be statistically significant ($p < 0.05$) in athletes category after performance compared to before performance. Saidi et al.⁽¹⁴⁾ found that athletes had a significant increase in WBC rates in their country, European and Turkey youth categories research on athletes. There is a significant increase in the prevalence of, MCH, MCHC values before and after the competition, as shown in the Gencer et al.⁽³⁾ (2018). The HCT and MPV values decreased significantly ($P < 0.05$). The findings show that intensive competitions may have affected the physiological characteristics of the basketball players. Chronic effects of exercise on blood parameters have been documented in some other research. Hematocritic and hemoglobin levels have been shown to be in activation. There are, however, not enough research on the impact of prolonged duration of competition on blood parameters. The analyzed the blood parameters of soccer players during the 10-day intense competition period and found a significant impact on the values of RBC (Erythrocyte), PLT (Platelet) and HGB (Hemoglobin) ($p < 0.05$) and statistically insignificant effect on the values of WBC (Leukocyte) ($p > 0.05$). Blood samples were taken the day after the research to rule out the acute impact of vigorous exercise.

Study by Wu et al⁽¹⁵⁾ (2004) on 24-hour marathon runners shows a substantial decrease in red cell count, Hb and Hct rates by day two after race. The mean concentration of cell Hb on day two was slightly lower than before the race. Mean cell Hb and the red cell distribution width remained constant at all times. Red cell count, Hb and Hct, three anemia markers, had been normal prior to the race. Consistent with RBC's rapid deterioration of endurance athletes, substantial declines were noticed in due course of time. The results and observations of vigorous training on athlete safety can be used to support athletes in future competitions. Is caused not only by hemolysis due to mechanical trauma but also by red cell oxidizing injuries. Red cells with a mean life of 120 days are renewed at approximately 1% daily under normal conditions.⁽¹⁶⁾ Turnover rate increases after the endurance training. The increased turnover rate is beneficial for athletes because young red cells can be more effective in carrying oxygen than older cells.⁽¹⁷⁾ The mean volume of cells, the mean concentration of cell hemoglobin and the mean concentration of cell hemoglobin all remained normal. Transient sports anemia has been caused by reduced red cell numbers, rather than red cell size or Hb volume⁽¹⁸⁾. The adjustment to the number of platelets was inconsistent with previous studies. Similar findings were observed in the present study.

CONCLUSION

The present study tries to conclude that the hematological parameters could be affected by physical well being, fitness and endurance of individuals based on performance depending on time of practice and intensity of physical performance. The most affected players were the athletes who practice for a long duration and in imminent stress. The hematological conditions of all the players should be evaluated periodically at different times. This step will be a beneficial benchmark for trainers to tailor the training program for different individuals practicing different sports, especially for athletes to increase performance constantly, and eventually for sports medicine to prevent and rehabilitate possible health problems in the due course of future.

Disclosure Statement: No potential conflict of interest was reported by the authors.

Acknowledgements:

Funding and grants: No funding was provided for the project. This is completely a self-financing project and research.

Academic and Professional Support: We sincerely thank the members of scientific and ethics committee of the institution for their kind and needed support during this project. We thank all the participants, Principal(s) and Superintendent(s) of S.V.Medical College, Tirupati and S.V.R.R.Govt. General Hospital, Tirupati respectively for their active involvement and unwavering support throughout the research project.

Authors' Contributions'

Dr. N.Nusrath: concept and design of the study, acquisition of data, statistical analysis, drafting of the manuscript.

Dr. Md Kadher Faheem.N: concept and design, interpretation of data, critical revision of the manuscript.

Dr. Shahanuma Shaik, Dr.C.Sushma & Dr.G.Indrani: laboratory supervision, interpretation of data, critical revision, clinical supervision, interpretation of data, critical revision of the manuscript.

All authors read and approved the final version of the manuscript to be published

REFERENCES

1. Brandão F, Fernandes HM, Alves JV, Fonseca S, Reis VM. Hematological and biochemical markersM after a Brazilian Jiu-Jitsu tournament in world-class athletes. *Revista Brasileira de Cineantropometria & Desempenho Humano*. 2014;16(2):144-51.
2. Tiller NB, Roberts JD, Beasley L, Chapman S, Pinto JM, Smith L, Wiffin M, Russell M, SparksSA, Duckworth L, O'Hara J. International Society of Sports Nutrition Position Stand: nutritional considerations for single-stage ultra-marathon training and racing. *Journal of the International Society of Sports Nutrition*. 2019 Dec 1;16(1):50.
3. Gencer YG, Coskun F, Sarikaya M, Kaplan S. Investigation on the effects of 12 days intensive competition on some blood parameters of basketball players. *Journal of Education and Training Studies*. 2018 Mar 7;6(4):79-83.
4. Murat Erdogan, Mehmet Faith Yuksel, Bulent Isik, Ekrem Boyali, Kenan

- Erdagi, Tarik Sevindi. The effects of acute moderate intensity training on hematological parameters in elite para-badminton athletes. *Journal of Men's Health*. 2022; 18(2): 035
5. De Oliveira Mota Ribeiro W. Performance analysis in wheelchair para-badminton matches. *International Journal of Racket Sports Science*. 2020; 2: 22-31.
6. Strapasson AM, Alves MLT, Duarte E. Para-badminton teaching for physical disabilities children. *Revista da Associação Brasileira de Atividade Motora Adaptada*. 2019; 20: 3-16.
7. Park HY, Park W, Lim K. Living High-Training Low for 21 Days Enhances Exercise Economy, Hemodynamic Function, and Exercise Performance of Competitive Runners. *Journal of Sports Science and Medicine*. 2019; 18: 427-437.
8. Banfi, G & Roi, Giulio & Dolci, Alberto & Susta, Davide. Behaviour of haematological parameters in athletes performing marathons and ultramarathons in altitude ('skyrunners'). *Clinical and laboratory haematology*. 2005; 26:373-7.
9. Baker S J, De Maeyer E M. Nutritional Anaemia: its understanding and control with special reference to the work of the World Health Organisation. *The American Journal of Clinical Nutrition* 1979; 32:368-417.
10. Park HY, Park W, Lim K. Living High-Training Low for 21 Days Enhances Exercise Economy, Hemodynamic Function, and Exercise Performance of Competitive Runners. *Journal of Sports Science and Medicine*. 2019; 18: 427-437.
11. Murat Erdogdu, Mehmet Faith Yuksel, Bulent Isik, ekrem Boyali, Kenan Ergagi, Tarik Sevindi. The effects of acute moderate intensity training on hematological parameters in elite para-badminton athletes. *J. Mens. Health* 2022; 18(2): 1-8.
12. Shumoos H Alwaid. The effects of different intensive physical performances by athletes on selected hematological parameters. *Indian Journal of Forensic Medicine and Toxicology*. 2021; 15(1): 2199-2203.
13. Ayhan S, Ersöz G, Güllü A, Akpolat V, Tizar E. The Effects of Competition Performance in Elite Male Football Players on Selected Biochemical and Hematological Parameters. *International Archives of Medical Research*. 2017;9(1):15-23.
14. Saidi K, Zouhal H, Rhibi F, Tijani JM, Boullosa D, Chebbi A, Hackney AC, Granacher U, Bideau B, Ben Abderrahman A. Effects of a six-week period of congested match play on plasma volume variations, hematological parameters, training workload and physical fitness in elite soccer players. *PloS one*. 2019 Jul 25; 14(7):e0219392.
15. Wu HJ, Chen KT, Shee BW, Chang HC, Huang YJ, Yang RS. Effects of 24 h ultra-marathon on biochemical and hematological parameters. *World journal of gastroenterology: WJG*. 2004; 10(18):2711.
16. Cinar V, Cengiz S, Pala R, Dundar A. Effect of football practices on certain blood values of athletes. *Advances in Environmental Biology*. 2013; 1:924-928.
17. Weight LM. Sports anaemia. *Sports medicine*. 1993 Jul 1;16(1):1-4.
18. Jordan J, Kiernan W, Merker HJ, Wenzel M, Beneke R. Red cell membrane skeletal changes in marathon runners. *International journal of sports medicine*. 1998 Jan;19(01):16-9.