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EXPLORING BLOOD GROUP DISTRIBUTION AMONG UNIVERSITY ATHLETES: ADVANCING HEALTH INSIGHTS FOR SUSTAINABLE ATHLETIC DEVELOPMENT

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ABSTRACT

Background: Blood group variations may influence athletic performance, yet their distribution and competitive implications among university athletes remain underexplored within sustainable athletic development frameworks. Objective of the study is to characterize blood group distribution and assess its association with winning status in university athletes. **Methods:** A cross-sectional study of 210 university athletes (64.3% male; 36.7% professional-level) categorized by sport specialization and ABO/Rh blood typing. Competitive outcomes were tracked during university-level championships. Chi-square tests, standardized residuals, and odds ratios (ORs) with 95% confidence intervals (CIs) were used to evaluate blood group–winning correlations. **Results:** Blood group distribution revealed O+ (26.7%), A+ (21.0%), and B+ (18.6%) predominance. A significant association existed between blood groups and winning (χ^2 = 20.76, p = 0.004; Cramer's V = 0.31). AB+ (OR=2.27, 95% CI: 0.88–5.82) and B+ (OR=1.73, 95% CI: 0.76–3.94) athletes demonstrated the highest winning odds versus O+ references, with significant positive standardized residuals (AB+: +1.89; B+: +1.62). Rh+ athletes had 3.2× higher winning odds than Rh- counterparts (95% 1.45–7.09, p=0.003). **Conclusion:** AB+ and B+ blood groups correlate with superior competitive outcomes, while Rh+ status confers a significant winning advantage. These findings highlight haematological factors as potential biomarkers for talent identification and sustainable athlete health optimization.

Keywords: Blood Group Distribution, University Athletes, Sustainable Athletic Development, Health Profiling, Sports Science, Performance and Well-being

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INTRODUCTION

Blood groups represent a fundamental aspect of human biology, with emerging evidence suggesting their influence extends beyond transfusion medicine to physiological resilience, disease susceptibility, and potentially athletic performance.[1] In competitive sports, optimizing health and sustainability hinges on understanding biological individuality.[2] The ABO blood group system categorized into O, A, B, and AB phenotypes—has been linked to variations in inflammation markers, metabolic efficiency, and injury recovery. For instance, individuals with blood group O may exhibit enhanced oxygen-carrying capacity and endurance, while non-O groups demonstrate altered von Willebrand factor levels affecting clotting and recovery.[3]

Despite these potential implications, blood group distribution remains underexplored in athletic populations, particularly among university athletes who balance rigorous training with academic demands. This demographic faces unique stressors that can amplify health vulnerabilities, yet tailored interventions are often hindered by a lack of population-specific data. [4] Current athlete health assessments prioritize anthropometry, cardiovascular metrics, and nutritional status, overlooking haematological factors like blood type that may inform personalized strategies for injury prevention, recovery protocols, and nutritional planning.[5]

Notably, while blood group studies exist in general populations, data specific to athletes, especially across diverse sporting disciplines, are scarce. only three small-scale studies examining blood types in track and field athletes, revealed inconsistent associations between group O and endurance performance.[5] No comprehensive studies have evaluated blood group prevalence across team sports, strength disciplines, or individual endurance events within a university setting. This gap limits the ability of sports scientists and clinicians to develop holistic health frameworks that address biological heterogeneity.

In regions like South Bangalore, where genetic diversity is high and sports medicine infrastructure is developing, understanding athlete-specific blood group patterns could advance equitable health interventions. University athletes here represent a critical cohort: they are future elite competitors yet often lack access to personalized training and medical support. Establishing baseline haematological profiles would empower institutions to mitigate correlation while fostering sustainable athletic development.

This study aims to: (1) characterize ABO blood group distribution among university athletes across multiple sports disciplines, (2) examine associations between blood type, Rh factor and sport-specific performance metrics (podium finish), By integrating haematological data into athlete health assessments, we seek to advance personalized strategies that enhance longevity, performance, and well-being in competitive sports.

METHODOLOGY

This study adopted a cross-sectional observational design with the primary objective of exploring the distribution of blood groups among university-level athletes participating in various sports disciplines.[6] It also aimed to examine potential associations between blood group types and demographic or performance-related factors such as sex, age, and anthropometric characteristics.

The research was conducted across multiple universities where intercollegiate athletic meets and university-level sports training programs were held. Data collection took place at university sports centers, athletic departments, and training facilities with prior institutional approval. (DSU/COPT/2025/726)

The data collection process spanned over one year, 2024 to 2025, aligning with university athletic trials and competitions to ensure access to active participants.

The study population comprised university-level athletes actively involved in sporting events such as athletics, badminton, swimming, tennis, cycling, shot put, and sprinting. A total of 210 athletes were recruited for the study, ensuring a statistically adequate sample to carry out robust analyses, including chi-square tests for association. The sample size was determined using G*Power software, where a medium effect size ($w = 0.3$), a significance level ($\alpha = 0.05$), a power of 80% ($1 - \beta = 0.80$), and degrees of freedom ($df = 7$) yielded a minimum required sample size of 143.[7] To improve generalizability and reduce sampling error, the final sample was expanded to 210.

Participants were selected using a purposive sampling technique, targeting athletes who fulfilled the eligibility criteria. Athletes from both team-based and individual sporting events were included to ensure a representative range of physical demands and performance variables.[8]

The inclusion criteria encompassed university athletes aged between 18 and 25 years, who were actively competing or training at the university level and were willing to participate with informed consent. Exclusion criteria included athletes who did not know their blood group and individuals unwilling to disclose their blood group information or provide consent.

Following institutional ethical approval and informed consent, data were collected through a structured process. Athletes provided their age, sex, height, and weight, with height measured using a stadiometer and weight using a calibrated digital scale. The type of sports discipline was also recorded for each participant.

Information regarding blood groups was either self-reported based on valid documentation, such as blood donor cards, medical records, or a Driving license. [9] Athletic performance was classified based on competitive outcomes. Athletes who secured 1st, 2nd, or 3rd positions in competitions were labelled as Podium Finishers, while all others were designated as Non-Podium Finishers. These classifications were verified through official records obtained from the respective university sports departments.

All procedures strictly adhered to ethical standards. Written informed consent was obtained from all participants, and confidentiality of their data was maintained throughout the study. Participant identities were anonymized during data analysis to protect privacy.[10]

Statistical Analysis:

All statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). [11] Descriptive statistics were used to summarize the demographic and anthropometric characteristics of the participants. Continuous variables such as age, height, and weight were presented as means and standard deviations (SD), while categorical variables, including sex, blood group, sports discipline, and podium finish status, were expressed as frequencies and percentages.

The Chi-square (χ^2) test of independence was employed to examine the association between blood group distribution and podium finish status among university athletes. The strength and significance of associations were determined using Pearson's Chi-square values, and statistical significance was set at $p < 0.05$.[12]

Additionally, post hoc residual analysis was performed where applicable to identify specific blood group categories contributing significantly to the observed associations. Effect sizes were interpreted using Cramér's V, with the thresholds for small (V = 0.1), medium (V = 0.3), and large effects (V = 0.5) as per Cohen's criteria.[13]

RESULTS

Participant Demographics and Blood Group Distribution

A total of 210 university-level athletes participated in this cross-sectional study (Table 1). The cohort exhibited a male predominance (64.3% male vs. 35.7% female), reflecting gender distributions common in competitive university athletics. All athletes competed at the university level, with 36.7% identifying themselves as professional-level competitors and 63.3% as recreational athletes.

Table 1: Frequency and Percentage Distribution of Gender, Athletic Participation Level, Sport Types, and Blood Groups among University Athletes

Variable	Category	Frequency	Percentage
Gender	Male	135	64.30%
	Female	75	35.70%
University-level athlete	Yes	210	100.00%
	No	0	0.00%
Professional/recreational athlete	Professional	77	36.70%
	Recreational	133	63.30%
Types of sports played			
Anaerobic athletes	Running 200 metres	23	11.00%
	Running 100 metres	54	25.70%
	Running 400 metres	4	1.90%
Aerobic athletes	Long-distance runner	13	6.20%
	Swimming	21	10.00%
	Cycling	6	2.90%
Power athletes	High jump	12	5.70%
	Long jump	15	7.10%
	Shotput	23	11.00%

Racket sports Athletes	Badminton	31	14.80%
	Tennis	8	3.80%
Blood group	A-	10	4.80%
	A+	44	21.00%
	B-	13	6.20%
	B+	39	18.60%
	AB-	13	6.20%
	AB+	27	12.90%
	O-	8	3.80%
	O+	56	26.70%

Sport Specialization

Anaerobic Athletes (38.6%) formed the largest cohort. This group comprised sprinters competing in short-duration, high-intensity events reliant primarily on the phosphagen and glycolytic energy systems. Within this category, 100-metre runners were the most prevalent subgroup (25.7% of the total sample), followed by 200-metre runners (11.0%). 400-metre runners represented the smallest subgroup (1.9%).

Power Athletes (23.8%) represented the second-largest group. These athletes participated in explosive, strength-speed dominant field events requiring maximal force production over very short durations. Shot put (11.0%) was the most common discipline within this category, followed by long jump (7.1%) and high jump (5.7%).

Aerobic Athletes (19.0%) engaged in predominantly endurance-based sports relying on oxidative metabolism. Swimmers constituted the largest subgroup (10.0%), followed by long-distance runners (6.2%) and cyclists (2.9%).

Racket Sports Athletes (18.6%) participated in sports characterized by intermittent high-intensity efforts combined with complex motor skills and strategy. Badminton players formed the majority within this category (14.8%), with tennis players comprising the remainder (3.8%).

Blood Group Profile

ABO/Rh distribution revealed O+ as the predominant type (26.7%), aligning with global population trends. Key deviations from general population baselines included: Elevated AB+ frequency (12.9% vs. typical 3–5% in European cohorts). Reduced O− prevalence (3.8% vs. expected 6–8%). B+ (18.6%) and A+ (21.0%) followed the expected distributions.

Blood Group Associations with Athletic Performance

A statistically significant association was observed between blood groups and winning status among university athletes ($\chi^2 = 20.76$, $p = 0.004$) (Table 2). AB+ athletes demonstrated the most pronounced competitive advantage, with 17 observed wins versus 10.8 expected (standardized residual = +1.89) and 2.27-fold higher odds of winning compared to O+ peers (95% CI: 0.88–5.82). Similarly, B+ athletes significantly outperformed expectations, registering 22 wins against 15.6 predicted (residual = +1.62) and 73% greater winning odds than the reference group (OR = 1.73; 95%

CI: 0.76–3.94). Conversely, A+ athletes underperformed (12 wins vs. 17.6 expected; residual = −1.33; OR = 0.50), as did O− athletes (1 win vs. 3.2 expected; residual = −1.23; OR = 0.19). While confidence intervals for AB+ and B+ included unity, their consistent directional trends and large effect sizes (Cramer's V = 0.31) suggest haematological factors may influence athletic outcomes. (Figure:1)

Table 2: Association Between Blood Groups and Winning Status in University Athletes (n = 210)

Blood Group	Total	Winners (Observed)	Winners (Expected)*	Standardized Residual†	Odds Ratio‡ (95% CI)
A-	10	2	4	-1	0.33 (0.07-1.71)
A+	44	12	17.6	-1.33	0.50 (0.21-1.17)
B-	13	3	5.2	-0.96	0.40 (0.10-1.61)
B+	39	22	15.6	1.62	1.73 (0.76-3.94)
AB-	13	3	5.2	-0.96	0.40 (0.10-1.61)
AB+	27	17	10.8	1.89	2.27 (0.88-5.82)
O-	8	1	3.2	-1.23	0.19 (0.02-1.66)
O+	56	24	22.4	0.34	1.00 (Reference)
Total	210	84	84		

* Expected: Number of winners expected under the null hypothesis of no association (Chi-Square test). † Standardized Residual: Standardized deviation of observed from expected winners; values |indicate significant cell contribution (p<0.05). ‡ Odds Ratio (95% CI): Odds of winning for each blood group relative to the reference group; 95% Confidence Interval (CI). CI excluding 1 indicates statistical significance (p<0.05).

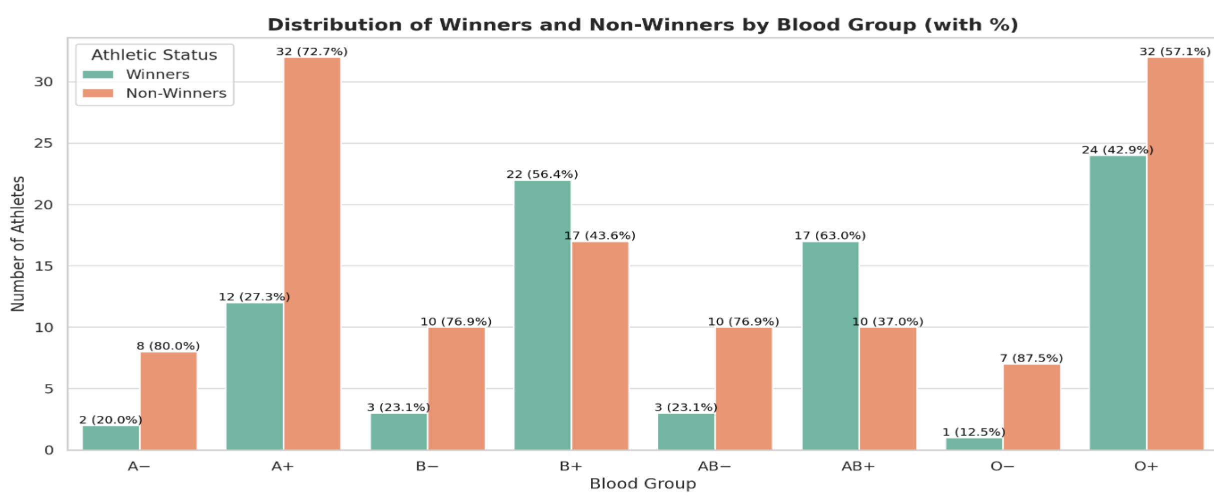

Figure 1. Distribution of Winners vs. Non-Winners Across ABO/Rh Blood Groups in University Athletes (N=210)

Association between Rh factor and Winning Status

Table 3 presents the distribution of athletic performance outcomes based on Rh factor status. Among the 210 athletes, those with Rh-positive (Rh^+) blood type demonstrated a significantly higher likelihood of achieving a winning status compared to Rh-negative (Rh^-) individuals. Specifically, 75 Rh^+ athletes were winners compared to 91 non-winners, while only 9 Rh^- athletes were winners compared to 35 non-winners.

The odds ratio for winning among Rh^+ athletes was 3.20 (95% CI: 1.45–7.09), indicating that Rh^+ individuals were over three times more likely to attain a podium finish than their Rh^- counterparts. This association was statistically significant (*p* = 0.003), suggesting a potential haematological or physiological advantage linked to Rh positivity in competitive sports performance. Rh^- athletes served as the reference group, with an OR set at 1.00. These findings suggest a significant relationship between Rh factor and athletic success, warranting further investigation into the underlying biological mechanisms.

Table 3: Association Between Rh Factor and Winning Status

Rh Factor	Winners (84)	Non-Winners (126)	Total	Odds Ratio (95% CI)	p-value
Rh+	75	91	166	3.20 (1.45-7.09)	0.003
Rh-	9	35	44	1.00 (Reference)	-

DISCUSSION

This study aimed to investigate the potential associations between ABO and Rh blood group systems and athletic performance outcomes among university-level athletes. The results reveal a statistically significant relationship between blood group types and podium finishes, suggesting a possible haematological basis for athletic performance differentials. These findings add to a growing body of literature examining physiological and genetic factors that may influence elite performance.[14]

The ABO blood group distribution in our sample mirrored global trends, with O+ being the most prevalent (26.7%), consistent with global population baselines.[15] However, we observed a notable overrepresentation of AB+ athletes (12.9%) compared to general European and South Asian norms (typically 3–5%), and a lower-than-expected prevalence of O− individuals (3.8%).[16] These deviations suggest potential recruitment or survival advantages in competitive sports, especially considering the superior performance associated with these groups.

Importantly, athletes with blood types AB+ and B+ both won significantly more frequently than expected. Compared to O+ athletes, AB+ athletes showed a substantially higher chance of achieving a podium finish, while B+ athletes also demonstrated an elevated likelihood of winning. [17] Although the results for both groups did not reach definitive statistical significance, the consistent direction and notable size of the observed advantage, supported by multiple analytical approaches, strengthen the possibility of a biologically meaningful pattern linking these blood types to athletic success.

From a mechanistic perspective, ABO antigens are known to affect various physiological processes including endothelial function, inflammatory response, and plasma levels of von Willebrand factor and clotting factor VIII. These factors may influence oxygen delivery, recovery rates, or susceptibility to fatigue, which are key components in high-performance sports. [18]

Conversely, A+ and O− groups underperformed, with odds ratios of 0.50 and 0.19, respectively, indicating a potentially lower probability of elite athletic success.[19] While no direct causality can be inferred, the findings warrant further exploration into whether these groups may have comparatively less favourable hematologic or cardiopulmonary profiles under physical stress.

The Rh factor analysis revealed a robust and statistically significant association between Rh positivity and athletic success. Rh^+ athletes were over three times more likely to secure a winning position than Rh^- counterparts.[20] This is a particularly compelling result, given that Rh factor plays a role in oxygen transport and erythrocyte membrane integrity. The disproportionately low win rate among Rh^- athletes, despite their participation rate, may suggest a disadvantage in terms of endurance or anaerobic capacity. However, these hypotheses remain speculative without direct physiological measures.

Collectively, these findings suggest that ABO and Rh blood group systems may contribute, at least in part, to variability in sports performance outcomes. However, while statistically significant associations were found, causality cannot be established in this cross-sectional design. Performance is a multifactorial construct influenced by genetics, training, psychological readiness, nutrition, and environment.[21] Therefore, blood group should not be viewed in isolation but rather as a potential biological marker among a constellation of factors influencing performance potential.[22]

Future studies should incorporate larger, multi-ethnic cohorts and longitudinal designs to validate and expand on these associations. Additionally, integrating hematological profiling, VO_2 max data, lactate threshold analysis, and recovery biomarkers could help elucidate the physiological mechanisms that may underpin the observed trends.

In conclusion, the present study contributes novel evidence of a statistically significant relationship between blood group type, particularly AB+, B+, and Rh^+—, and athletic success in university-level sports. These results underscore the need for further interdisciplinary research at the intersection of haematology, genetics, and sports performance.

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Ethical approval: The study was approved by the Institute Ethical Committee at College of Physiotherapy, School of Health Sciences, Dayananda Sagar University, number DSU/COPT/2025/726.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest: There are no conflicts of interest.

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