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RESEARCH ARTICLE Indian Journal of Animal Research

Hematological Variations in Sahraoui Dromedaries: A Multivariate Analysis of Age and Sex Effects

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10.18805/IJAR.BF-2089

ABSTRACT

Background: The dromedary camel plays a crucial role in sustainable pastoralism in arid zones due to its remarkable physiological adaptations to extreme desert conditions. Hematological and biochemical parameters serve as essential indicators for assessing animal health, physiological status, and adaptive mechanisms. While previous research has examined factors influencing these parameters in dromedaries, there remains a need to establish breed-"specific reference values under different physiological conditions. This study focuses on the Sahraoui dromedary, aiming to determine the effects of age and sex on hematological profiles.

Methods: This study was conducted in the El Oued region of southeastern Algeria. A total of 35 clinically healthy dromedaries raised under semi-intensive conditions were included. Blood samples were analyzed using a MINDRAY BC-3000 Plus auto-analyzer. Nineteen hematological parameters were measured, including complete blood count, differential leukocyte count, erythrocyte indices, and platelet metrics. Statistical analyses comprised; Descriptive statistics; Spearman correlation matrices; principal component analysis (PCA) and pairwise Wilcoxon rank-sum tests.

Result: The analysis revealed that age was the primary factor influencing hematological profiles. Young dromedaries exhibited significantly higher red blood cell counts, hemoglobin levels, hematocrit, platelet counts and lymphocyte percentages, alongside smaller erythrocyte size and greater red cell distribution width. Adult camels displayed a mature profile characterized by larger erythrocytes with higher hemoglobin content and granulocyte prevalence. Although sex-related differences were less pronounced than ages effects. Young camels for the Sahraoui dromedary exhibit a profile consistent with active growth and immune development, while adults show a mature erythrocyte-dominant pattern.

Key words: Blood, Dromedary, Erythrocyte, Hematology, Leukocyte.

INTRODUCTION

In the context of increasing climate variability and resource scarcity, the dromedary camel (*Camelus dromedarius*) stands out as a key species for sustainable pastoralism in arid and semi-arid regions (Sahoo, 2020; Monaco, 2025). Its exceptional physiological and behavioral adaptations allow it to survive where water and forage are limited, making it the most resilient domestic animal in desert ecosystems (Fesseha and Desta, 2020; Ashour *et al*., 2024). The camel's ability to endure prolonged droughts, tolerate extreme heat and convert sparse desert vegetation into high-value products such as milk and meat underscores its strategic importance to pastoral communities (Ashour *et al*., 2024; Mohammed *et al*., 2025). Historically, the dromedary has played a central role in desert societies not only as a means of transport but also as a vital source of nutrition (Bekele *et al*., 2025). Camel milk, recognized for its rich nutritional profile and functional properties, is increasingly valued in food security strategies. Camel meat could offer an attractive path to sustainable development, particularly in places where it does not compete with resources used to feed people. Despite its potential, camel husbandry remains largely extensive, with low productivity and limited integration into modern livestock systems (Djenane, 2023). To unlock the full value of this species, targeted research is essential. Investigations

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How to cite this article: MAYOUF, R., MENNANI, A., FARES, M.A., HANAFI, M.T., BOUALI, N. and CHIKHA, M. (2026). Hematological Variations in Sahraoui Dromedaries: A Multivariate Analysis of Age and Sex Effects. *Indian Journal of Animal Research*. 1-10. doi: 10.18805/IJAR.BF-2089.

Submitted: 11-11-2025 **Accepted:** 09-01-2026 **Online:** 24-01-2026

must address both ecological interactions in natural habitats and performance under controlled breeding conditions (Manheem *et al*., 2023). A rigorous scientific approach combining field observations, experimental trials and technological innovation will be crucial over the next decade to enhance productivity, inform policy and support the sustainable development of camel-based pastoral systems (Gagaoua *et al*., 2021). Dromedary camels exhibit remarkable physiological plasticity that enables them to adapt to seasonal fluctuations in ambient climatic conditions (Kandil *et al*., 2023). One key adaptive mechanism involves modulating body temperature by storing heat during the day and dissipating it at night, thereby minimizing water loss through evaporative cooling (Faraz *et al*., 2025). This thermoregulatory strategy, along with other physiological adjustments, supports their survival in harsh desert environments (Kebir *et al*., 2024). Evaluating hematological and biochemical parameters is essential, as these indicators reflect the animal's health, physiological status and productive potential. Hematological and serum biochemical profiles are widely recognized as vital diagnostic tools in veterinary medicine (Lamraoui *et al*., 2024). Numerous studies have investigated the influence of factors such as season, age, sex, health status and lactation stage on these parameters in camels across diverse regions including Algeria, Ethiopia, Saudi Arabia, Sudan and Iran (Hamad *et al*; 2017., Roba *et al*., 2024; Ghali and Al-Qayim, 2020; Alharbi *et al*., 2025; Kelanemer *et al*., 2025). Blood metabolite profiling not only provides insights into the nutritional and metabolic status of animals but also serves as a sensitive indicator of their adaptive responses to environmental stressors (Tran *et al*., 2020). Recent research has emphasized the importance of establishing reference values for hematological and biochemical parameters in different camel breeds and under varying physiological conditions (Mousa *et al*., 2025). In this context, the present study aims to define and evaluate the effects of age and sex on hematological profiles in Sahraoui dromedary camels raised under extensive conditions in southern Algeria, thereby contributing to the development of breed-specific health and productivity benchmarks.

MATERIALS AND METHODS

Study area

The study was conducted in the El Oued region (33°22′N, 6°51′E) in northeastern Algeria, situated within the Sahara Desert,covering an area of 35,752 km^2 (Chouia *et al*., 2024), the region is dominated by the Oued Souf area and features striking geomorphological elements such as the Grand Erg Oriental sand dunes and ChottMelrhir, Algeria's lowest point at 30 meters below sea level (Ramdan and Mourad, 2025). The climate is classified as hot desert, marked by extremely hot summers (up to 50°C), mild winters, minimal rainfall (134 mm annually) and over 3,500 hours of sunshine per year (Abdessattar *et al*., 2024). Ecologically, El Oued is a vital Saharan agro-ecosystem, with oases supporting date palm cultivation and agriculture sustained by underground water. However, the region faces significant environmental challenges, including desertification and land degradation due to aridity, drought and human pressures, making it a strategic site for research on sustainable land management in arid zones (Barkat *et al*., 2022).

Experimental animals

The present study focused on the Sahraoui dromedary, a medium-sized breed (adult height: about 1.7-1.8 m at the shoulder) characterized by a predominantly light to dark coffee brown coat, sparse hair and exceptional heat tolerance (Meghelli *et al*., 2020). Well adapted to Saharan arid conditions, this population is capable of travelling long distances daily and is widely recognized in Algeria as an excellent working animal used for both milk production and transportation in the northern and central Sahara (Harek *et al*., 2022). A total of 35 dromedaries of this breed, ranging in age from 1 to 12 years, were included. Young camels (1-4 years) weighed approximately 280-350 kg, while adults (≥5 years) weighed 400-500 kg. Age was determined based on dentition and owner records. The cohort consisted of 5 adult males, 10 adult females, 10 young males and 10 young females, all confirmed to be clinically healthy. Sample sizes were determined by availability of healthy animals meeting inclusion criteria. While we aimed for balanced groups, adult males were limited to n=5 due to their reduced availability in the study area, as most intact males are actively used for breeding and transport purposes a direct reflection of their primary economic role as working animals. Indeed, the number of adult males is limited in camel herds in Algeria, as breeders keep mostly the females and cull the majority of the males for economic reasons. The animals were reared in a semi intensive production system in the El Oued region of southeastern Algeria. Their housing was an open shelter located in a remote desert area, far from potential disturbances. The daily management protocol involved morning grazing on natural desert pasture, with return to the pen around midday. In addition to grazing, a standardized supplement of Alfalfa and a mixture of barley and bran was provided daily, guaranteeing uniform nutritional and environmental exposure across the entire study group.

Blood collection and analysis

All camels were housed under uniform semi-intensive conditions for a minimum of 14 days prior to blood collection to ensure metabolic stabilization and adaptation to the standardized diet and management protocol. Blood was collected from all 35 dromedaries in the morning. Approximately 5 mL of whole blood was drawn from the jugular vein using a sterile needle into EDTA-coated vacuum tubes. The samples were immediately placed on cold packs and transported to the laboratory for haematological analysis.

Hematological analysis was performed using a MINDRAY BC-3000Plus automatic hematology analyzer (Mindray Bio-Medical Electronics Co., Ltd., Shenzhen, Guangdong Province, China) equipped with impedance technology and cyanide-free hemoglobin detection. The panel included white blood cell count (WBC) and its differentials, red blood cell indices (RBC, HGB, HCT, MCV, MCH, MCHC) and platelet metrics (PLT and MPV).

Data source and preparation

The dataset was compiled from individual hematological analysis reports of 35 dromedary camels (*Camelus dromedarius*). The raw data, including 19 hematological parameters, were digitally transcribed from the provided reports. Each animal's unique identifier was used to derive two categorical variables for stratification: Sex (Male, Female) and Age Group (Adult, Young).

Initial data processing involved cleaning and standardization. Non-numeric characters indicating high ('H') or low ('L') values relative to a reference range were removed and missing data points, denoted by asterisks ('***'), were coded as NA (Not Available). The final, cleaned dataset was structured as a data frame for statistical analysis.

RESULTS AND DISCUSSION

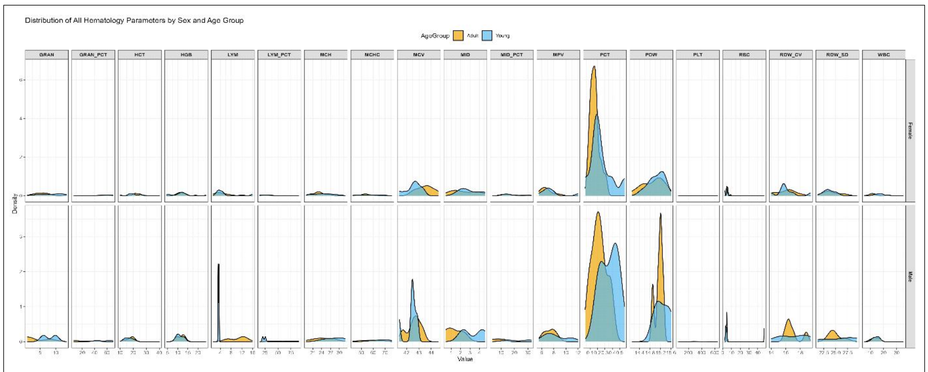
The hematological profiles of the dromedary camels were comprehensively analyzed, focusing on the influence of age and sex and inter-parameter relationships. A total of 35 individual camel samples were included in the analysis (Table 1).

Descriptive statistics and data distributions

The distribution patterns for all 19 hematological parameters, stratified by sex and age group, are presented as density plots in (Fig 1). Visual inspection of these distributions provides initial insights into population variability and potential sub-group differences. Notably,

Table 1: Summary of hematological parameters and their units.

Abbreviation	Full parameter name	Unit
WBC	White blood cell count	(109/L)
LYM	Lymphocyte count	(109/L)
MID	Mid-range cell count	(109/L)
GRAN	Granulocyte count	(109/L)
LYM_PCT	Lymphocyte percentage	(%)
MID_PCT	Mid-range cell percentage	(%)
GRAN_PCT	Granulocyte percentage	(%)
HGB	Hemoglobin	(g/dL)
RBC	Red blood cell count	(1012/L)
HCT	Hematocrit	(%)
MCV	Mean corpuscular volume	(fL)
MCH	Mean corpuscular hemoglobin	(pg)
MCHC	Mean corpuscular hemoglobin concentration	(g/dL)
RDW_CV	Red cell distribution width (CV)	(%)
RDW_SD	Red cell distribution width (SD)	(fL)
PLT	Platelet count	(109/L)
MPV	Mean platelet volume	(fL)
PDW	Platelet distribution width	(%)
PCT	Plateletcrit	(%)



Density plots are faceted by sex (rows) and parameter (columns), with distributions for adult and young camels overlaid by color.

Fig 1: Distribution of all hematology parameters by sex and age group.

erythrocyte indices such as Mean Corpuscular Volume (MCV) and Mean Corpuscular Hemoglobin Concentration (MCHC) exhibit distinct patterns. MCV distributions, particularly in younger animals, show a sharp, narrow peak at lower values, indicative of microcytosis, which is a physiological characteristic in dromedaries. Conversely, MCHC distributions consistently peak at higher values, suggesting a compensatory mechanism or adaptation for oxygen transport. Leukocyte counts, specifically White Blood Cell (WBC) and Platelet (PLT) counts, display broader distributions, reflecting greater individual variation. Some parameters, like MCV in females, suggest potential bimodal distributions within certain subgroups, warranting further investigation into underlying physiological states.

Inter-parameter correlations

A Spearman correlation matrix was constructed to elucidate the relationships among the hematological parameters (Fig 2). The matrix reveals a complex network of interdependencies. As expected, strong positive correlations were observed within the erythrocyte indices: Red Blood Cell Count (RBC) with Hematocrit (HCT) (= 0.95), Hemoglobin (HGB) with HCT (= 0.91) and RBC with HGB (= 0.71). Mean Corpuscular Hemoglobin (MCH) and MCHC also exhibited a strong positive correlation (= 0.99), indicative of their inherent relationship in describing cellular hemoglobin content. Similarly, strong positive correlations were evident within the platelet parameters: Platelet Count (PLT) with Plateletcrit (PCT) (= 0.96) and Mean Platelet Volume (MPV) with Platelet Distribution Width (PDW) (= 0.72).

Within the leukocyte differentials, a notable inverse relationship was found between Lymphocyte Percentage (LYM_PCT) and Granulocyte Percentage (GRAN_PCT) (= -0.90), which is physiologically anticipated given that these represent proportions of the total white blood cell count. White Blood Cell (WBC) count was positively correlated with absolute Granulocyte (GRAN) count (= 0.88), suggesting that granulocytes are often the predominant leukocyte population contributing to total WBC variations in this cohort. Furthermore, MCV displayed moderate negative correlations with MCH (= -0.50) and MCHC (= -0.38), indicating that smaller red blood cells tend to have higher hemoglobin concentrations in the dromedary, consistent with their unique erythrocyte morphology.

Principal component analysis

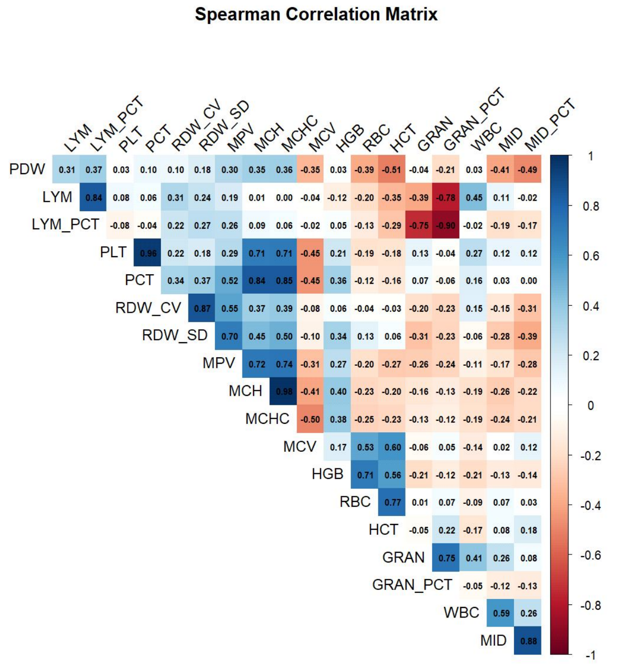
Principal component analysis (PCA) was employed to reduce dimensionality and identify major sources of variation within the hematological dataset. The scree plot (Fig 3) indicates that the first three principal components (PCs) account for approximately 64.2% of the total variance (PC1: 28.6%, PC2: 19.6%, PC3: 16.0%), suggesting that these components capture a substantial proportion of the underlying biological information.

The PCA biplots provide a visual representation of how individual camels cluster and how parameters contribute to these clusters based on age and sex. Fig 4 shows the PCA biplot grouped by Age Group. There is a discernible separation between Adult and Young camels along the first principal component (Dim1), which explains 28.6% of the variance. Vectors for RBC, HCT, HGB, PLT, PCT, RDW_CV, RDW_SD, MCH and MCHC point towards the Adult cluster, while LYM and LYM_PCT are more associated with the Young cluster. This suggests that age is a primary driver of variation in erythrocyte and platelet parameters. Young camels appear to be characterized by higher lymphocyte counts, whereas adults exhibit higher values for most red blood cell indices.

While (Fig 5) illustrates the PCA biplot grouped by Sex. While the ellipses for Female and Male groups largely overlap, suggesting less pronounced differentiation compared to age, a subtle separation is observed along both Dim1 and Dim2. Male camels show a slight tendency towards higher values for WBC, GRAN and MID, while females show a tendency towards higher values for MCH, MCHC and RDW_CV. This indicates that while sex contributes less to overall variance than age, there are specific leukocyte and erythrocyte morphology parameters that show some sex-specific patterns.

Comparative analysis of hematological parameters by age and sex

A detailed comparative analysis using pairwise Wilcoxon tests, with Benjamini-Hochberg p-value adjustment, was conducted to identify significant differences in hematological



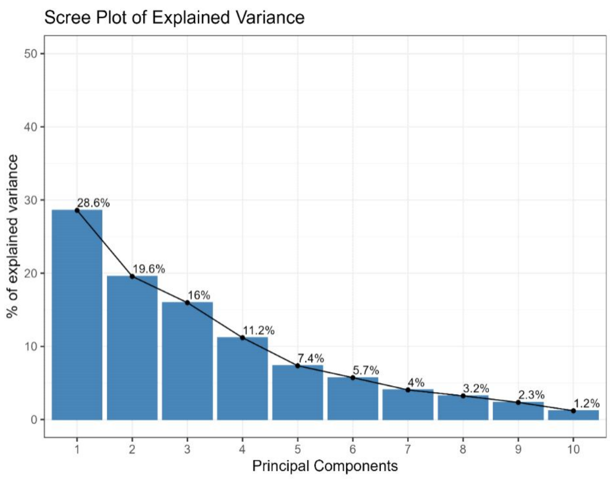
The correlogram displays the Spearman's rank correlation coefficients for all pairs of hematological parameters. Blue indicates a positive relationship, red indicates a negative relationship and color intensity corresponds to the correlation strength.

Fig 2: Spearman correlation matrix.

parameters between age groups (Adult vs. Young) within each sex. The results are summarized in (Fig 6), where significant differences are indicated by asterisks.

Erythrocytic parameters

Highly significant differences ($p<0.001$ to $p<0.0001$) were observed in most erythrocytic parameters between age groups. Young camels, both male and female, consistently presented with higher Red Blood Cell (RBC) counts, Hematocrit (HCT) and Hemoglobin (HGB) levels compared to their adult counterparts. Conversely, adult camels exhibited significantly higher mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) values. These findings suggest that young dromedaries have more numerous, but smaller red blood cells, possibly reflecting developmental changes in erythropoiesis or adaptations to growth. The Red Cell Distribution Width (RDW_CV and RDW_SD) was also significantly higher in young animals for both sexes, indicating greater heterogeneity in red blood cell size.



Bar plot showing the percentage of total variance explained by each principal component.

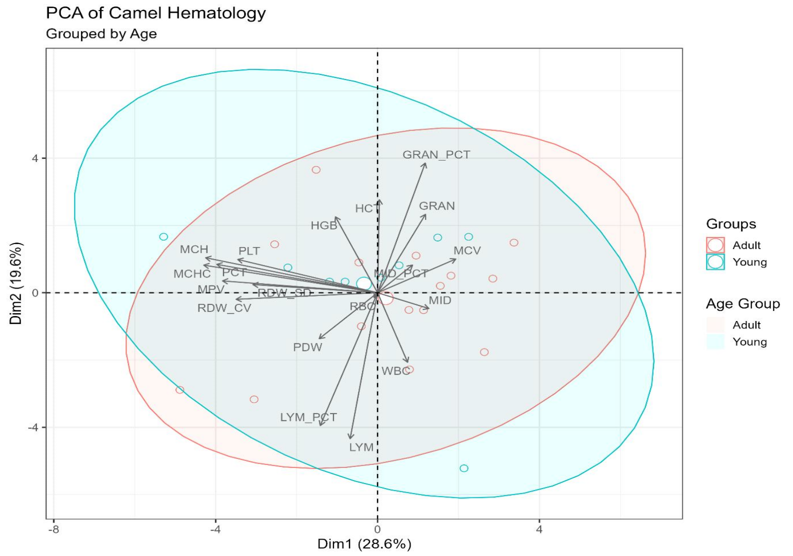
Fig 3: Scree plot of explained variance.

Leukocytic parameters

Significant age-related differences were also noted in certain leukocyte populations. Young female camels had significantly higher Granulocyte counts (GRAN) and Granulocyte percentages (GRAN_PCT) compared to adult females. A similar trend was observed for Mid-range cell counts (MID) in young males. Interestingly, Lymphocyte percentages (LYM_PCT) were significantly higher in adult females than in young females. These variations suggest age- and sex-dependent immune profiles. Overall White Blood Cell (WBC) count showed some variability but no universally significant age-or sex-related differences across all subgroups.

Thrombocytic parameters

Platelet parameters showed marked age-related differences. Both young male and female camels had significantly higher Platelet counts (PLT) and Plateletcrit (PCT) compared to adults. Conversely, adult camels exhibited significantly higher Mean Platelet Volume (MPV)



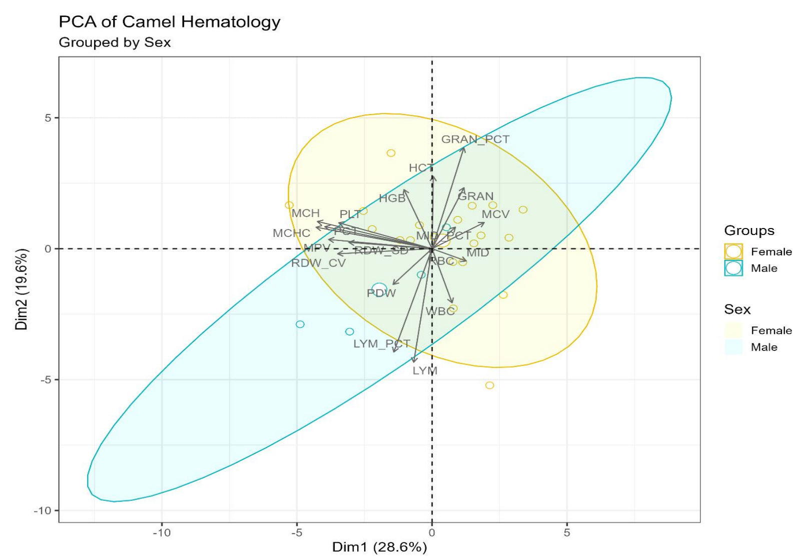
Biplot showing the distribution of samples (points) and the contribution of variables (arrows) to the first two principal components, with ellipses representing 95% confidence intervals for adult and young age groups.

Fig 4: PCA of camel hematology grouped by age.

and Platelet Distribution Width (PDW). This indicates that young dromedaries tend to have a greater number of smaller platelets, a pattern potentially related to active growth or different physiological demands.

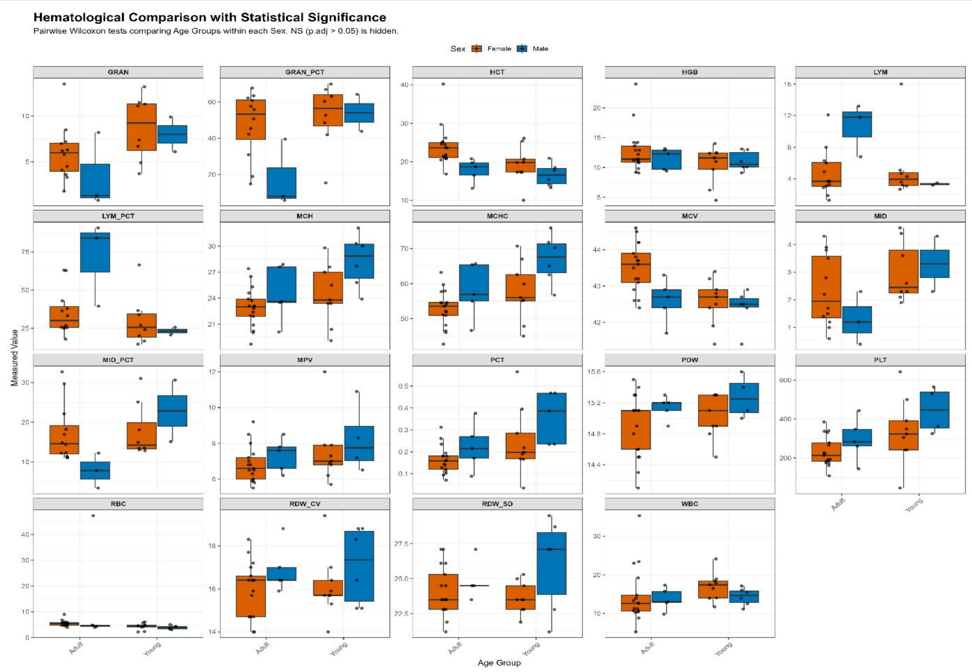
Descriptive statistics and data distributions

Fig 1 illustrates the variations in hematological parameters of dromedaries according to age (young vs. adult) and sex (female vs. male). Examining these variations, several



Biplot showing the distribution of samples (points) and the contribution of variables (arrows) to the first two principal components, with ellipses representing 95% confidence intervals for female and male sex groups.

Fig 5: PCA of camel hematology grouped by sex.



Boxplots display the distribution of each parameter, grouped by age and sex. Pairwise wilcoxon tests, comparing age groups within each sex, are annotated with significance levels (*: p<0.05, **: p<0.01, ***: p<0.001, ****: p<0.0001; non-significant comparisons are hidden).

Fig 6: Hematological comparison with statistical significance.

hematological aspects show significant differences according to age and sex. For example, lymphocytes (LYM, LYM_PCT) are much more present in young camels, confirming the presence of lymphocytosis in this age group (Gaashan *et al*., 2020; Ghodsian *et al*., 1978), while the total leukocyte count (WBC) reveals a marked bimodality, signaling a clear distinction between young and adult camels. Erythrocyte indices (MCH, MCHC, MCV) show notable overlaps, indicating a low sensitivity to age variations, results obtained in Mauritania by Chartier *et al*., (1986), in India by Faye and Bengoumi, (2018). Furthermore, platelet counts (PLT, PCT) are much higher in young individuals, confirming the existence of growth-associated hyperplateletosis (Hussein *et al*., 2010). Regarding sex, the data distribution reveals subtle variations, especially in males where some metrics such as PCT and RDW_SD appear more scattered. These correlations and variations reflect distinct biological mechanisms according to age and sex, such as accentuated erythropoietic activity in young individuals and differentiated immune adaptation. The higher variation indices (RDW_CV, RDW_SD) in young individuals suggest a more dynamic and diverse erythropoiesis (Tejedor-Junco *et al*., 2023; Faye and Bengoumi, 2018), while granulocyte-related parameters (GRAN, GRAN_PCT) show relatively constant stability across groups. This study highlights the importance of taking into account age and sex for an adequate interpretation of hematological parameters in dromedaries, in agreement with recent research on the biological variability of these measurements carried out by Monaco (2025); Tejedor-Junco *et al*. (2023) and Gaashan *et al*. 2020).

Inter-parameter correlations

The Spearman correlation matrix (Fig 2) highlights significant relationships among the hematological characteristics of dromedaries, highlighting several distinct functional categories. The most marked positive correlations (r>0.80) are found within the white blood cell lineage, notably between LYM-PDW (r = 0.84), RDW_CV-LYM (r = 0.87), MID-MID_PCT (r = 0.88) and WBC-MID (r = 0.59), as well as for the erythrocyte indices MCH-MCV (r = 0.89) and the platelet measures PLT-PCT (r = 0.84-0.85) and MPV-PCT (r = 0.74), confirm the physiological relationships observed by Tejedor-Junco *et al*. (2023) as well as Faye and Bengoumi (2018). Moderate positive associations between HGB-RBC (r = 0.77), HGB-MCV (r = 0.71), RBC-HGB (r = 0.56) and GRAN-HCT (r = 0.75) show the interrelationship of red lineage components and their efficiency in oxygen transport. Significant negative correlations between LYM-HGB (r = -0.76), LYM_PCT-GRAN (r = -0.90), LYM_PCT-HCT (r = -0.75), PDW-MCHC (r = -0.35), PDW-HGB (r = -0.39), PDW-RBC (r = -0.51) and MCHC-MCH (r = -0.50) highlight the inversion of the ratio of lymphocytes to granulocytes, typical of immune maturation, results reported by Gaashan *et al*. (2020), as well as compensatory adjustments related to cell volume and concentration, as described by Chartier *et al*. (1986) and Abdel *et al*., 2025. The weak or non-existent correlations between HCT and the majority of other parameters (r<0.22), as well as between GRAN_PCT and erythrocyte indices (r<-0.13), suggest a relative independence between these systems, in line with the results of Abdalmula *et al*. (2019) which indicate that hematological changes in camelids are distributed according to cell lineages and are influenced differently by factors such as age, sex and physiological conditions.

Principal component analysis

The examination of hematological parameter distributions (Fig 3) highlights significant distinctions related to age and more subtle variations according to sex. Young dromedaries consistently show higher levels of red blood cells, hemoglobin, hematocrit, platelets and lymphocytes, accompanied by lower mean corpuscular volume and more pronounced red blood cell heterogeneity, reflecting dynamic erythropoiesis and a maturing immune system (Al-Himali *et al*., 2020; Gaashan *et al*., 2020; Tejedor-Junco *et al*., 2023). In adults, a more mature profile is observed, characterized by larger erythrocytes with higher hemoglobin content and granulocyte dominance, indicating completed metabolic and immune adaptation. Although less pronounced, sex-related differences emerge, with females tending to show higher erythrocyte indices, while males exhibit greater variability in leukocytes and erythrocytes, confirming differential modulation of cell lineages (Abdalmula *et al*., 2019; Al-Himali *et al*., 2020). These findings emphasize the importance of establishing age-specific hematological reference ranges for appropriate clinical interpretation.

PCA findings indicate that age (Fig 4) has an impact on the hematological characteristics of dromedaries. Multivariate models are consistent with age-associated hematological variations observed in camelids as well as other mammalian species (Saeed and Hussein, 2008; Martín-Barrasa *et al*., 2023).

On the one hand, adult camelids showed higher values of MCV, granulocyte count, monocyte-related measures and strong relationships with hemoglobin (HGB), hematocrit (HCT) and erythrocytes. This indicates that the maturation process results in accumulated erythropoietic capacity and a proportional increase in granulocyte populations to meet metabolic and immune demands. These observations align with studies reporting that erythrocytes, HGB and hematocrit increase with aging in camelids (Saeed and Hussein, 2008; Elkhair, 2025).

Second, young dromedaries showed higher values for platelet indices (PLT, MPV, PCT) and RDW measurements, as well as for lymphocyte-related parameters (LYM, LYM_PCT). This could indicate hematological flexibility during their growth and a more active immune environment in young specimens. Previous studies have shown that young dromedaries tend to display higher white blood cell or lymphocyte counts than adults (Martín-Barrasa *et al*., 2023).

Third, the overlap of reliability zones indicates that hematological development occurs gradually and that individual differences due to (genetics, diet and environmental factors) influence this evolution. Therefore, age alone does not fully define the hematological phenotype.

In practice, these results highlight the importance of establishing age-specific hematology reference intervals in camels. Using adult reference thresholds for young animals could lead to misidentification of various normal developmental changes as pathological. Recently, previous research has also recommended the creation of reference intervals that take into consideration age, sex and physiological status (Martín-Barrasa *et al*., 2023).

PCA analysis reveals a clear differentiation between sexes (Fig 5), representing 48.2% of the total variation. Females are characterized by higher values regarding red line parameters (HCT, HGB, GRAN) as well as erythrocyte indices (MCH, MCHC, MCV), validating the findings of Tejedor-Junco *et al*. (2023). On the other hand, males show a strong correlation with leukocyte parameters (LYM, LYM_PCT, WBC) and variability indices (RDW_CV, RDW_SD), in agreement with the work of Ghodsian *et al*. (1978) and Gaashan *et al*. (2020). The inverse orientation of the GRAN_PCT and LYM_PCT vectors demonstrates the reversal of the ratio between granulocytes and lymphocytes during the maturation of the immune system (Faye and Bengoumi, 2018), demonstrating the transition from lymphocyte dominance in youth to granulocyte predominance in adulthood. The partial overlap of the confidence ellipses signals that despite some shared parameters, there is a significant statistical difference between the sexes, notably concerning the red lineage in females and the variability indices in males (Abdalmula *et al*., 2019; Murphy, 2014).

Comparative analysis of hematological parameters by age and sex

Fig 6 illustrates the variations in hematological parameters of dromedaries according to age (young and adult) and sex (female and male). Examining these variations, several hematological aspects show significant differences according to age and sex. For example, lymphocytes (LYM, LYM_PCT) are much more present in young camels, confirming the presence of lymphocytosis in this age group (Gaashan *et al*., 2020; Ghodsian *et al*., 1978), while the total leukocyte count (WBC) reveals a marked bimodality, signaling a clear distinction between young and adult camels. Erythrocyte indices (MCH, MCHC, MCV) show notable overlaps, indicating a low sensitivity to age variations, results obtained in Mauritania by Chartier *et al*., (1986), in India by Faye and Bengoumi, (2018). Furthermore, platelet counts (PLT, PCT) are much higher in young individuals, confirming the existence of growth-associated hyperplateletosis (Hussein *et al*., 2010). Regarding sex, the data distribution reveals subtle variations, especially in males where some metrics such as PCT and RDW_SD appear more scattered. These correlations and variations reflect distinct biological mechanisms according to age and sex, such as accentuated erythropoietic activity in young individuals and differentiated immune adaptation. The higher variation indices (RDW_CV, RDW_SD) in young individuals suggest a more dynamic and diverse erythropoiesis (Tejedor-Junco *et al*., 2023; Faye and Bengoumi, 2018), while granulocyte-related parameters (GRAN, GRAN_PCT) show relatively constant stability across groups. This results are in agreementwith recent research on the biological variability of these measurements carried out by Tejedor-Junco *et al*. (2023).

CONCLUSION

This study aimed to determine the effects of age and sex on hematological profiles in Sahraoui dromedary camels to establish breed-specific health benchmarks. Our findings definitively establish that age is the primary factor influencing hematological variation. A clear distinction was observed between young and adult camels: younger animals exhibited higher red blood cell counts, platelet counts and lymphocyte percentages, alongside smaller erythrocyte size and greater size variation, reflecting active growth and a developing immune system. Adults, in contrast, displayed a mature profile characterized by larger, hemoglobin-rich red blood cells and a shift towards granulocyte prevalence.

While less pronounced than age, sex also contributed to significant variation, with females more associated with erythrocyte quality and males with leukocyte parameters and red cell heterogeneity. The strong inter-parameter correlations revealed the integrated physiology of the hematological system and its adaptive compensatory mechanisms.

These findings underscore the critical importance of using age-specific reference intervals for accurate clinical diagnosis in this species. Applying adult standards to young camels risks misinterpreting normal developmental physiology as pathology. This research provides essential baseline data for the Sahraoui breed, directly contributing to improved veterinary care, health monitoring and sustainable management practices for dromedary camels in arid regions. Future studies should expand on these findings by incorporating seasonal and physiological states like pregnancy to further refine these benchmarks.

Conflict of interest

The authors declare that they have no conflicts of interest.

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