

Research Article

Hematological Profile of Apparently Healthy Dogs in Sokoto Metropolis, Northwestern Nigeria: Influence of Age and Sex

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Abstract

Hematological parameters is an important tools for investigating the physiological and health status of animals. However, hematological indices may differ based on the age, sex, breed, environmental conditions, nutrition, management, and other physiological factors of an animal. This study assessed selected hematological profile and influence of age and sex of apparently healthy dogs in Sokoto Metropolis, Northwestern Nigeria. Blood samples were collected aseptically from the jugular veins from dogs presented to the Veterinary Teaching Hospital, Usmanu Danfodiyo University, Sokoto. Complete blood count was performed using an automated hematology analyzer. Descriptive statistics were used to summarize the data, while Student's *t*-test was used to compare age and sex groups. The overall mean values for WBC (11.37 ± 2.91), lymphocytes ($2.82 \pm 1.67\%$), mixed cells ($2.46 \pm 1.03\%$), neutrophils ($6.10 \pm 3.39\%$), RBC (4.90 ± 1.80), HGB (10.55 ± 3.57 g/L), HCT ($31.69 \pm 10.65\%$), MCV (49.51 ± 13.21 fL), MCH (49.00 ± 10.16 pg), MCHC (1116.47 ± 373.25 g/L), PLT (117.23 ± 104.63), MPV (12.17 ± 15.69 fL), PDW (21.47 ± 6.20 fL), and PCT (0.085 ± 0.071) were observed. No statistically significant differences were observed between age and sex. The findings provide preliminary hematological data for apparently healthy dogs in Sokoto Metropolis. These findings may provide useful baseline information for veterinary clinical assessment in the region, although interpretation should consider breed, nutrition, environmental conditions, and other sources of biological variation.

Keywords

Hematology, Dogs, Age, Sex, Sokoto, Nigeria

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1. Introduction

Blood is an important pointer of physiological and pathological changes in animals, and evaluation of their cellular components provides valuable information about the health status of an individual [1, 2]. Hematological examination encompasses assessment of parameters such as erythrocytes, leukocytes, platelets, and associated red-cell indices and is commonly used in the diagnosis and monitoring of disease [3, 4]. Hematological parameters can provide information about oxygen-carrying capacity, inflammatory responses, and immune status of animals [5]. The erythrocyte constituent of blood is important because red blood cells and hemoglobin are responsible for oxygen transport [1, 6]. Red blood cell count, hemoglobin concentration, and hematocrit are generally used in the assessment of erythrocyte mass and oxygen-carrying capacity [7]. The erythrocyte indices, including mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration, provide additional information regarding red-cell size and hemoglobin content and can assist in the characterization of erythrocyte abnormalities [8].

Leukocytes constitute a significant component of the immune system [9]. Neutrophils, lymphocytes, monocytes, eosinophils, and basophils have distinct roles in host defense, inflammation, and immune regulation [8]. Changes in leukocyte numbers may therefore provide useful indications of inflammatory, infectious, or other physiological processes [10]. Similarly, platelets play an essential role in primary hemostasis [11], while platelet indices such as mean platelet volume and platelet distribution width may provide additional information regarding platelet production and turnover [12]. Platelets participate in both innate [13] and adaptive [14] immunity. Although hematological parameters are clinically useful, they are influenced by several biological and environmental factors [15]. Several factors including physiological [16], sex [17], environmental condition [18], dietary content [19], fasting [20], age [21], breed [22], anti-aflatoxin treatment [23], and continuous supplementation of vitamin [24] affect the blood profile of healthy animal. Consequently, the use of appropriate population- and species-specific reference information is important when interpreting hematological findings in clinical practice. Dogs are widely kept in Nigeria for companionship, security, and other purposes [25]. In northern Nigeria, including Sokoto State, dogs may be maintained under diverse management and environmental conditions [2, 26]. Sokoto is located within the semi-arid region of Northwestern Nigeria, characterized by high ambient temperatures and relatively low humidity for much of the year [27]. Such environmental characteristics, together with differences in nutrition, management, breed, and physical activity, may influence hematological profiles.

Despite the clinical importance of hematological evaluation, there is limited information on hematological characteristics of apparently healthy dogs in Sokoto Metropolis. Therefore,

this study evaluated selected hematological parameters of apparently healthy dogs in Sokoto Metropolis and examined whether these parameters differed according to age and sex.

2. Materials and Methods

2.1. Study Area

The study was conducted within Sokoto metropolis in Sokoto state. Sokoto is geographically located in the semi-arid region of North Western Nigeria located between the latitudes 10°N and 13°58' N; and the longitudes 4° 8'E and 60 54' E, with population of 6,391,000 and population density of 205.9/km² as at 2022 [27]. The state is bordered by the Republic of Niger to the north and west for 363 km (226 miles), Zamfara to the east, and Kebbi to the South and west. The minimum relative humidity is less than 20% for most part of the year and ambient temperature ranges from 22°C to 43°C [28]. The study was conducted through the Veterinary Teaching Hospital of Usmanu Danfodiyo University, Sokoto.

2.2. Study Animals and Sample Collection

Apparently healthy dogs presented to the Veterinary Teaching Hospital were included in the study. The samples were collected between April and July 2025. Approximately 4 mL of blood was aseptically collected from the jugular vein of each dog into heparinized sample bottles. Samples were appropriately labeled and transported in ice packs to the Clinical Pathology Laboratory for analysis. Dogs were categorized according to age as young or adult and according to sex as male or female. The age-comparison dataset comprised 10 adult and 10 young dogs, while the sex-comparison dataset comprised 10 females and 10 males for most parameters.

2.3. Hematological Analysis

Blood samples were gently mixed to ensure homogeneity before analysis. Hematological examination was performed using an automated hematology analyzer (HB7021) at the Clinical Pathology Laboratory. The parameters evaluated included total WBC count, lymphocyte percentage, mixed-cell percentage, neutrophil percentage, RBC count, HGB, HCT, MCV, MCH, MCHC, PLT, MPV, PDW, and PCT. The samples were aspirated into the analyzer, and the hematological results were automatically generated by the instrument.

2.4. Statistical Analysis

The statistical analysis was using InVivoStat software (version 4.0.2). Descriptive statistics were used to summarize the data. Results were presented as mean $\pm$ SD. Student's *t*-test was used to compare hematological parameters between adult

and young dogs and between female and male dogs. Statistical significance was considered at $p < 0.05$.

3. Results

3.1. Overall Hematological Profile

The overall hematological profile of the sampled apparently healthy dogs is summarized in Table 1. The mean WBC count

was 11.37 ± 2.91 , while the mean lymphocyte, mixed-cell, and neutrophil values were $2.82 \pm 1.67\%$, $2.46 \pm 1.03\%$, and $6.10 \pm 3.39\%$, respectively. The mean RBC count was 4.90 ± 1.80 , HGB was 10.55 ± 3.57 g/L, and HCT was $31.69 \pm 10.65\%$. The mean MCV, MCH, and MCHC were 49.51 ± 13.21 fL, 49.00 ± 10.16 pg, and 1116.47 ± 373.25 g/L, respectively. Platelet count, MPV, PDW, and PCT were 117.23 ± 104.63 , 12.17 ± 15.69 fL, 21.47 ± 6.20 fL, and 0.085 ± 0.071 , respectively.

Table 1. Overall complete blood count of apparently healthy dogs.

Parameter	Mean $\pm$ SD
WBC	11.37 ± 2.91
Lymphocytes (%)	2.82 ± 1.67
Mixed cells (%)	2.46 ± 1.03
Neutrophils (%)	6.10 ± 3.39
RBC	4.90 ± 1.80
HGB (g/L)	10.55 ± 3.57
HCT (%)	31.69 ± 10.65
MCV (fL)	49.51 ± 13.21
MCH (pg)	49.00 ± 10.16
MCHC (g/L)	1116.47 ± 373.25
PLT	117.23 ± 104.63
MPV (fL)	12.17 ± 15.69
PDW (fL)	21.47 ± 6.20
PCT	0.085 ± 0.071

Key: WBC (white blood cell), RBC (red blood cell), HGB (hemoglobin), HCT (hematocrit), MCV (mean corpuscular volume), MCH (mean corpuscular hemoglobin), MCHC (mean corpuscular hemoglobin concentration), PLT (platelet), MPV (Mean Platelet Volume), PDW (Platelet Distribution Width), and PCT (Plateletcrit).

3.2. Effect of Age

No statistically significant differences were observed between adult and young dogs for the evaluated hematological parameters. WBC count was higher in young dogs than adults

(12.38 vs. 11.12 ; $p = 0.452$), whereas RBC count was higher in adults (5.25 vs. 3.50 ; $p = 0.080$). Hemoglobin and HCT were similar between adults and young dogs, with p -values of 0.885 and 0.881 , respectively. MCV, MCH, MCHC, PLT, MPV, PDW, and PCT also showed no statistically significant differences between age groups.

Table 2. Comparison of hematological parameters between young and adult dogs.

Parameter	Adult Mean $\pm$ SD	Young Mean $\pm$ SD	p -value
WBC	11.12 ± 3.15	12.38 ± 1.44	0.452
Lymphocytes (%)	2.90 ± 1.73	2.48 ± 1.59	0.670

Parameter	Adult Mean $\pm$ SD	Young Mean $\pm$ SD	<i>p</i> -value
Monocytes (%)	2.40 $\pm$ 0.82	2.71 $\pm$ 1.79	0.596
Neutrophils (%)	5.83 $\pm$ 3.29	7.18 $\pm$ 4.11	0.489
RBC	5.25 $\pm$ 1.47	3.50 $\pm$ 2.52	0.080
HGB (g/L)	10.49 $\pm$ 3.68	10.83 $\pm$ 3.55	0.885
HCT (%)	31.52 $\pm$ 10.99	32.57 $\pm$ 10.65	0.881
MCV (fL)	47.90 $\pm$ 13.84	57.90 $\pm$ 3.10	0.243
MCH (pg)	50.60 $\pm$ 5.16	42.50 $\pm$ 21.21	0.155
MCHC (g/L)	1153.70 $\pm$ 396.98	918.00 $\pm$ 41.51	0.330
PLT	111.30 $\pm$ 110.92	137.00 $\pm$ 97.73	0.726
MPV (fL)	13.70 $\pm$ 18.11	7.58 $\pm$ 0.38	0.583
PDW (fL)	20.90 $\pm$ 6.02	23.18 $\pm$ 7.78	0.605
PCT	0.081 $\pm$ 0.074	0.097 $\pm$ 0.072	0.759

Key: WBC (white blood cell), RBC (red blood cell), HGB (hemoglobin), HCT (hematocrit), MCV (mean corpuscular volume), MCH (mean corpuscular hemoglobin), MCHC (mean corpuscular hemoglobin concentration), PLT (platelet), MPV (Mean Platelet Volume), PDW (Platelet Distribution Width), and PCT (Plateletcrit).

3.3. Effect of Sex

No statistically significant differences were observed between male and female dogs for the hematological parameters

examined. Females had slightly higher mean WBC, lymphocyte, RBC, HGB, and HCT values, whereas males had higher MCV and some platelet indices; however, none of these differences reached statistical significance ($p > 0.05$).

Table 3. Comparison of hematological parameters between female and male dogs.

Parameter	Female Mean $\pm$ SD	Male Mean $\pm$ SD	<i>p</i> -value
WBC	11.79 $\pm$ 2.45	10.95 $\pm$ 3.38	0.535
Lymphocytes (%)	3.16 $\pm$ 1.86	2.47 $\pm$ 1.47	0.370
Monocytes (%)	2.52 $\pm$ 0.89	2.40 $\pm$ 1.20	0.797
Neutrophils (%)	6.11 $\pm$ 3.03	6.08 $\pm$ 3.88	0.987
RBC	5.30 $\pm$ 1.34	4.50 $\pm$ 2.16	0.331
HGB (g/L)	10.78 $\pm$ 3.74	10.29 $\pm$ 3.57	0.774
HCT (%)	32.34 $\pm$ 11.19	30.96 $\pm$ 10.65	0.787
MCV (fL)	45.30 $\pm$ 13.56	54.20 $\pm$ 11.70	0.143
MCH (pg)	50.20 $\pm$ 4.68	47.80 $\pm$ 13.90	0.608
MCHC (g/L)	1212.70 $\pm$ 416.35	1009.60 $\pm$ 306.60	0.247
PLT	113.33 $\pm$ 80.35	120.57 $\pm$ 128.40	0.907
MPV (fL)	7.58 $\pm$ 0.53	16.77 $\pm$ 22.15	0.334
PDW (fL)	23.15 $\pm$ 6.27	19.79 $\pm$ 6.20	0.373

Parameter	Female Mean $\pm$ SD	Male Mean $\pm$ SD	<i>p</i> -value
PCT	0.078 $\pm$ 0.060	0.092 $\pm$ 0.085	0.761

Key: WBC (white blood cell), RBC (red blood cell), HGB (hemoglobin), HCT (hematocrit), MCV (mean corpuscular volume), MCH (mean corpuscular hemoglobin), MCHC (mean corpuscular hemoglobin concentration), PLT (platelet), MPV (Mean Platelet Volume), PDW (Platelet Distribution Width), and PCT (Plateletcrit).

4. Discussion

This study provides a comprehensive analysis of hematological and serum biochemical parameters in apparently healthy dogs in Sokoto, revealing important insights into canine health. Hematological evaluation is widely recognized as an important component of veterinary clinical assessment because blood parameters respond to physiological, nutritional, environmental, and pathological conditions [4]. The mean WBC count was 11.37 ± 2.91 , with mean lymphocyte, mixed-cell, and neutrophil values of $2.82 \pm 1.67\%$, $2.46 \pm 1.03\%$, and $6.10 \pm 3.39\%$, respectively. The absence of significant differences between age groups suggests that the leukocyte profiles of the sampled young and adult dogs were broadly comparable. Although young dogs had a numerically higher WBC count than adults, the difference was not statistically significant ($p = 0.452$). This finding is consistent with the general observation that hematological values in healthy animals may remain relatively stable despite biological variation, although age can influence blood characteristics under particular conditions [1]. The erythrocyte findings showed a numerically higher RBC count among adult dogs than young dogs (5.25 versus 3.50), although the difference did not reach statistical significance ($p = 0.080$). The direction of this difference may reflect developmental changes in erythrocyte mass, although this interpretation should be made cautiously because the number of young dogs was relatively small and is align with the study of [29]. The similar HGB and HCT values between age groups suggest that the observed numerical difference in RBC count did not translate into a statistically detectable difference in these related measures.

The mean HGB and HCT values were 10.55 ± 3.57 g/L and $31.69 \pm 10.65\%$, respectively. These parameters provide information regarding the oxygen-carrying capacity and proportion of blood occupied by erythrocytes [30]. The lack of significant differences in HGB and HCT between adult and young dogs indicates relatively similar erythrocyte-related profiles within the sampled population. Nevertheless, the substantial variability in HCT and the erythrocyte indices indicates that individual biological variation was present. The erythrocyte indices also showed no significant differences according to age or sex. MCV was numerically greater in young dogs than adults, whereas MCH was higher in adults. These indices provide information on erythrocyte size and hemoglobin content and can assist in identifying patterns associated with different forms of

anemia [5]. The lack of statistically significant differences suggests that age- and sex-related variation in erythrocyte morphology was not prominent in this sample.

Platelet parameters were similarly unaffected by age and sex. Platelets play an important role in primary hemostasis, and platelet indices may provide information about platelet production and turnover [31]. The absence of significant differences in PLT, MPV, PDW, and PCT suggests that platelet profiles were broadly comparable across the demographic categories investigated. Sex-related comparisons showed no significant differences in any of the evaluated hematological parameters. Female dogs had numerically higher WBC, lymphocyte, RBC, HGB, and HCT values, whereas males had somewhat higher MCV and selected platelet indices. However, the p -values for these comparisons were all greater than 0.05. This finding suggests that sex did not exert a major detectable influence on the hematological profile of the dogs included in the present study. Nevertheless, previous studies have demonstrated that hematological characteristics can vary with sex and other biological factors [32], and differences between studies may be attributable to breed composition, sample size, environmental conditions, nutrition, reproductive status, and management [33].

The absence of statistically significant age- or sex-associated differences should therefore not be interpreted as evidence that age and sex never influence canine hematology. Rather, the findings suggest that such differences were not detectable under the conditions and sample size of the present study. This distinction is important because hematological reference information is influenced by multiple interacting factors, including breed, age, sex, geographical location, climate, nutrition, stress, and management [15, 21, 32]. An important feature of the present study is its geographical focus. The study was conducted in Sokoto, a semi-arid region with relatively high temperatures and low humidity [27, 28]. Environmental conditions can influence physiological responses and may contribute to variation in blood parameters. The present findings also support the broader concept that hematological measurements can provide useful baseline information for apparently healthy animals. Previous work has emphasized the diagnostic and physiological value of hematological assessment, while studies in different animal populations have demonstrated the influence of age, sex, breed, nutrition, and management on blood parameters. The current findings extend this body of information by providing preliminary data from dogs in Sokoto Metropolis.

5. Conclusion

The present study provides preliminary hematological data for apparently healthy dogs in Sokoto Metropolis, Northwestern Nigeria. The evaluated erythrocyte, leukocyte, and platelet parameters showed no differences between adult and young dogs or between female and male dogs. The findings suggest equivalent hematological profiles among the demographic groups examined and provide useful baseline information for

veterinary clinical assessment in the study area. Future investigations should include larger numbers of dogs, wider representation of breeds and age categories, and standardized assessment of nutritional, environmental, management, and physiological factors. Establishment of formal local canine reference intervals using appropriately designed reference-interval methodology would further strengthen the clinical application of these findings.

Abbreviations

WBC	White Blood Cell
RBC	Red Blood Cell
HGB (g/L)	Hemoglobin
HCT (%)	Hematocrit
MCV (fL)	Mean Corpuscular Volume
MCH (pg)	Mean Corpuscular Hemoglobin
MCHC (g/L)	Mean Corpuscular Hemoglobin Concentration
PLT	Platelet
MPV (fL)	Mean Platelet Volume
PDW (fL)	Platelet Distribution Width
PCT	Plateletcrit

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Hussaini Usman Durkwa: Data curation

Nafisat Abdulazez: Resources

Ibrahim Maina Hassan: Project administration.

Data Availability Statement

The data generated and/or analyzed during the present study are available from Dr. Ibrahim Maina Hassan upon reasonable request and with permission from the corresponding authority at Usmanu Danfodiyo University, Sokoto, Nigeria.

Conflicts of Interest

The authors declare no conflicts of interest.

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