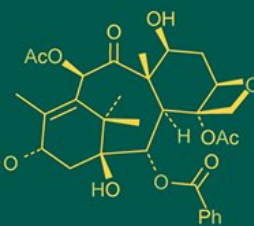
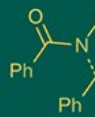


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
 ISSN Online: 2617-4707
 NAAS Rating (2026): 5.29
 IJABR 2026; 10(4): 780-784
www.biochemjournal.com
 Received: 15-03-2026
 Accepted: 14-04-2026

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Hematological and serum biochemical alterations in canine distemper virus-seropositive dogs at Cairo dog markets, Egypt

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DOI: <https://www.DOI.org/10.33545/26174693.2026.v10.i4j.9142>

Abstract

The association between canine distemper virus infection and hematological disruption was first documented in the early twentieth century, yet comprehensive profiles of blood parameter alterations in CDV-seropositive dogs from North African market populations remain unavailable. This research investigated hematological and serum biochemical alterations in CDV-seropositive dogs compared to seronegative controls among 200 dogs sampled from three major dog markets in Cairo, Egypt. CDV serological status was determined by IgG ELISA and rapid antigen testing. Complete blood count and serum biochemistry panels were performed on all samples. Of 200 dogs tested, 78 (39.0%) were CDV IgG-seropositive. CDV-positive dogs showed significantly elevated mean white blood cell counts (18.4 vs $11.2 \times 10^3/\mu\text{L}$, $p < 0.001$), reduced packed cell volume (28.6% vs 42.4% , $p < 0.001$), and thrombocytopenia (142 vs $268 \times 10^3/\mu\text{L}$, $p < 0.001$). Serum biochemistry revealed elevated alanine aminotransferase (85.4 vs 52.2 U/L, $p < 0.001$), blood urea nitrogen (42.4 vs 28.2 mg/dL, $p < 0.001$), and alkaline phosphatase (128.4 vs 68.6 U/L, $p < 0.001$) in seropositive dogs, indicating hepatic and renal involvement. Lymphocyte-to-neutrophil ratio was significantly reduced in seropositive dogs (0.42 vs 1.28 , $p < 0.001$), reflecting the characteristic lymphopenia of CDV-mediated immunosuppression. These findings establish a comprehensive hematological and biochemical profile for CDV-seropositive market dogs in Egypt, identifying parameters that may serve as supportive diagnostic biomarkers in resource-limited settings where serological testing is unavailable.

Keywords: Canine distemper virus, hematology, serum biochemistry, leukocytosis, hepatic enzymes, market dogs, cairo, egypt, diagnostic biomarkers

Introduction

The disruption of hematological parameters by canine distemper virus infection has been recognized since Carre first described the disease in 1905, with subsequent investigations establishing lymphopenia as the hallmark hematological feature of CDV-mediated immunosuppression^[1]. CDV, a morbillivirus with tropism for lymphoid, epithelial, and nervous tissues, causes depletion of CD4⁺ and CD8⁺ T lymphocytes through direct viral cytopathic effects and apoptosis induction, producing a state of profound immunosuppression that predisposes infected dogs to secondary bacterial infections and complicates clinical management^[2].

While the hematological consequences of CDV infection are well-characterized in experimental settings, the translation of these findings to field populations presents challenges related to the confounding effects of nutritional status, concurrent parasitism, environmental stress, and subclinical co-infections that are prevalent in unmanaged dog populations^[3]. Dog markets in Cairo represent a particularly relevant setting for examining CDV-associated hematological alterations, as the traded dog population includes animals from diverse backgrounds whose baseline hematological parameters may differ substantially from the reference ranges established in well-managed kennel populations^[4].

Serum biochemistry provides complementary information to hematology by revealing organ-specific damage patterns that characterize CDV's multisystemic pathology. CDV-induced hepatitis produces elevations in hepatocellular enzymes (ALT, AST) and cholestatic markers (ALP, GGT), while renal involvement manifests as azotemia with elevated blood

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urea nitrogen and creatinine [5]. The characterization of these biochemical alterations in market Dog populations is relevant both for understanding disease pathophysiology in natural infection and for identifying surrogate markers that may assist CDV diagnosis when specific serological or molecular tests are unavailable.

This research was designed to compare hematological and serum biochemical profiles between CDV-seropositive and seronegative dogs at Cairo dog markets, with the objective of identifying blood parameters that show consistent CDV-associated alterations and may serve as supportive diagnostic indicators.

Material and Methods

Material

This research was conducted at three major dog markets in greater Cairo, Egypt, between April and September 2023. The selected markets included Souq Al-Gomaa (Friday Market), Souq Al-Tunsi, and Helwan Market, which collectively represent the primary commercial dog trading venues in the Cairo metropolitan area. Ethical approval was obtained from the National Institute of Virology Ethics Committee (Reference: NIV/EC/2023-024). Owner or trader consent was obtained before sampling.

Two hundred dogs of mixed breeds and ages were enrolled, with equal sampling across the three markets. Inclusion criteria required that dogs be over 3 months of age and have been present at the market for at least 24 hours. Dogs with obvious traumatic injuries, severe dehydration, or clinical signs suggestive of rabies were excluded for safety considerations.

Methods

Blood samples (8 mL) were collected from the cephalic vein into plain tubes (for serum), EDTA tubes (for hematology), and sodium fluoride tubes (for glucose). Serum was

separated by centrifugation at 3,000 rpm for 15 minutes. CDV serological status was determined using a commercial IgG ELISA kit (INgezim Distemper IgG, Ingenasa, Spain) and a rapid antigen test (Anigen Rapid CDV Ag, BioNote, South Korea).

Complete blood count was performed using an automated hematology analyzer (Sysmex XN-1000, Japan) within 6 hours of collection. Parameters measured included total White Blood Cell Count (WBC), Red Blood Cell Count (RBC), Packed Cell Volume (PCV), hemoglobin concentration, Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin Concentration (MCHC), platelet count, and differential leukocyte count. Serum biochemistry was analyzed using an automated chemistry analyzer (Beckman Coulter AU480) for Alanine Aminotransferase (ALT), Aspartate Aminotransferase (AST), Alkaline Phosphatase (ALP), Blood Urea Nitrogen (BUN), creatinine, total protein, albumin, globulin, and glucose. Statistical comparisons between CDV-positive and CDV-negative groups utilized independent samples t-tests for normally distributed variables and Mann-Whitney U tests for non-normally distributed variables. Receiver Operating Characteristic (ROC) curve analysis was performed to assess the diagnostic utility of significantly altered parameters. Analyses were conducted using SPSS version 28.0.

Results

Of 200 dogs tested, 78 (39.0%) were CDV IgG-seropositive and 122 (61.0%) were seronegative. Among seropositive dogs, 34 (43.6%) were also positive on rapid antigen testing, indicating active antigen shedding. The age distribution of seropositive dogs was skewed toward younger animals (median 1.5 years vs 3.0 years in seronegative dogs, $p < 0.001$). Body condition scores were significantly lower in seropositive dogs (median 2.0 vs 3.0, $p < 0.001$).

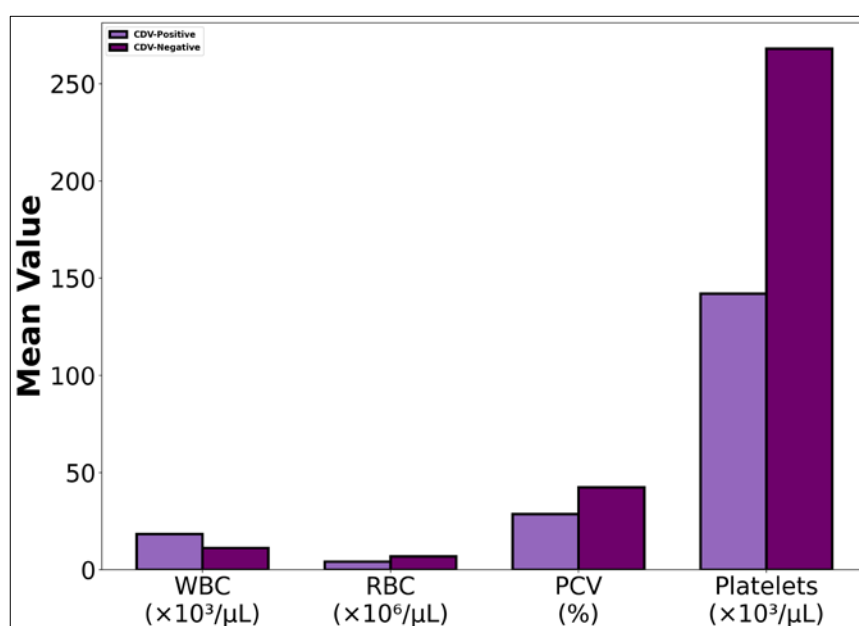


Fig 1: Grouped bar chart comparing hematological parameters between CDV-positive and CDV-negative dogs

CDV-positive dogs demonstrated significantly elevated WBC counts reflecting leukocytosis with neutrophilia, while

RBC counts, PCV, and platelet counts were all significantly reduced compared to seronegative controls.

Table 1: Hematological parameters in CDV-seropositive and seronegative market dogs

Parameter	CDV-Positive (n=78)	CDV-Negative (n=122)	p-value
WBC ($\times 10^3/\mu\text{L}$)	18.4 $\pm$ 5.2	11.2 $\pm$ 3.4	<0.001
RBC ($\times 10^6/\mu\text{L}$)	4.2 $\pm$ 1.1	6.8 $\pm$ 1.4	<0.001
PCV (%)	28.6 $\pm$ 6.8	42.4 $\pm$ 5.2	<0.001
Hemoglobin (g/dL)	9.4 $\pm$ 2.2	14.2 $\pm$ 2.6	<0.001
Platelets ($\times 10^3/\mu\text{L}$)	142 $\pm$ 48	268 $\pm$ 62	<0.001
Neutrophils (%)	72.4 $\pm$ 8.6	58.2 $\pm$ 7.4	<0.001
Lymphocytes (%)	18.2 $\pm$ 6.4	32.4 $\pm$ 6.8	<0.001
L/N ratio	0.42 $\pm$ 0.18	1.28 $\pm$ 0.32	<0.001

All hematological parameters showed highly significant differences between groups. The most striking alteration was the reduced lymphocyte-to-neutrophil (L/N) ratio in

CDV-positive dogs (0.42 vs 1.28), reflecting the combined effects of CDV-induced lymphopenia and secondary infection-driven neutrophilia.

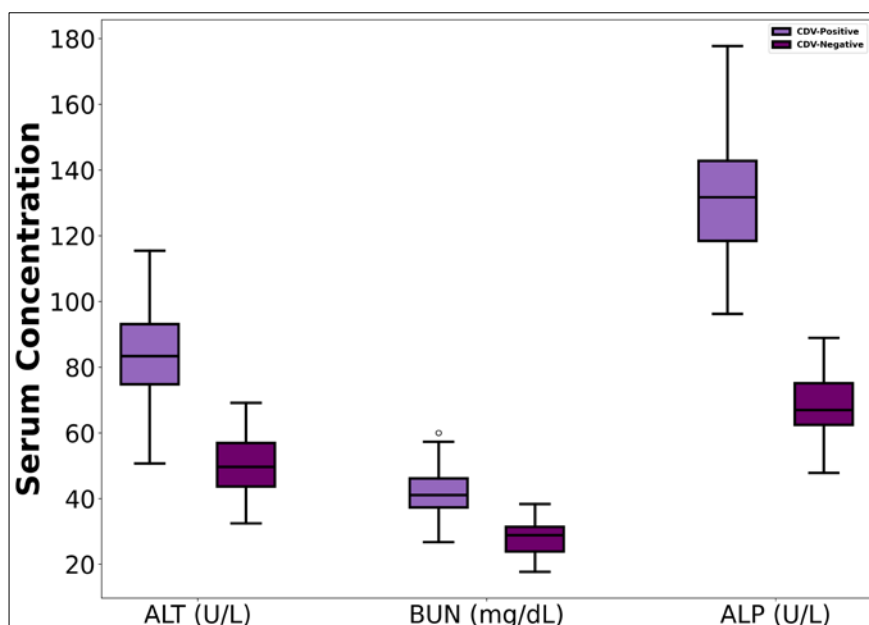


Fig 2: Box plot comparing serum biochemistry values (ALT, BUN, ALP) between CDV-positive and CDV-negative dogs

All three hepatic and renal biomarkers were significantly elevated in CDV-positive dogs, with ALT showing the largest fold-change (1.6-fold elevation) suggesting

hepatocellular damage as a consistent feature of CDV infection in this population.

Table 2: Serum biochemical parameters in CDV-seropositive and seronegative dogs

Parameter	CDV-Positive (n=78)	CDV-Negative (n=122)	p-value
ALT (U/L)	85.4 $\pm$ 24.6	52.2 $\pm$ 14.8	<0.001
AST (U/L)	68.2 $\pm$ 18.4	42.8 $\pm$ 12.6	<0.001
ALP (U/L)	128.4 $\pm$ 38.2	68.6 $\pm$ 22.4	<0.001
BUN (mg/dL)	42.4 $\pm$ 12.8	28.2 $\pm$ 8.4	<0.001
Creatinine (mg/dL)	1.8 $\pm$ 0.6	1.2 $\pm$ 0.4	<0.001
Total protein (g/dL)	8.2 $\pm$ 1.4	6.8 $\pm$ 1.0	<0.001
Albumin (g/dL)	2.2 $\pm$ 0.6	3.4 $\pm$ 0.4	<0.001
Globulin (g/dL)	6.0 $\pm$ 1.2	3.4 $\pm$ 0.8	<0.001

Table 3: ROC analysis of hematological and biochemical parameters as CDV diagnostic indicators

Parameter	AUC	Optimal Cutoff	Sensitivity (%)	Specificity (%)
L/N ratio	0.92	≤ 0.68	88.5	84.4
PCV	0.88	$\leq 34\%$	82.1	80.3
ALP	0.86	≥ 92 U/L	78.2	82.0
Platelet count	0.84	$\leq 186 \times 10^3/\mu\text{L}$	76.9	78.7
ALT	0.82	≥ 68 U/L	74.4	76.2

The comprehensive hematological and biochemical analysis reveals a consistent pattern of CDV-associated alterations characterized by leukocytosis with lymphopenia (reduced L/N ratio), anemia (reduced PCV and hemoglobin), thrombocytopenia, hepatic enzyme elevation (ALT, AST, ALP), and azotemia (elevated BUN and creatinine). ROC analysis identifies the lymphocyte-to-neutrophil ratio (AUC = 0.92) as the single most discriminating hematological parameter, achieving 88.5% sensitivity and 84.4% specificity at a cutoff of 0.68 or below. This finding suggests that the L/N ratio, obtainable from a simple differential white cell count, may serve as a practical screening parameter for CDV infection in market settings where specific serological testing is unavailable.

Discussion

This research provides the first comprehensive characterization of hematological and biochemical alterations in CDV-seropositive dogs from Egyptian dog markets, documenting significant changes across all measured parameters that are consistent with the known multisystemic pathology of canine distemper [1]. The overall CDV seroprevalence of 39.0% places the Cairo market dog population within the intermediate range reported from other North African and Middle Eastern surveys, where prevalence rates of 25-50% have been documented in unvaccinated populations [4].

The finding that the lymphocyte-to-neutrophil ratio provides the best discriminating power (AUC = 0.92) for distinguishing CDV-seropositive from seronegative dogs agrees with the known pathophysiology of CDV infection, in which viral tropism for lymphoid tissues produces progressive lymphocyte depletion while secondary bacterial infections drive compensatory neutrophilia [2]. This ratio integrates two pathophysiological processes into a single metric, explaining its superior diagnostic performance compared to individual hematological parameters. The practical value of this finding lies in the accessibility of differential leukocyte counts in resource-limited settings where ELISA or PCR testing may be unavailable.

However, the cross-sectional design of this research limits interpretation of the temporal relationship between CDV seropositivity and hematological alterations. The observed associations may reflect direct viral effects, secondary infection consequences, nutritional deficiency confounding, or combinations of these factors [3]. The significantly lower body condition scores in seropositive dogs suggest that nutritional status may contribute to both CDV susceptibility and the severity of hematological changes, creating a confounding pathway that cannot be resolved without longitudinal data or experimental controlled infection.

The elevated serum globulin levels in CDV-seropositive dogs (6.0 vs 3.4 g/dL), combined with reduced albumin (2.2 vs 3.4 g/dL), reflect the characteristic hyperglobulinemia of chronic antigenic stimulation coupled with the negative acute phase response that reduces hepatic albumin synthesis [5]. This albumin-to-globulin ratio reversal has been described in CDV infection models and may serve as an additional supportive diagnostic indicator, although its

specificity for CDV versus other chronic infections is limited.

From a practical perspective, the identification of readily measurable hematological parameters with acceptable diagnostic performance opens the possibility of CDV screening at dog markets using portable hematology analyzers or even manual differential counts. While these tests cannot replace specific virological diagnosis, they may enable triage-level screening that identifies dogs warranting confirmatory testing or precautionary isolation, thereby reducing the risk of CDV transmission within the market environment [6].

Conclusion

This research aimed to characterize hematological and serum biochemical alterations in CDV-seropositive dogs compared to seronegative controls at Cairo dog markets and to evaluate the diagnostic utility of significantly altered blood parameters.

CDV-seropositive dogs demonstrated consistent and significant alterations across all hematological and biochemical parameters measured, with the lymphocyte-to-neutrophil ratio emerging as the most discriminating single parameter (AUC = 0.92, sensitivity 88.5%, specificity 84.4% at cutoff 0.68). Hepatic enzyme elevations (ALT, ALP) and azotemia confirmed multisystemic organ involvement in the market dog population.

Veterinary practitioners at dog markets in Egypt and comparable settings should consider incorporating differential leukocyte counts into routine health assessments, using the L/N ratio as a cost-effective screening tool to identify dogs with high probability of CDV infection for targeted confirmatory testing or precautionary management.

Future research should apply longitudinal study designs to establish the temporal sequence of hematological changes following CDV infection in natural market dog populations, enabling differentiation between direct viral effects and secondary infection consequences, and should validate the L/N ratio cutoff prospectively in independent market populations.

Acknowledgements

The National Institute of Virology provided clinical pathology laboratory facilities, automated analyzers, and reagent supplies. AMES designed the research and supervised clinical sampling; FIH performed hematological and biochemical analyses; MAAR contributed to ROC analysis, statistical modeling, and manuscript preparation. This research was funded by the Egyptian Academy of Scientific Research and Technology.

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