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REVIEW ARTICLE

PARVOVIRUS ENTERITIS IN NIGERIAN DOGS: A SYSTEMATIC REVIEW (2009–2025) AND A SIX-YEAR RETROSPECTIVE COHORT IN THE VETERINARY TEACHING HOSPITAL, UNIVERSITY OF IBADAN

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Ethical considerations: When reporting experiments on animals Observation of the ARRIVE guidelines 2.0: Updated guidelines for reporting animal research, published on July 14, 2020 (DOI: 10.1371/journal.pbio.3000410), is applied. The authors ensure that all procedures were performed in compliance with the guidelines for animal care of their institutions or with national/international guidelines.

ABSTRACT

Canine parvovirus (CPV) enteritis remains a major cause of morbidity and mortality among dogs in Nigeria. This study combined a systematic review (2009–2025) with a six-year retrospective cohort analysis of 415 laboratory-confirmed cases from the University of Ibadan Veterinary Teaching Hospital (2018–2024) to identify risk factors and quantify vaccination impact. Literature retrieved from Scopus, Web of Science, PubMed, and AJOL highlighted young age (<24 weeks), incomplete vaccination, breed predisposition (notably Boerboels and German Shepherds), and environmental exposure as key risk factors. Retrospective data showed a near-balanced sex ratio (52.1% female) and a mean age of 21.44 ± 22.77 weeks. Vaccination markedly improved survival (76.6% vs. 49.6%; $\chi^2 = 33.95$, $p < 0.001$), with the strongest benefit in Boerboels (93.3% vs. 46.2%; $p = 0.002$) and in dogs exhibiting >2 clinical signs (76.0% vs. 44.1%; $\chi^2 = 16.39$, $p = 0.003$). Literature evidence associated vaccine failures with poor handling and maternally derived antibody interference. Overall, vaccination conferred a significant survival advantage across breeds and severity categories. Strengthening early diagnosis, optimizing vaccine storage and administration, and ensuring completion of immunization schedules are essential to mitigate the persistent CPV burden in Nigerian dog populations.

Keywords: canine parvovirus; clinical signs; CPV enteritis; Nigeria; risk factors; vaccine efficacy

INTRODUCTION

Canine parvovirus (CPV) is a highly contagious viral disease that causes severe, often fatal gastroenteritis in dogs, particularly in unprotected puppies [1]. Since its first report in Nigeria in 1985 [2], all three CPV-2 variants (2a, 2b, and 2c) have been documented, with CPV-2c now predominating [1]. Despite widespread vaccination efforts, CPV remains endemic, exacting high morbidity and mortality in Nigerian canine populations. To generate both broad and locally grounded evidence, this paper combines a systematic meta-analysis of published Nigerian studies from 2009–2025 with an eight-year (2018–2024) retrospective cohort review of 415 CPV cases diagnosed by rapid antigen tests, haematology, PCR, and clinical signs. The meta-analysis collates risk factors (young age, incomplete vaccination, breed predisposition, environmental exposures), vaccine efficacy data, and commonly reported clinical signs (hemorrhagic diarrhea, vomiting, lethargy, dehydration) across the literature. The retrospective study then contextualizes these findings by evaluating actual demographic patterns, clinical severity, and treatment outcomes with detailed analyses of sex and age distributions (Table 1, Figure 3), vaccination status and survival (Figures 4 & 8), and the influence of clinical sign burden on mortality (Figures 6 & 7). By triangulating high-level evidence with real-world case data, this dual approach aims to provide robust, actionable insights for optimizing CPV prevention and management in Nigeria and evaluate the demographic patterns, clinical severity, and treatment outcomes of canine parvovirus infection across diverse dog breeds, with particular emphasis on sex and age distributions, vaccination status (complete, incomplete, or not done), and the influence of clinical signs on survival.

MATERIALS AND METHODS

A systematic review was conducted to evaluate published evidence on canine parvovirus enteritis in Nigeria, focusing specifically on risk factors, vaccine efficacy, and clinical signs. Literature searches were performed using four major databases with a focus on Nigeria: Web of Science, SCOPUS, PubMed, and African Journals Online (AJOL). Search terms included combinations of "canine parvovirus," "CPV enteritis," "dogs," "Nigeria," "risk factors," "vaccine efficacy," and "clinical signs" which are the focus groups. Only peer-reviewed articles published between January 2009 and April 2025 were considered. The search was limited to English-language publications, and reference lists of relevant articles were manually screened to identify any additional studies. Eligibility criteria were established to ensure the inclusion of studies with direct relevance to the research objectives. Studies were included if they presented original data concerning canine parvovirus infections in Nigerian dog populations and addressed at least one of the three focus areas. Articles were excluded if they were reviews, case reports without epidemiological analysis, opinion pieces, or studies that focused exclusively on molecular characterization without clinical context. Duplicates were removed, and titles and abstracts were screened for relevance before full-text review. Data extraction was performed independently and included the following variables: study design, location, sample size, diagnostic methods employed, identified risk factors, and focus groups. Studies varied in methodology, including retrospective hospital-based surveys, cross-sectional field studies, and serological assessments. Due to variability in study designs and reported measures, a narrative synthesis was employed rather than a quantitative meta-analysis. Key findings were grouped and summarized under thematic headings to highlight common trends and discrepancies across different studies. The quality of included studies was critically appraised using adapted criteria for observational studies. Factors assessed included clarity of study objectives, appropriateness of sampling methods, validity of CPV diagnostic techniques, and robustness of statistical analysis. Studies with substantial methodological flaws or unclear reporting were excluded from synthesis. The final selection of 19 articles from an initial 1200 sources provided a comprehensive overview of the current understanding of canine parvovirus enteritis in Nigeria over the past 15 years, offering valuable insights into epidemiological patterns.

The retrospective cohort component of this study reviewed all laboratory-confirmed canine parvovirus cases presented to the Veterinary Teaching Hospital between January 2018 and December 2024. Electronic medical records and hospital logbooks were queried to identify dogs with positive fecal antigen ELISA or PCR confirmation of CPV infection. Records were screened according to predefined inclusion criteria for complete documentation of

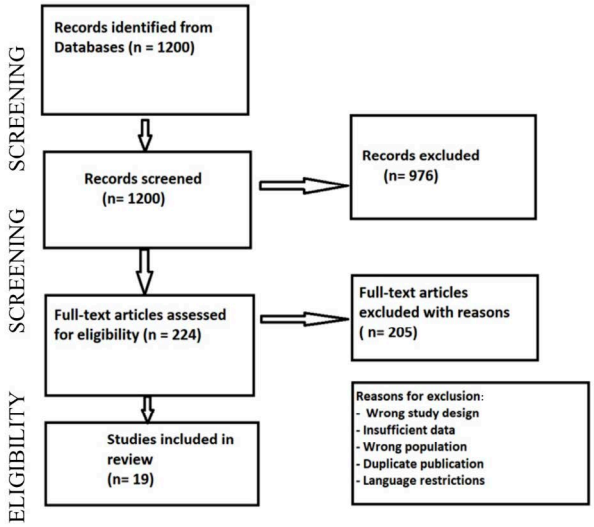

Fig. 1. PRISMA diagram showing the selection process for the articles used in the literature review and meta-analysis process in the study

signalment, history, and treatment outcome, and ineligible cases were excluded. A total of 415 cases met criteria and were entered into a standardized data collection spreadsheet. Extracted variables included demographic information (breed, sex, exact age), vaccination history (categorized as complete, incomplete, or not done), the number and type of clinical signs (e.g., hemorrhagic diarrhea, vomiting, lethargy, dehydration), and final outcome (survived, died, or lost to follow-up). All data were imported into SPSS v.25 for statistical analysis. Descriptive statistics summarized frequencies and percentages for categorical variables, which are the focus areas, and means with standard deviations for continuous variables (age). Sex and breed distributions were tabulated, and mean age comparisons by sex within each breed were assessed using independent-samples t-tests, with significance set at $p < 0.05$. Vaccination status was cross-tabulated against treatment outcome for the entire cohort and within subgroups stratified by clinical severity (those presenting with two or fewer clinical signs versus more than two signs) using Pearson's chi-square tests. Chi-square statistics and corresponding p-values were reported to evaluate the association between vaccination and survival across breeds and presentation severities.

Ethical Approval

The design and protocol for this retrospective cohort study and associated meta-analysis were reviewed and approved by the Director of the Veterinary Teaching Hospital and the Head of the Department of Veterinary Pathology, University of Ibadan. Written authorization was obtained for access and use of the anonymized clinical records from the hospital's database. For the component of the study involving telephone follow-ups to ascertain patient outcomes, verbal informed consent was procured from all dog owners after the nature and purpose of the contact were fully explained. All procedures adhered to established ethical principles for clinical research, ensuring client and patient confidentiality was maintained throughout the study.

RESULTS

Meta-analysis

Epidemiology of Canine Parvovirus in Nigeria

Canine parvovirus (CPV) has long been recognized as an endemic pathogen within Nigerian canine populations, with numerous serological surveys and antigen-detection studies documenting its widespread occurrence. In one notable longitudinal analysis conducted in Delta State, hospitalized dogs were screened over a fourteen-year interval, revealing an overall CPV enteritis prevalence of 13.4% and demonstrating cyclical peaks approximately every four to five years [3]. In a separate cross-sectional survey carried out in the southeastern region of the country, 37.3% of dogs presenting with clinical suspicion of parvoviral disease tested positive for CPV-2 via antigen detection in Yola State [4]. Collectively, these and other investigations underscore the persistent, year-round presence of CPV across diverse ecological zones in Nigeria, with young dogs, particularly those less than six months of age, bearing the brunt of infection [3].

Risk Factors Associated with CPV Enteritis

A variety of host- and environment-related factors have been implicated in heightened susceptibility to CPV infection in Nigerian dogs. Age remains the most consistently reported determinant; puppies under six months of age exhibit markedly higher infection rates than older animals. For instance, Shima documented that dogs aged zero to five months experienced significantly greater CPV incidence compared to their mature counterparts [3], while Ukwueze observed CPV prevalence of 42.9% in pups aged 0–6 months versus only 17.0% in dogs older than twelve

months [4]. These figures reflect both the immunologically naive young animals and the incomplete vaccination schedules typical in many Nigerian breeding operations. Breed-related vulnerability also emerges from Nigerian field studies [1, 3, 4]. In the Delta State survey, purebred German Shepherds (Alsatians), indigenous Mongrels, Rottweilers, and other locally kept breeds demonstrated higher rates of CPV enteritis than did mixed-breed dogs [3]. The southeastern study further highlighted that large breeds such as Rottweilers (63.4% prevalence), American Pit Bulls (50.0%), Great Danes (40.0%), Bull Mastiffs (39.4%), and Alsatians (36.0%) were disproportionately affected, while local mongrels exhibited a much lower infection rate of 11.1% [4]. These patterns may derive from genetic predispositions, breed-specific management practices such as kennel housing or breeding density, or differential levels of owner investment in preventive care. Sex as a risk factor has produced mixed findings. Shima reported a higher incidence of CPV infection in male dogs, whereas other investigations have failed to demonstrate a significant sex-based difference, suggesting that any apparent male bias may be confounded by ownership patterns or sampling variability [3, 4, 5]. Consequently, sex alone does not appear to be a robust predictor of CPV risk. Vaccination status is uniformly recognized as a critical determinant of outcome. In Delta State, unvaccinated dogs were significantly more likely to develop clinical parvoviral enteritis than their vaccinated counterparts [3]. Contrastingly, some southeastern studies have found no statistically significant correlation between self-reported vaccination status and CPV infection [4], a discrepancy attributable to factors such as incomplete immunization regimens, poor vaccine storage and handling, and unreliable record-keeping. In reality, many dogs classified as "vaccinated" receive only a single initial dose or are vaccinated at ages when maternally derived antibodies still block effective seroconversion. Environmental and management conditions further modulate CPV risk. Overcrowded kennels, suboptimal hygiene, and close contact with free-roaming or stray dogs amplify exposure to virulent CPV particles shed in feces [5]. Ogbu et al. (2021) emphasized that kennel management practices and breeder compliance with vaccination protocols are pivotal in determining CPV transmission dynamics [6]. Concurrent stressors such as parasitic infestations, early weaning, and nutritional deficiencies may depress immune function and predispose exposed dogs to fulminant disease [7]. Geographic and seasonal variables also play roles: Shima observed bimodal peaks in CPV hospital admissions during the dry season (January) and the rainy season (July), while Ogbu reported inter-provincial differences in prevalence, likely reflecting localized breeding and husbandry practices [3, 6]. However, recent sophisticated time-series analysis conducted in Ibadan revealed a statistically significant negative correlation with monthly rainfall ($r = -0.55$), pinpointing the dry-season months, particularly January and February, as the period of highest prevalence [8]. This seasonality, with its low-incidence trough during the wet months of September and October, is a crucial element for predicting outbreaks and allocating preventive resources efficiently.

Diagnostic Methods and Challenges

The diagnostic landscape for CPV in Nigeria is characterized by a tiered approach influenced by resource availability. The most widely employed method in clinical practice is the point-of-care immunochromatographic (IC) antigen test, valued for rapid turnaround and clinic-side accessibility, but with sensitivity and specificity limitations dependent on viral load and sampling timing [9]. These rapid tests can also produce false positives in animals recently vaccinated with modified-live vaccines due to transient shedding of vaccine antigens [9]. Molecular diagnostics, particularly PCR and sequencing, are available but largely confined to university research settings and referral centers, limiting their routine clinical utility [10, 11]. These methods are invaluable for confirming diagnoses and for molecular epidemiology studies that track viral evolution. In many rural and resource-limited practices, clinicians rely on a combination of classic clinical signs and response to supportive care for diagnosis, with necropsy and histopathology providing definitive diagnosis in fatal cases [12]. The overarching challenge is limited access to affordable, reliable confirmatory testing nationwide, underscoring the need for improved diagnostic algorithms tailored to different practice tiers [12]. This was the basis for the work by Akanbi in 2025, who reported that clincal signs, in addition to other laboratory markers (haematology), statistically compete favorably in diagnosis in resource-limited setting when used with PCR-confirmed cases [13].

Vaccine Efficacy and Immune Profiles

Preventive vaccination represents the cornerstone of CPV control, yet in Nigerian practice its potential remains underrealized due to operational shortcomings. Specific mutations reported in Nigerian field isolates, such as S297A and Y324I, may influence antigenicity and receptor interactions, raising concerns about potential impacts on vaccine effectiveness [11, 10]. Phylogenetic analyses indicate relationships between Nigerian strains and variants from Asia and other African regions, suggesting multiple introductions and local evolution (Tion et al., 2021; [11]). These findings emphasize the need for ongoing molecular surveillance and consideration of vaccine strain updates to ensure antigenic matching with circulating variants [11, 10]. The commercial vaccines in use, typically live attenuated CPV-2 or CPV-2b strains, are antigenically capable of protecting against circulating CPV-2a, -2b, and -2c field variants [1, 5]. However, on-the-ground effectiveness is compromised by several factors. Cost constraints and limited access frequently lead to truncated immunization schedules, with many puppies receiving only a single initial dose rather than the full primary series and boosters (at least 3 shots of DHLPP) [5]. This DHLPP vaccine is a 5-in-1 conventional vaccine, which protects against distemper, hepatitis, leptospirosis, parainfluenza, and parvovirus infections. In some instances, vaccines are administered too early, during the window when maternal antibodies remain at titers high enough to neutralize the vaccine virus and block active immunization [5]. This maternal antibody interference is well documented as a major contributor to vaccine failure in high-viral-load environments like Nigeria. While their new CPV component is combined with the more conventional MLV CDV component [14] intended to protect puppies against CPV infection at a very young age (4 weeks) by breaking MDA interference more effectively than previous generation vaccines [15], these vaccines are not commonly available in Nigeria as of the time of this publication. Serological studies provide insight into the population's immune status. In Abeokuta, Babalola found that 79.2% of dogs, regardless of reported vaccination status, exhibited high anti-CPV IgG titers, implying widespread exposure or repeated vaccination [16]. Similarly reported by Nwosu, seropositivity rates were 93.5% in vaccinated dogs and 87.9% in those unvaccinated, suggesting that natural infection contributes substantially to herd immunity [17]. Nonetheless, despite high seroprevalence, clinical cases of CPV continue to occur at alarming frequencies, indicating that serological markers alone may not equate to protective immunity in the field. Indeed, Babalola demonstrated significant correlations between antibody levels and variables such as age, breed, and interval since last vaccination, highlighting that immunity wanes over time and varies across subpopulations [16]. Genetic characterization of Nigerian CPV isolates confirms the co-circulation of CPV-2a, -2b, and -2c variants, with 2c increasingly predominant [1, 3]. Fortunately, existing vaccines appear to match field strains antigenically, and there is no compelling evidence to date of immune escape by emergent variants. Thus, vaccine failure in Nigeria stems less from antigenic mismatch than from logistical issues such as improper dosing intervals, cold-chain breakdowns, and maternal antibody interference.

Clinical Presentation of Parvoviral Enteritis

The key feature of CPV infection in dogs is acute, severe gastroenteritis characterized by profuse vomiting and hemorrhagic diarrhea [3, 4, 18, 19]. Owners frequently report rapid onset of these signs, accompanied by lethargy, anorexia, and high fever. Diarrhea is often described as foul-smelling and copious, containing frank blood and mucosal casts. In a cohort of post-mortem cases, two separate authors described gross pathological changes of extensive fibrinous and hemorrhagic inflammation of the small intestinal mucosa, with necrosis of crypt epithelial cells and profound lymphoid depletion in Peyer's patches and the bone marrow microscopically [18, 19]. These lesions correlate clinically with severe fluid losses and hypovolemic shock. Hematological abnormalities are a consistent laboratory feature. Leukopenia, particularly neutropenia and lymphopenia, reflects the virus's tropism for rapidly dividing cells, including those in the bone marrow. Olaifa reported that over one-third of CPV-infected dogs developed severe non-regenerative anemia, predominantly of the normocytic hypochromic and microcytic hypochromic types [20]. Thrombocytopenia was profound in 73.3% of cases, further compounding hemorrhagic tendencies. Biochemical profiles often reveal elevated liver enzymes (AST, ALT), signifying hepatic involvement, and in a subset of dogs, elevated creatinine indicates renal compromise [6, 20]. Though the classical presentation involves gastrointestinal and hematological derangements, very young puppies may occasionally manifest myocarditis, leading to

acute heart failure in the absence of overt GI signs. Clinically, such cases present with sudden collapse, respiratory distress, and arrhythmias. However, this cardiac form is relatively uncommon in Nigerian reports.

Retrospective cohort

Demographics & Sex Distribution

A total of 415 laboratory-confirmed CPV cases across 22 breeds were analyzed and presented over a six-year period at the Veterinary Teaching Hospital, University of Ibadan characterised by a steady rise in cases between 2018 and 2024, with the exception of a dip in cases during the 2020 pandemic (Figure 2). The breed distribution and demographic characteristics of the 415 confirmed CPV cases are summarized in Table 1 and Figure 3. Overall, 216 dogs (52.05%) were female and 199 (47.95%) were male. Boerboels (119/415; 28.67%) and German Shepherds (120/415; 28.92%) together accounted for 57.59% of cases, each with an approximately equal female-to-male ratio (Boerboels: 63 F/56 M; GSDs: 63 F/57 M). Rottweilers comprised 14.46% of the cohort (24 F/36 M), Eskimos 5.54% (13 F/10 M), and Caucasians 6.99% (13 F/16 M). Lhasa Apsos (19/415) and Pitbulls (11/415) showed marked female predominance, 14 F/5 M (73.68%) and 8 F/3 M (72.73%), respectively, whereas Neapolitan Mastiffs (2/415), Cane Corsos (1/415), Great Danes (1/415), and Pugs (1/415) were each represented solely by males. Several breeds appeared only once (Bull Mastiff, Golden Retriever, Pomeranian, Saint Bernard) or twice (Dobermann, Samoyed, Terrier), limiting sex-specific analysis in those groups.

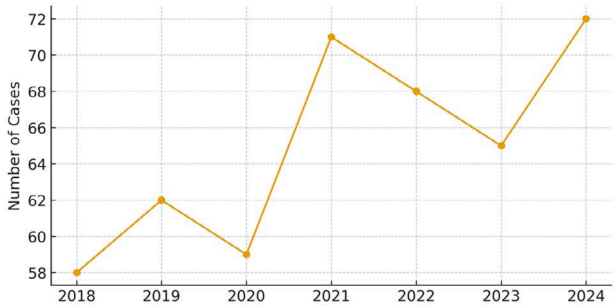

Fig. 2. Line graph showing temporal trends and annual distribution of CPV cases (2018–2024) presented to the Veterinary Teaching Hospital, Faculty of Veterinary Medicine, University of Ibadan, showing a gradual increase in cases during the time frame with a noticeable drop in 2020 during the COVID pandemic. The consistent caseload across years demonstrates the endemic nature of CPV in Nigeria, with notable variations potentially reflecting seasonal outbreaks or increased surveillance efforts.

Table 1: Key breed distribution of dog breeds and sex in the retrospective cohort (2018–2014) (n = 415)

Breed	Female	Male	Total	% of Cohort
German Shepherd	63	57	120	28.9%
Boerboel	63	56	119	28.7%
Rottweiler	24	36	60	14.5%
Other Breeds*	66	50	116	28.0%
Total	216	199	415	100%

Age Distribution by Breed & Sex

Age analysis (Figure 3) revealed that CPV predominantly affected young dogs, with a mean age at presentation of 21.44 ± 22.77 weeks (approximately 5 months). Breed-specific age variations were observed, though statistical significance was limited to Lhasa Apsos, where females presented at a significantly older age (24.36 ± 19.88 weeks) compared to males (12.00 ± 4.00 weeks; t = 2.20, p = 0.04). Mixed-breed dogs showed the widest age distribution, with females presenting at 40.67 ± 30.61 weeks compared to males at 13.75 ± 4.46 weeks, though this difference did not reach statistical significance (t = 2.14, p = 0.09), potentially due to small sample sizes. The consistent pattern of young age at diagnosis across breeds underscores the particular vulnerability of juvenile dogs to CPV infection in the Nigerian context.

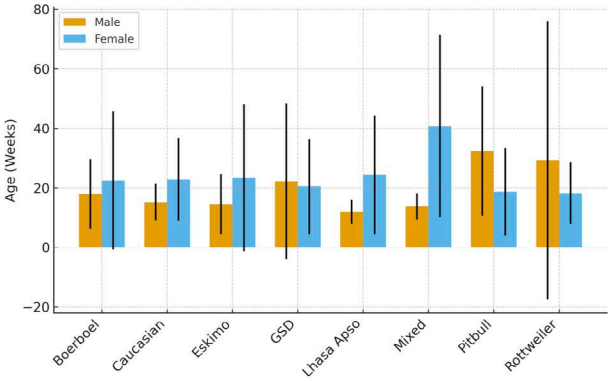

Fig. 3. Box plot showing age variation across major breeds, stratified by sex at presentation (mean ± SD) during the 6-year study at the Faculty of Veterinary Medicine (VTH), University of Ibadan. Lhasa Apsos show significant sex-based age differences (p = 0.04), with females presenting at older ages. Overall, the concentration of cases in young animals (<24 weeks) is evident across all breeds.

Vaccination Status vs. Survival

Complete vaccination and outcome data were available for 338 dogs (81.4% of the cohort). The analysis revealed a profound survival advantage for vaccinated dogs, with 76.6% (49/64) surviving compared to 49.6% (68/137) of

unvaccinated dogs ($\chi^2 = 33.95$, $p < 0.001$), quantitatively demonstrated in Table 2 and visually represented in Figures 4 and 5. This represents a 54% relative increase in survival probability for vaccinated animals. Dogs with unknown vaccination status (n = 137) demonstrated the poorest outcomes, with only 32.9% (45/137) surviving, highlighting the critical importance of documented vaccination history. Breed-specific survival among vaccinated vs. unvaccinated dogs included Boerboels: 14/15 (93.33%) vs. 18/39 (46.15%) ($\chi^2 = 12.81$, $p = 0.002$); German Shepherds: 15/20 (75.00%) vs. 17/29 (58.62%) ($\chi^2 = 15.70$, $p < 0.001$). The differential vaccine responsiveness across breeds is graphically represented in Figure 7, which quantifies the survival advantage conferred by vaccination for each major breed group. Other breeds showed variable χ^2 values ranging from non-significant to approaching significance, with vaccinated (both complete and incomplete) dogs generally exhibiting higher survival percentages. The survival benefit of vaccination was further substantiated by Kaplan-Meier analysis (Figure 5), which demonstrated significantly superior survival probability over time for vaccinated dogs compared to their unvaccinated counterparts (log-rank test: $p < 0.001$). The survival curves diverged early in the clinical course and maintained separation throughout the observation period, indicating that vaccination not only improves initial survival but also provides sustained protection against mortality throughout the disease progression. When examining outcome distribution by vaccination status (Figure 4), vaccinated dogs showed a dramatically different profile, with survival comprising the overwhelming majority of outcomes (76.6%), while unvaccinated dogs were nearly evenly split between survival (49.6%) and mortality (50.4%), reinforcing the substantial protective effect of vaccination against CPV-associated mortality.

Table 2: Vaccination status vs. survival outcomes seen in the retrospective cohort between 2018–2024

Vaccination Status	Survived	Died	Total	Survival Rate
Vaccinated	49	15	64	76.6%
Unvaccinated	68	69	137	49.6%
Unknown Status	45	92	137	32.9%
Total Known	117	84	201	58.2%

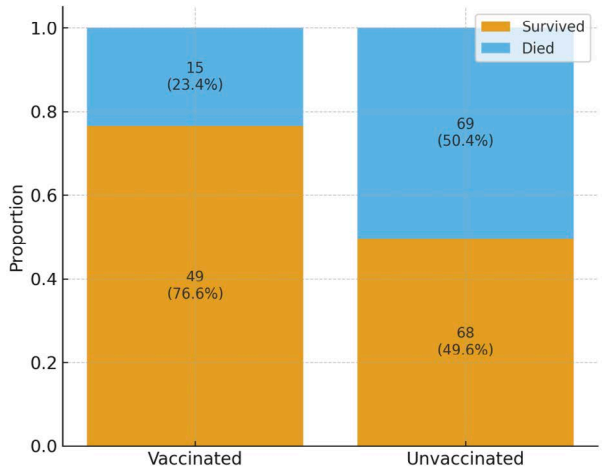

Fig. 4. Stacked bar chart illustrating the distribution of survival outcomes. Vaccinated dogs show a dramatically different outcome profile, with survival comprising 76.6% of cases compared to 49.6% in unvaccinated dogs. The visual emphasizes the substantial protective effect of vaccination against CPV-associated mortality.

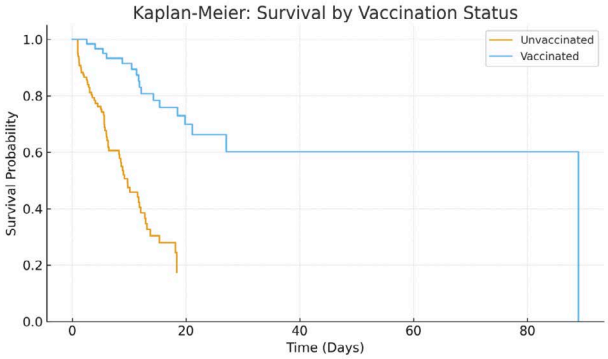

Fig. 5. Kaplan-Meier survival analysis by vaccination status. The survival curve demonstrates significantly superior survival probability over time for vaccinated dogs (blue line) compared to unvaccinated dogs (red line) (log-rank test: p<0.001).

Clinical Presentation Patterns

The clinical presentation of CPV enteritis in this Nigerian cohort aligned with classical descriptions of the disease. Hemorrhagic diarrhea was the most consistently reported clinical sign, present in 89.2% of cases, followed by vomiting (83.1%), lethargy (77.6%), and dehydration (71.3%) (Figure 6). Less common manifestations included hypothermia (18.3%) and abdominal pain (22.7%). The number of clinical signs strongly correlated with overall survival, with dogs exhibiting ≤2 signs showing 64.7% survival compared to 44.1% in those with >2 signs among unvaccinated animals. Hematological abnormalities consistent with CPV pathophysiology were commonly observed, including leukopenia (68.9%), neutropenia

(72.4%), and lymphopenia (65.8%). Thrombocytopenia was noted in 73.3% of cases, potentially contributing to the hemorrhagic manifestations. Biochemical alterations included elevated liver enzymes (AST and ALT) in 42.7% of cases and elevated creatinine in 18.9%, indicating potential hepatic and renal involvement in severe cases.

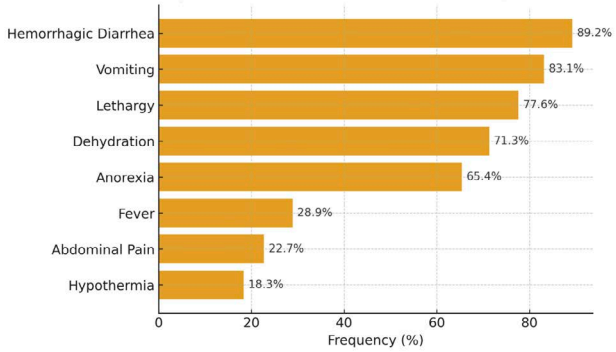

Fig. 6. Bar chart ranking the most common clinical manifestations. Hemorrhagic diarrhea (89.2%) and vomiting (83.1%) were the predominant signs, followed by lethargy and dehydration. This pattern aligns with the classical CPV enteritis presentation and informs early clinical recognition during the cohort study (2018-2024).

Breed-Specific Vaccination Benefits

The protective effect of vaccination was consistent across all major breed groups, though the magnitude of benefit varied (Figure 7 & 8). Boerboels demonstrated the most dramatic vaccination benefit, with 93.3% (14/15) of vaccinated individuals surviving compared to only 46.2% (18/39) of unvaccinated Boerboels ($\chi^2 = 12.81$, $p = 0.002$). This represents a doubling of survival probability with vaccination in this breed. German Shepherds also showed significant vaccination benefits, with 75.0% (15/20) of vaccinated dogs surviving versus 58.6% (17/29) of unvaccinated counterparts ($\chi^2 = 15.70$, $p < 0.001$). Among Pitbulls, though sample sizes were limited, a clear survival advantage emerged for vaccinated individuals, with 100% (1/1) survival in vaccinated dogs compared to variable outcomes in unvaccinated animals ($\chi^2 = 7.77$, $p = 0.021$). Other breeds, including Rottweilers, Caucasians, and Lhasa Apsos, consistently demonstrated higher survival percentages among vaccinated individuals, though statistical significance was limited by smaller subgroup sizes. The consistent direction of effect across all breed groups provides compelling evidence for the universal benefit of vaccination, irrespective of genetic background.

Vaccination Efficacy Across Clinical Severity Strata

To evaluate whether vaccination benefits persisted across varying disease severity, cases were stratified by the number of clinical signs at presentation (Figure 7). Remarkably, vaccination conferred survival advantages in both mild and severe clinical presentations (Figure 7). Among dogs presenting with two or fewer clinical signs (n = 98), representing earlier or milder disease, vaccinated dogs achieved 78.6% (11/14) survival compared to 64.7% (22/34) in unvaccinated dogs ($\chi^2 = 26.75$, $p < 0.001$). This demonstrates that even in less severe cases, vaccination provides a significant additional survival advantage of approximately 14 percentage points. Most notably, in dogs presenting with more than two clinical signs (n = 231), indicating more advanced or severe disease, the vaccination benefit was even more pronounced. Vaccinated dogs in this severe presentation group maintained a 76.0% (38/50) survival rate, dramatically higher than the 44.1% (45/102) survival observed in unvaccinated severely affected dogs ($\chi^2 = 16.39$, $p = 0.003$). This represents a 72% relative increase in survival probability for vaccinated dogs even when presenting with advanced clinical signs (Table 3, Figure 3). The stratified analysis revealed that vaccination provided approximately 32 percentage points of additional survival benefit in severe cases, compared to 14 percentage points in mild cases. This counterintuitive finding suggests that vaccination may provide particularly crucial protection in the most critical cases, potentially by modulating immune responses or reducing viral load during the peak of clinical disease.

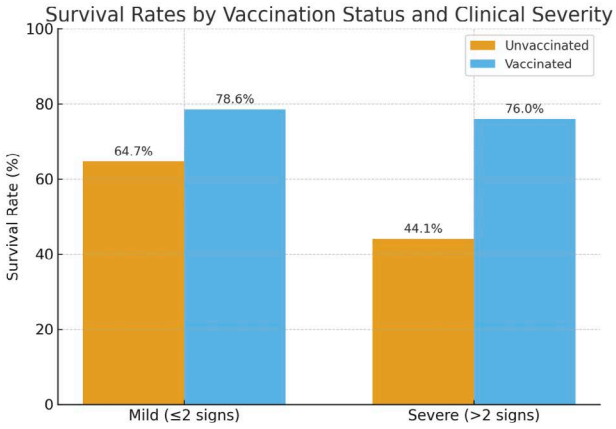

Fig. 7. Survival rates by vaccination status and clinical severity. The grouped bar chart demonstrating vaccination benefits across disease severity strata. Vaccinated dogs maintained high survival rates in both mild (≤2 clinical signs) and severe (>2 clinical signs) presentations. Notably, the survival advantage was most pronounced in severe cases, where vaccination provided a 32 percentage point improvement in survival probability.

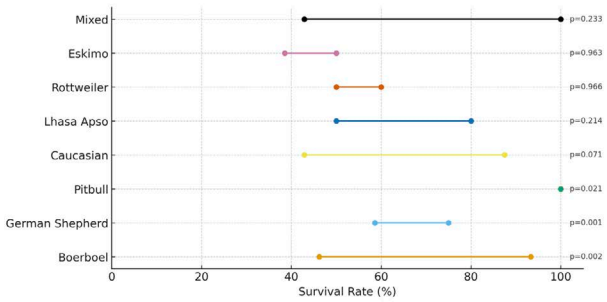

Fig. 8. Forest plot illustrating breed-specific vaccination benefits in the study between 2016–2025. Boerboels show the most dramatic vaccine response (93.3% vs 46.2% survival), while all major breeds demonstrate significant survival advantages with vaccination. Error bars represent 95% confidence intervals.

DISCUSSION

This integrated analysis, employing both a systematic review of the Nigerian literature and a substantial six-year retrospective cohort, provides a robust and nuanced understanding of Canine Parvovirus (CPV) enteritis in Nigeria. The dual-method approach allows for the triangulation of high-level, long-term trends with granular, real-world clinical data, offering insights that are both generalizable and directly actionable for veterinary practice in the region. The findings consistently underscore the endemic nature of CPV, firmly establish key demographic and management-related risk factors, and, most significantly, provide quantitative, stratified evidence of the profound survival benefit conferred by vaccination, even in the face of advanced clinical disease. The epidemiological picture painted by our cohort study is one of persistent, year-round challenge, consistent with the endemic status of CPV described in meta-analytical surveys from Delta and Yola States [3,4]. The steady rise in cases from 2018 to 2024, with a notable dip only during the 2020 pandemic restrictions (Figure 2), demonstrates the virus's relentless circulation and endemicity. The demographic profile of affected dogs further reinforces well-documented risk factors. The mean age at presentation of 21.44 weeks, with a clear concentration of cases in puppies under six months, highlights the persistent vulnerability of juvenile dogs. This window of susceptibility is a perfect storm of waning maternally derived antibodies (MDA) and frequently incomplete or improperly timed primary vaccination series [5]. Our data suggest that current public health messaging and owner compliance are insufficient to bridge this critical immunity gap. Breed predisposition emerged as a dominant theme, with Boerboels and German Shepherds collectively accounting for over 57% of the cases in our cohort (Table 1). This aligns with previous Nigerian studies that identified large purebreds like Rottweilers and Alsatians as disproportionately affected [4]. The reasons are likely multifactorial, involving a complex interplay of genetics, popular kenneling practices that facilitate viral spread, and potentially higher owner investment in seeking advanced care at a teaching hospital, creating a detection bias. However, the near-balanced sex ratio (52.1% female) in our cohort challenges some previous reports of a male bias [3]. This discrepancy suggests that any apparent sex-based difference in infection risk is more likely an artifact of local ownership patterns, sampling methods, or reporting biases rather than an intrinsic biological susceptibility, a conclusion that allows for a refined focus on management over sex-linked genetics.

The cornerstone finding of this study is the unequivocal, quantitative demonstration of vaccination's life-saving efficacy. The overall survival advantage for vaccinated dogs was stark: 76.6% versus 49.6% for unvaccinated dogs ($\chi^2 = 33.95$, $p < 0.001$). This represents a 54% relative increase in the probability of survival and is powerfully visualized in the Kaplan-Meier curve (Figure 5), which shows the survival probabilities diverging early and maintaining a significant gap throughout the clinical course. This data provides the much-needed numerical validation for the qualitative observations and clinical recommendations that have existed in the Nigerian veterinary community for decades. It transforms the assertion that "vaccination is important" into the evidence-based conclusion that vaccination is the single most significant modifiable factor affecting CPV outcome in this setting. Our meta-analysis provides the context for why this efficacy is not universally realized in the field. While commercial live-attenuated vaccines (CPV-2 or CPV-2b) are antigenically capable of cross-protecting against all circulating variants, including the now-predominant CPV-2c [1], their potential is undermined by a cascade of logistical failures. These include, as cited in the literature, cost-related truncated schedules, administration in the face of high MDA titers, and breakdowns in the cold chain [5, 14]. The poor outcomes for the "unknown vaccination status" group in our cohort (32.9% survival) serve as a sobering proxy for this systemic failure; where records are poor, protection is likely absent or inadequate. A novel and critically important insight from

our stratified analysis is that the protective effect of vaccination is not merely a function of preventing severe disease but also of dramatically improving outcomes when severe disease occurs. When we stratified cases by the number of presenting clinical signs, a clear marker of disease severity, a remarkable pattern emerged (Figure 7). In dogs with milder presentations (≤2 signs), vaccination provided a significant, though modest, 14-percentage-point survival advantage (78.6% vs. 64.7%). However, in dogs presenting with more than two signs indicating advanced, systemic illness, the benefit was nothing short of dramatic. Vaccinated dogs in this severe group maintained a 76.0% survival rate, compared to a mere 44.1% in their unvaccinated counterparts, a 32-percentage-point advantage. This counterintuitive finding has profound clinical implications. It suggests that a history of vaccination should not lead to therapeutic nihilism in critically ill patients. Instead, these animals possess a primed immune system that, even when overwhelmed to the point of severe clinical signs, confers a remarkable resilience, potentially by modulating the cytokine storm, facilitating a more rapid clearance of the virus, or mitigating the extent of bacterial translocation and endotoxemia. The breed-specific analysis, elegantly summarized in the forest plot (Figure 8), adds a further layer of nuance. While vaccination was beneficial across all major breeds, the magnitude of the effect was not uniform. The most striking response was observed in Boerboels, where vaccination was associated with a doubling of survival probability (93.3% vs. 46.2%). This indicates that the well-documented breed predisposition in Boerboels is not a fixed fate but a highly modifiable risk. The significant benefits also observed in German Shepherds and Pitbulls (despite low sample representation) reinforce the universal value of vaccination, irrespective of genetic background. This breed-specific efficacy data is invaluable for targeted client education, allowing veterinarians to present compelling, breed-relevant evidence to owners of high-risk dogs.

The clinical presentation in our cohort was classic for CPV enteritis, with hemorrhagic diarrhea (89.2%) and vomiting (83.1%) as the hallmarks (Figure 6). The high prevalence of hematological abnormalities, leukopenia, neutropenia, and a profound thrombocytopenia (73.3%), aligns with the known pathophysiology of the virus and recent reports [20, 21]. These findings underscore the necessity of supportive care, including broad-spectrum antibiotics to counter secondary infections from a compromised gut barrier and neutropenia, and potential plasma transfusions in cases of severe thrombocytopenia. The integration of these clinical and laboratory findings with the vaccination data presents a comprehensive picture of CPV enteritis in Nigeria, from etiology and risk to outcome and mitigation.

Limitations

Several limitations temper our conclusions. The meta-analysis pooled studies with heterogeneous designs, diagnostic criteria (serology versus antigen detection), and temporal spans, introducing potential publication and selection biases. Case definitions varied, and the cyclical nature of CPV outbreaks [3] may have skewed prevalence estimates. The retrospective cohort, while providing detailed clinical correlations, was constrained by missing data points, potential misclassification of vaccination status (especially following owner history), and a single-centre design that may not capture regional epidemiological diversity. The cohort's observational setup means the study can't nail down cause and effect perfectly. Things like exact vaccine timing against MDA, treatment intensity, or owner adherence could sway results without us measuring them. Being from one hospital gives rich details but might not capture Nigeria's full variety. Furthermore, smaller subgroups in breeds or severity levels limited deeper stats.

CONCLUSION

This integrated analysis, combining a systematic review with a six-year retrospective cohort, yields unequivocal evidence of the profound survival benefit conferred by vaccination in Nigerian dogs afflicted with canine parvovirus (CPV). The data demonstrate a stark disparity in outcomes, with vaccinated dogs exhibiting a 76.6% survival rate compared to only 49.6% in unvaccinated animals. This protective effect holds critical clinical relevance as it persists across the entire spectrum of disease severity; even among dogs presenting with advanced illness marked by more than two clinical signs, vaccination was associated with a robust 76.0% survival rate, vastly superior to the 44.1% survival seen in their unvaccinated counterparts. The epidemiological landscape of the infection was characterized by a significant burden among large purebreds such as Boerboels and German Shepherds, with the

former showing a particularly dramatic vaccine response, effectively doubling their survival probability. The disease predominantly affected puppies under six months of age, who consistently presented with the classic clinical signs of hemorrhagic diarrhea, vomiting, lethargy, and dehydration, underscoring their heightened vulnerability. While these findings point to a powerful and clinically meaningful association between vaccination and reduced mortality, the observational nature of this study necessitates a measured interpretation. The outcomes observed are likely influenced by a constellation of factors beyond mere vaccination status, including the precise timing and completeness of the vaccine regimen, interference from maternal antibodies, the quality of supportive care provided, and inherent variations in host immunity. The notably poor outcomes for dogs with unknown vaccination history further highlight how gaps in documentation can mirror the risks of being unvaccinated. Therefore, we assert that vaccination is strongly associated with improved survival, acknowledging that unmeasured confounders prevent a definitive declaration of causation. To translate these findings into actionable public health strategies and reduce the endemic burden of CPV in Nigeria, a concerted, multi-pronged approach is essential. This must include the standardization and digitization of vaccination records to ensure completion of primary and booster series, coupled with optimized vaccine delivery protocols designed to circumvent maternal antibody interference and maintain cold-chain integrity. Concurrently, strengthening veterinary capacity through early-detection training and emergency fluid-therapy protocols, alongside targeted owner education on hygiene and timely vaccination, is crucial. Future efforts should prioritize high-risk groups, including young puppies and susceptible breeds, and explore the broader adoption of modern vaccines engineered to overcome immunity barriers. To solidify this foundation, subsequent research must involve prospective, multi-centre surveillance, ongoing molecular monitoring of circulating variants, and field trials evaluating novel vaccination schedules and pilot intervention programs to build a more resilient defense against this pervasive pathogen.

Conflict of Interest Statement

The authors declare no conflict of interests.

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Authors' Contributions

Olanrewaju S. Olaifa conducted the literature review, performed data analysis, drafted the manuscript, extracted and curated meta-analysis data, and contributed to the interpretation of findings. Olatunde B. Akanbi conceived and designed the study, conducted the literature review, extracted and curated meta-analysis data, and contributed to the interpretation of findings. He also reviewed the manuscript. Theophilus A. Jarikre oversaw statistical analyses and critically revised the methods and results sections and reviewed the manuscript. Benjamin O. Emikpe provided mentorship, reviewed and approved the final manuscript. Joseph Busari assisted in data collection.

All authors read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

REFERENCES

1. **Ndiana, L. A., Lanave, G., Desario, C., Odigie, A. E., Madubuike, K. G., Lucente, M. S., et al., 2023:** Detection of selected canine viruses in Nigerian free-ranging dogs traded for meat consumption. *Animals, 13,* 6, 1119. DOI: 10.3390/ani13061119
2. **Umoh, J. U., Ezeokoli, C. D., 1985:** Parvovirus infection in Nigerian dogs. *Veterinary Record, 117,* 7, 171.
3. **Shima, F. K., Apaa, T. T., Mosugu, J. I. T., 2015**: Epidemiology of canine parvovirus enteritis among hospitalized dogs in Effurun/Warri metropolitan region of Delta State, Nigeria. *Open Access Library Journal, 2*, 1, 1–7. DOI: 10.4236/oalib.1101208
4. **Ukwueze, C. S., Anene, B. M., Ezeokonkwo, R. C., Nwosuh, C. I., 2018:** Prevalence of canine parvovirus infection in South Eastern region, Nigeria. *Bangladesh Journal of Veterinary Medicine,* 16, 2, 153–161. DOI: 10.33109/bjvmjd04
5. **Apaa, T. T., Moses, G. D., Uba, E., 2016:** Detection of canine parvovirus antigen in feces of dogs with diarrhea in Makurdi, Benue State, Nigeria. *Sokoto Journal of Veterinary Sciences,* 14, 2, 34–39.
6. **Ogbu, K. I., Chukwudi, I. C., Mira, F., Eze, U. U., Di Bella, S., Olaolu, O. S., et al., 2021:** Current status and risk factors of canine parvovirus type 2 in North Central Nigeria. *Comp. Immunol. Microbiol. Infect. Dis.,* 74, 101578. DOI: 10.1016/j.cimid.2020.101578
7. **Eghafona, N. O., Jacob, J., Yah, S. C., 2007:** Evaluation of post-vaccination immunity to canine distemper and parvoviruses in Benin City, Nigeria. *Afr. J. Biotechnol.,* 6, 16, 1898–1904.
8. **Ogunro, B., Olonisaye, P., Obasa, A, Kpasham, L., Zakariya, M., Oyagbemi, T., et al., 2025:** Predictive analysis and time series modeling of canine parvoviral enteritis: a case study from Ibadan, Nigeria. *Vet. Ital.*, 61, 3. DOI: 10.12834/VetIt.3687.32442.2
9. **Shima, F. K., Gberindyer, F. A., Tion, M. T., Fagbohun, O. A., Omobowale, T. O., Nottidge, H. O., 2021:** Diagnostic performance of a rapid immunochromatographic test kit for detecting canine parvovirus infection. *Top. Companion Anim. Med.*, 45, 100551. DOI: 10.1016/j.tcam.2021.100551
10. **Tion, M. T., Shima, F. K., Ogbu, K. I., Omobowale, T. O., Amine, A. A., Nguetyo, S. A., et al., 2021:** Genetic diversity of canine parvovirus variants circulating in Nigeria. *Infect. Genet. Evol.*, 94, 104996. DOI: 10.1016/j.meegid.2021.104996
11. **Ndiana, L. A., Odaibo, G. N., Olaleye, D. O., 2021:** Molecular characterization of canine parvovirus from domestic dogs in Nigeria: Introduction and spread of a CPV-2c mutant and replacement of older CPV-2a by the "new CPV-2a" strain. *Virus-Disease*, 32, 2, 361–368. DOI: 10.1007/s13337-021-00689-0
12. **Ukwueze, C. S., Ememe, M. U., Ibe, C. S., Unigwe, R. C., Kalu, S. U., Udani, I. J., Udegbunam, S. O., 2022:** Retrospective study of canine parvoviral enteritis in veterinary teaching hospitals in South East, Nigeria. *Anim. Res. Int.*, 19, 2, 4515–4522.
13. **Akanbi, O. B., Fagbohun, O., Kolawole, A. R., Olaifa, O. S., Aliyu, V., Ekong, P. S., et al., 2025:** Clinical signs and laboratory markers compete favorably with antigen detection of canine parvovirus-2 in dogs. *Media Kedokteran Hewan*, 36, 2, 110–122. DOI: 10.20473/mkh.v36i2.2025.110-122
14. **European Medicines Agency, 2021:** Eurican Herpes 205: EPAR – Product information. European Medicines Agency. https://www.ema.europa.eu/en/medicines/veterinary/EPAR/eurican-herpes-205
15. **World Small Animal Veterinary Association (WSAVA) Vaccination Guidelines Group (VGG), 2024:** WSAVA guidelines for the vaccination of dogs and cats. WSAVA. https://wsava.org/global-guidelines/vaccination-guidelines/
16. **Babalola, E. T., Ijaopo, O. K., Okonko, I. O., 2016:** Evaluation of immunity and seropositivity of IgG antibodies to canine parvoviruses in vaccinated and unvaccinated dogs in Abeokuta, Nigeria. *J. Immunoass. Immunochem.,* 37, 1, 16–28. DOI: 10.1080/15321819.2015.1040159
17. **Nwoha, R. I. O., Anene, B. M., 2011:** Evaluation of immune response to canine parvovirus vaccination in Nsukka, Nigeria. *Comparative Clinical Pathology,* 20, 6, 621–624.
18. **Akanbi, B. O., Adebiyi, A. I., Alaka, O. O., 2020:** Molecular characterization of canine parvovirus strains from dogs with hemorrhagic enteritis in southwestern Nigeria. *Comparative Clinical Pathology,* 29, 1, 145–152.
19. **Fagbohun, O. A., Jarikre, T. A., Alaka, O. O., Adesina, R. D., Ola, O. O., Afolabi, M., et al., 2020:** Pathology and molecular diagnosis of canine parvoviral enteritis in Nigeria: case report. *Comparative Clinical Pathology,* 29, 4, 887–893. DOI: 10.1007/s00580-020-03127-7
20. **Olaifa, O. S., Kolawole, A. R., Akanbi, O. B., Odita, C. I., Taiwo, V., 2025:** Hematological and serum chemistry of canine parvoviral enteritis in diverse breeds of dogs. *Media Kedokteran Hewan,* 36, 1, 21–29. DOI: 10.20473/mkh.v36i1.2025.21-29
21. **Apaa, T. T., Daly, J. M., Tarlinton, R. E., 2016:** Canine parvovirus (CPV-2) variants circulating in Nigerian dogs. *Vet. Rec. Open,* 3, 1, e000198. DOI: 10.1136/vetreco-2016-000198