

Hematological and serum biochemistry profiles in dogs with hypercortisolism or hypothyroidism: a comparative analysis¹

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ABSTRACT.- Santos LP, Nogueira TB, Pöppl AG. **Hematological and serum biochemistry profiles in dogs with hypercortisolism or hypothyroidism: a comparative analysis.** *Pesquisa Veterinária Brasileira* 46:e07832, 2026. Hematological and Serum Biochemistry Parameters as Tools for Differentiating Hypercortisolism and Hypothyroidism in Dogs. *Pesquisa Veterinária Brasileira* 45:00, 2025. Faculdade de Veterinária, Universidade Federal do Rio Grande do Sul, Avenida Bento Gonçalves, 9090, Agronomia, Porto Alegre, RS 91540-000, Brazil. E-mail: gomespoppl@hotmail.com

Hypercortisolism (HC) and hypothyroidism (HT) are common endocrine disorders in dogs, and their overlapping clinical signs can hinder initial differentiation. This retrospective study compared hematological and serum biochemical parameters between dogs with HC and HT to establish a comparative laboratory profile and identify variables more frequently altered in each condition. Thirty-eight dogs with HT and 38 with HC were included. Continuous variables were analyzed using Student's t-test or the Mann-Whitney test, according to data distribution, and the chi-square test was used to compare the proportion of results outside reference intervals. Significant differences ($p < 0.05$) between groups were observed in hemoglobin and hematocrit concentrations; erythrocyte, segmented neutrophil, eosinophil, monocyte, and lymphocyte counts; alkaline phosphatase (ALP) and alanine aminotransferase (ALT) activities; serum creatinine and glucose concentrations. Dogs with HC were significantly more likely ($p < 0.05$) to exhibit increased ALT (OR = 18.05) and increased ALP (OR = 14.48). These findings suggest that careful evaluation of routine laboratory data, combined with clinical and demographic information, may improve the initial distinction between HC and HT and guide the selection of appropriate confirmatory endocrine testing.

INDEX TERMS: Cushing's syndrome, thyroid hypofunction, alkaline phosphatase, alanine aminotransferase, complete blood count, canine.

RESUMO.- [Parâmetros hematológicos e bioquímicos em cães com hipercortisolismo ou hipotireoidismo: Análise comparativa.] O hipercortisolismo (HC) e o hipotireoidismo (HT) são endocrinopatias comuns em cães, e a sobreposição de seus sinais clínicos pode dificultar a diferenciação inicial. Este estudo retrospectivo comparou parâmetros hematológicos e bioquímicos séricos entre cães com HC e HT, com o objetivo de estabelecer um perfil laboratorial comparativo e identificar as variáveis mais frequentemente alteradas em cada condição. Foram incluídos 38 cães com HT e 38 com HC. As variáveis contínuas foram analisadas pelo teste t de Student ou pelo teste de Mann-Whitney, de acordo com a distribuição dos dados, e o teste do qui-quadrado foi utilizado para comparar a proporção de resultados fora dos intervalos de referência. Diferenças significativas ($p < 0,05$) entre os grupos foram observadas nas concentrações de hemoglobina e hematócrito; nas contagens de eritrócitos, neutrófilos segmentados, eosinófilos, monócitos e linfócitos; nas atividades de fosfatase alcalina (FA) e alanina aminotransferase (ALT); e nas concentrações séricas de creatinina e glicose. Cães com HC

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apresentaram maior probabilidade de aumento de ALT (OR = 18,05) e de FA (OR = 14,48). Esses achados sugerem que a avaliação criteriosa dos exames laboratoriais de rotina, associada aos sinais clínicos e dados demográficos, pode facilitar a distinção inicial entre HC e HT e auxiliar na seleção do teste endócrino confirmatório mais apropriado.

TERMOS DE INDEXAÇÃO: Síndrome de Cushing, hipofunção tireoidiana, fosfatase alcalina, alanina aminotransferase, hemograma, canino.

INTRODUCTION

Hypercortisolism (HC), also known as Cushing's syndrome (CS) (Niessen et al. 2025), and hypothyroidism (HT) are common endocrine diseases in dogs, and their diagnosis can be challenging because both conditions may present similar clinical signs and physical examination findings (Lathan 2023). Their insidious onset and variable manifestations further complicate differentiation (Peterson 2007, Spence, 2022), particularly when dermatological signs are the most prominent (Behrend 2015, Spence 2022). When these diseases present classic clinical features, clinicians can diagnose them based on clinical signs and endocrine test results (Bugbee et al. 2023). However, since multiple factors can influence the diagnostic accuracy of endocrine tests, the minimum database plays a crucial role in the initial evaluation of these patients. Both disorders influence lipid metabolism and may lead to hyperlipidemia (Sieber-Ruckstuhl 2022). Fasting hypercholesterolemia is highly prevalent, occurring in 90% of dogs with HC and 75% of those with HT, and concurrent hypertriglyceridemia may also be observed (Mooney, 2011, Behrend, 2015). A moderate increase in alanine aminotransferase (ALT) activity may occur in both diseases (Gilor 2011). Because isolated hormonal measurements may lead to diagnostic errors, knowledge of the clinicopathological abnormalities associated with each condition helps differentiate conditions more accurately before hormone testing (Lathan 2023). Additionally, HC may reduce total thyroxine (T4) and free thyroxine (fT4) concentrations, occasionally yielding false-positive HT results in dogs with CS (Behrend 2015). In these patients, cortisol excess may also suppress thyroid-stimulating hormone (TSH). Although most dogs with primary HT exhibit compensatory TSH elevation (Gilor 2011), 20–40% have TSH values within the reference interval (Bugbee et al. 2023).

Although the clinicopathological features of both diseases are well described in the literature, few studies have directly compared them at diagnosis (Sieber-Ruckstuhl 2022, Huang et al. 2025). This study aimed to establish a comparative profile of clinicopathological abnormalities among dogs with HC and HT. We hypothesized that dogs with HC would show higher hypertriglyceridemia than dogs with HT, and that the magnitude of hypercholesterolemia could be greater in HT dogs, as well as other parameters in the complete blood count (CBC), and serum biochemistry analytes such as creatinine and liver enzymes would be helpful screening tools to support the differentiation of these two disorders.

MATERIALS AND METHODS

Ethical approval. This study was not submitted to the Ethics Committee on the Use of Animals (CEUA) of the Universidade Federal do Rio Grande do Sul (UFRGS) because it was a retrospective study based exclusively on the review of medical records and previously obtained laboratory results, with no additional animal intervention or handling. Furthermore, current legislation applies only to the use of live animals for experimental purposes.

A retrospective cross-sectional study was conducted using patient records from the Veterinary Endocrinology and Metabolism Service (SEMV) at the Hospital de Clínicas Veterinárias (HCV) of the Federal University of Rio Grande do Sul (UFRGS) in Porto Alegre, Brazil. Data from 180 medical records of dogs evaluated between 2016 and 2022 were reviewed. As general inclusion criteria, medical records were selected when they contained complete clinical records, hormone test results at the diagnosis, and a substantial number of complementary diagnostic tests (complete blood count and serum biochemistry) obtained at the time of diagnosis of HC or HT.

Eligibility criteria. For inclusion in the HC group, the criteria were: the presence of at least three compatible clinical signs (i.e.; polyuria/polydipsia, polyphagia, potbelly abdomen, endocrine alopecia, thin skin, telangiectasia, muscle wasting, panting), a positive result on dynamic adrenal function tests (i.e.; low-dose dexamethasone suppression test and/or ACTH stimulation test), ultrasonographic evidence of compatible adrenal gland abnormalities, and registered initiation of treatment with adrenal function–modulating drugs. For inclusion in the HT group, the criteria were: the presence of at least three compatible clinical signs (i.e.; lethargy, weight gain, somnolence, endocrine alopecia, dry and/or dull coat hair, myxedema, hyperpigmentation, bradycardia, hypothermia); documentation of abnormalities in the thyrotropic axis [low tT4 and/or low fT4 by equilibrium dialysis, and/or elevated TSH]; ultrasonographic evidence of thyroid abnormalities when available; and successful initiation of levothyroxine replacement therapy. Reference laboratories performed hormone analyses using validated immunoassays. Cortisol and tT4 measurements were performed by radioimmunoassay

(RIA) or chemiluminescence (CLIA, Immulite - Siemens) according to clinician description at hormone test requisition, while fT4 by equilibrium dialysis was measured by a double antibody specific RIA (Free T4 by ED, IVD Technologies), and TSH was measured by CLIA (Immulite TSH, Siemens).

For both groups, the coexistence of diabetes mellitus and other polyendocrinopathies, or severe comorbidities (e.g., chronic kidney disease stages III–IV, malignant neoplasia, heart failure) was considered an exclusion criterion. For each dog, demographic data (sex, age, breed, body weight, body condition score [BCS 1–9], and reproductive status) were collected, in addition to results of the complete blood count (CBC), serum albumin, ALT, ALP, creatinine, urea, glucose, triglycerides, and cholesterol concentrations measured at least after 12 hours fasting, following SEMV's standard protocol. All CBCs were performed using automated equipment (ProCyt DX Hematology/Analyzer, IDEXX Laboratories, USA) followed by a manual differential count. Serum biochemistry was performed using automatic equipment (CM 200 – Wiener Lab, Argentina), including total cholesterol and triglycerides evaluation. Lipemic samples were not submitted to techniques to reduce interference in other analytes. All hematologic and serum biochemistry analyses were performed by the Laboratório de Análises Clínicas Veterinárias (LACVet/UFRGS).

Statistical analysis. All analyses were performed using GraphPad Prism 8.0.1. The Shapiro-Wilk test was applied to assess the normality of data distribution. Variables with parametric distribution were expressed as mean $\pm$ standard deviation and compared between the HC and HT groups using Student's t-test. Variables with nonparametric distributions were reported as median (range) and compared using the Mann-Whitney U test. Differences in the proportions of abnormal values (above or below the reference interval [RI]) and in the likelihood of an abnormal result for each evaluated parameter were calculated using odds ratios (ORs) with corresponding 95% confidence intervals (95% CIs), and comparisons between groups were performed using the chi-square test. Reference intervals for hematologic and serum biochemistry variables previously validated for the analytical platform routinely used at LACVet/UFRGS were applied as cutoffs and are available at https://www.ufrgs.br/lacvet/servicos/int_ref/. A p-value < 0.05 was considered statistically significant for all analyses, except for ORs, which were considered statistically significant only when the 95% CI did not cross 1.0.

RESULTS

A total of 38 patients were selected for each group according to the established inclusion criteria. Among dogs with HC, 24 (63%) were female, and 14 (37%) were male. Seventy-nine percent of the females and 64% of the males were neutered. One female had no information regarding reproductive status. The mean age was 11 ± 2.7 years. Mixed-breed dogs were overrepresented with 31% of cases (12/38), followed by Poodles (9/38; 23%), and Yorkshire Terriers (4/38; 10%). Lhasa Apsos (2/38; 5%) and Shih-Tzus (2/38; 5%) were less frequent, whereas Terrier, American Pit Bull Terrier, Maltese, Dachshund, Labrador Retriever, Boxer, Pinscher, Bichon Frisé, and Pomeranian were each represented by one dog (1/38; 3%). Median body weight was 8.7 kg (3.6–54) and median BCS was 7 (3–9).

In dogs with HT, the proportions of females (63%) and males (37%) were the same; however, 70% of females and 57% of males were neutered. Two females and one male had unknown reproductive status due to incomplete medical records. Neutering was slightly more frequent among HC patients ($p = 0.0989$). Dogs with HT were younger than those in the HC group, with a mean age at diagnosis of 7.7 ± 3.2 years ($p < 0.0001$). The most prevalent breeds were mixed-breed dogs (11/38; 28%), followed by Beagles (3/38; 7%), Lhasa Apsos (3/38; 7%), Maltese (3/38; 7%), and Cocker Spaniels (3/38; 7%). Schnauzers (2/38; 5%) and Golden Retrievers (2/38; 5%) were less frequent, whereas Brazilian Fila, Doberman, Scottish Terrier, Rottweiler, Weimaraner, Akita, Dachshund, Pug, Labrador Retriever, Dalmatian, and Poodle were each represented by one dog (1/38; 2%). Median body weight in dogs with HT was 19.8 kg (5.2–60), significantly higher ($p = 0.0005$) than in dogs with HC. Nonetheless, the median BCS was 7 (5–9), with no statistically significant difference compared with the HC group ($p = 0.31$). Figure 1 shows the comparative distribution of age, body weight, and BCS for the study population.

Table 1 shows comparative analysis of CBC results of dogs with HC or HT included in the study. Dogs with HC had significantly ($p < 0.05$) higher erythrocyte count, hemoglobin concentration, and segmented neutrophil and monocyte counts, and smaller eosinophil and lymphocyte counts compared with dogs with HT (Fig. 2), as well as significantly higher segmented neutrophil and monocyte counts and smaller eosinophil and lymphocyte counts (Fig. 3).

Table 2 shows comparative serum biochemistry parameters for dogs with HC or HT included in the study. Dogs with HC showed significantly higher fasting glucose and higher serum ALT and ALP activities than dogs with HT. In contrast, dogs with HC had lower serum creatinine levels than dogs with HT. Figure 4 shows the distribution of serum biochemistry results for each group.

Regarding the proportion of altered results (above or below the RI), Table 3 summarizes the ORs and respective 95% CIs for abnormal results in the parameters that achieved statistically significant differences between groups (Fig. 2 and 3) to evaluate the mean abnormalities commonly associated with HC, HT, or both.

DISCUSSION

The results reported here may help clinicians during the initial evaluation of dogs with suspected common endocrinopathies such as HT and HC, especially when considering CBC results, liver enzymes, and serum creatinine. However, this population did not support the initial hypothesis that HC would be associated with more severe hypertriglyceridemia, whereas HT would be associated with more severe hypercholesterolemia. Notwithstanding, several factors may have influenced these results.

A statistical trend toward a higher likelihood for HC among neutered individuals was observed. The exact mechanism linking spaying and HC predisposition (Bock & Pöpl 2018) remains unclear despite the description of LH-dependent HC (Espiñeira et al. 2021) secondary to elevated LH levels following gonadectomy. In contrast, a higher likelihood of HT in both neutered males and females has been described (O'Neill et al. 2022), raising the hypothesis that gonadectomy may influence the development of immuno-mediated HT. Dogs with HT were younger than those with HC, which may be explained by HT's autoimmune etiology, with onset typically at younger ages (Scott-Moncrieff 2015). Nevertheless, HT clinical signs only become evident once 75–80% of the thyroid gland has been destroyed (Graham 2007, Mooney 2011, Scott-Moncrieff 2015, Spence 2022). In contrast, the main etiologies of HC are pituitary or adrenal neoplasms. Although a genetic basis for these tumors in dogs has not been established, neoplastic diseases occur more often in older animals (Behrend 2015).

Body weight also differed between groups. Dogs with HT exhibited significantly higher weight. This may reflect the disease's greater prevalence in large-breed dogs (O'Neill et al. 2022), whereas HC is more frequently diagnosed in small-breed dogs (Behrend 2015). This hypothesis is supported by the lack of difference in median body condition score (BCS) between groups, given that both populations mainly comprised overweight or obese individuals.

The lower erythrocyte count, hemoglobin concentration, and hematocrit observed in dogs with HT were not associated with a significantly increased likelihood of anemia, despite 30–50% of dogs with HT developing a mild, non-regenerative, normocytic, normochromic anemia (Panciera 2001, Mooney 2011, Di Paola et al. 2021). Although other causes of anemia may also be present in these dogs, thyroid hormone deficiency (T3 and T4) negatively affects erythropoietin synthesis and secretion, as well as the responsiveness of erythroid precursors to this hormone, resulting in reduced erythrocyte mass (Panciera 2001, Mooney 2011, Scott-Moncrieff 2015). Conversely, dogs with HC tend to develop erythrocytosis due to glucocorticoid-mediated effects (Bennaim et al. 2019a). This erythrocytosis may also be supported by hypoxia secondary to hypoventilation due to pulmonary mineralization, muscle weakness, and thoracic compression by an enlarged liver, as well as by relative hemoconcentration from polyuria-induced dehydration (Bennaim et al. 2019a). However, the likelihood of polycythemia in dogs with HC was not significant in our study.

Elevated serum cortisol typically leads to a stress leukogram - characterized by neutrophilia, lymphopenia, monocytosis, and eosinopenia (Gilor 2011, Bennaim et al. 2019a, Lathan 2023). In this study, the influence of glucocorticoids on the leukogram was a key distinction between dogs with HC and HT. Although leukocyte relative counts are usually considered not useful in practice, they may serve as a simple, clinically helpful tool for predicting HC or HT odds, especially when combined with a thorough physical examination and the patient's history. For example, even with different leukocyte subtypes within the reference range, a distribution of 90% segmented neutrophils, 10% lymphocytes, and 0% eosinophils should raise the clinician's suspicion for a stress leukogram. Notwithstanding, the specificity of this finding is questionable because inflammatory leukograms may overlap some features of a stress leukogram (Brooks et al., 2022). Complementary information on HC probability can also be obtained from neutrophil-to-lymphocyte and platelet-to-lymphocyte ratios, despite suboptimal sensitivities (67.2% and 56.7%) and specificities (65.5% and 70.7%), respectively (Yun et al. 2024).

Hypertriglyceridemia and hypercholesterolemia are remarkable biochemical abnormalities of both HC and HT (Mooney 2011, Sieber-Ruckstuhl, 2022); however, our results showed no differences in the degree of hyperlipidemia between the two groups. Overweight and obesity are known causes of insulin resistance and dyslipidemia in dogs (Verkest et al. 2012), and the similar BCS between dogs with HC and HT in our study could help explain this result. Nutritional factors (i.e., high-fat diets and the carbohydrate and fiber content of the diet) may also influence hyperlipidemia in endocrine diseases (Xenoulis & Steiner 2010, Xenoulis & Steiner 2015), but evaluating the patients' alimentary history was not within the scope of the present study. In contrast, fasting for less than 10 hours may result in hypertriglyceridemia (Yi et al. 2023), and the 12-hour fasting standard protocol adopted at SEMV's routine aimed to avoid this interference. In a study by Huang et al. (2025), hypercholesterolemia was more common in HT (91%) than in HC (81%), with significantly higher median values in dogs with HT. Reduced cholesterol clearance (De Marco et al. 2017), and slow, insidious HT progression compared with HC (Sieber-Ruckstuhl et al. 2022) were implicated as potential causes for hypercholesterolemia in dogs with HT, as well as reduction in both lipid synthesis and degradation; however, degradation is disproportionately suppressed because thyroid hormone deficiency reduces LDL receptor expression and impairs cholesterol clearance (Scott-Moncrieff, 2015). In HC, decreased cholesterol catabolism occurs secondary to steroid-induced hepatopathy and cholestasis (Scott-Moncrieff, 2015). In contrast, HC was associated with

pronounced increases in triglycerides rather than in cholesterol (De Marco et al. 2017) due to the glucocorticoids influencing cholesterol metabolism by reducing LDL clearance and stimulating lipolysis, and decreased lipoprotein lipase activity (Scott-Moncrieff, 2015). Furthermore, glucocorticoids stimulate peripheral lipolysis and increase hormone-sensitive lipase in mesenteric fat, thereby mobilizing stored triglycerides (Behrend 2015). Thus, previous exposure to exogenous glucocorticoids (Xenoulis & Steiner 2015) may result in hyperlipidemia.

In dogs with HT, increases in ALT activity are generally mild and less frequent than those observed in HC (Gilor 2011, Spence 2022), consistent with our findings. The marked ALT elevation observed in dogs with HC is attributed to enzyme induction and increased hepatocellular membrane permeability secondary to vacuolar hepatopathy (steroid hepatopathy) (Gilor 2011). Dogs with HC in our study were 17 times more likely to have ALT above the reference interval than dogs with HT, suggesting that substantial ALT elevation, particularly when accompanied by increased ALP activity, strongly favors a HC diagnosis over HT. ALP increases are documented in 76–100% of HC cases (Bennaim et al. 2019b) due to induction of the corticosteroid-induced isoenzyme (C-ALP) and cholestasis associated with glycogen-accumulating vacuolar hepatopathy (Lathan 2023). Consistent with the literature, dogs with HC in our study had 13-fold higher odds of ALP elevation than dogs with HT. Greater ALP elevation increases the likelihood of HC, particularly when other hepatic enzymes remain normal (Mooney 2011), and the absence of ALP elevation has been associated with a lower probability of HC (Schofield et al. 2020). Also, the degree of ALT and ALP abnormalities was associated with more severe HC clinical signs (Bennaim et al. 2019b); however, elevations of ALT and ALP are not disease-specific findings. A possible cause of ALP elevation in dogs with HT is biliary mucocele formation and cholestasis (Aicher et al. 2019), as thyroid hormone deficiency increases biliary sphincter tone and alters bile acid composition, contributing to bile stasis (Smalle et al. 2015), as well as hyperlipidemia might also promote cholestasis in either disease, or increased gallbladder volume post-feeding (Villm et al. 2023).

Hyperglycemia is reported in up to 30% of HC cases, and 5–15% may develop diabetes mellitus (Pöppel et al. 2016, Miceli et al. 2017). Glucocorticoids antagonize insulin by 1) reducing peripheral glucose uptake, 2) increasing hepatic glucose production via stimulation of gluconeogenic enzymes (PEPCK and glucose-6-phosphatase), and 3) mobilizing substrates through cortisol-mediated catabolism of proteins and lipids (Guptill et al. 1997, Miceli et al. 2017, Di Paola et al. 2021, Lathan 2023). In contrast, primary HT may be associated with increased GH secretion and insulin resistance in dogs (Lee et al. 2001, Johnstone et al. 2014). Although the mean glucose concentration in HC dogs was slightly higher than that of HT dogs, the likelihood of hyperglycemia did not differ between groups.

Although mean creatinine values in both groups remained within species-specific reference intervals, creatinine was significantly lower in the dogs with HC than in dogs with HT. These findings align with previous studies reporting higher creatinine in HT dogs (Di Paola et al. 2021) due to reduced glomerular filtration rate (GFR) (Gommeren et al. 2009). Conversely, dogs with HC usually exhibit creatinine values within or below the reference interval (Smets 2010), which may result from reduced muscle mass (Hall et al. 2015) and increased GFR due to elevated endogenous glucocorticoids (Smets 2010). Another study reported significantly lower creatinine levels in dogs with HC than in dogs with non-adrenal diseases ($p < 0.001$), consistent with our findings (Bennaim et al. 2018). However, the differences in creatinine values between groups in our study did not result in a significantly higher likelihood of a dog with HC having reduced creatinine values.

This study has limitations that should be recognized, beginning with its retrospective nature and relatively small sample size. Because data were obtained retrospectively, we cannot confirm standardized 12h fasting prior to sampling for serum biochemistry, as recommended in our practice. Also, dietary variability among dogs regarding food types, as well as table scraps and snacks, was not evaluated and represents a bias in the results reported herein. Moderate to severe hypertriglyceridemia may interfere with the analytical performance of other biochemical parameters, and no techniques to prevent these interferences were applied in this study. However, the similar hypertriglyceridemia distribution between the two groups is less likely to represent a bias in the interpretation of other serum biochemistry results in this study. A validated disease stratification system for both diseases (e.g., mild, moderate, and severe) could have helped explore the data better in this and future studies, as could including a comparison group without HC and HT. This is particularly important in a specialized service such as SEMV to avoid referral bias. Finally, because patients were diagnosed over a six-year period, variability in laboratory performance across years could have influenced results, as could concurrent subclinical diseases not diagnosed in the medical records evaluated.

CONCLUSION

The distribution of the main alterations in CBC and serum biochemistry associated with HC and HT described in this study may assist clinicians in prioritizing confirmatory endocrine testing when patients present with overlapping clinical signs of HT and HC. However, the degree and prevalence of hypercholesterolemia and hypertriglyceridemia in this study did not provide a helpful clue distinguishing either disease.

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Data availability statement.- The raw data supporting the conclusions of this article will be made available by the authors on request.

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Figures

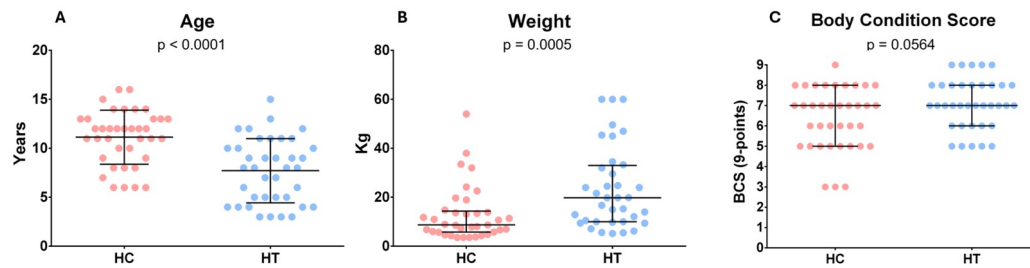


Fig. 1. Comparison of age (A), body weight (B), and body condition score (BCS - C) between dogs with hypercortisolism (HC) and hypothyroidism (HT). Each dot represents an individual dog. Horizontal lines indicate each group's mean (age) or median (weight and BCS), with respective standard deviation or interquartile range represented by the error bars.

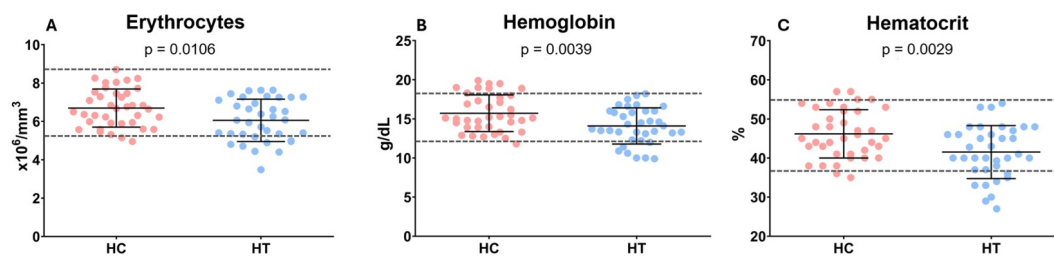


Fig. 2. Comparison of erythrocytes (A), hemoglobin (B), and hematocrit (C) between dogs with hypercortisolism (HC) and hypothyroidism (HT). Each dot represents an individual dog. Horizontal lines indicate each group's mean, with respective standard deviation represented by the error bars. Dotted lines represent the respective reference limit of each parameter. Dashed lines represent the reference limit of each parameter.

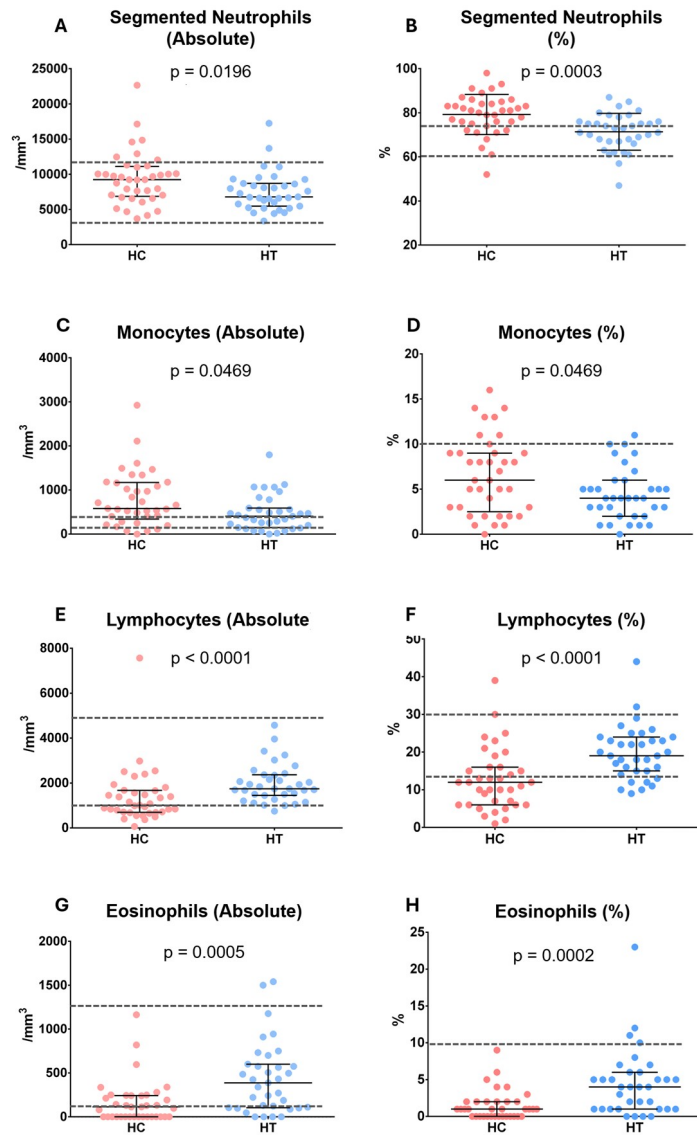


Fig. 3. Comparison of absolute counts of segmented neutrophils (A), monocytes (C), lymphocytes (E), and eosinophils (G) between dogs with hypercortisolism (HC) and hypothyroidism (HT). Each dot represents an individual dog. Graphs B, D, F, and H show the relative distribution of each cell type by group. Horizontal lines indicate group means, with respective standard deviations represented by the error bars. Dotted lines represent the respective reference limit of each parameter. Dashed lines represent the reference limit of each parameter.

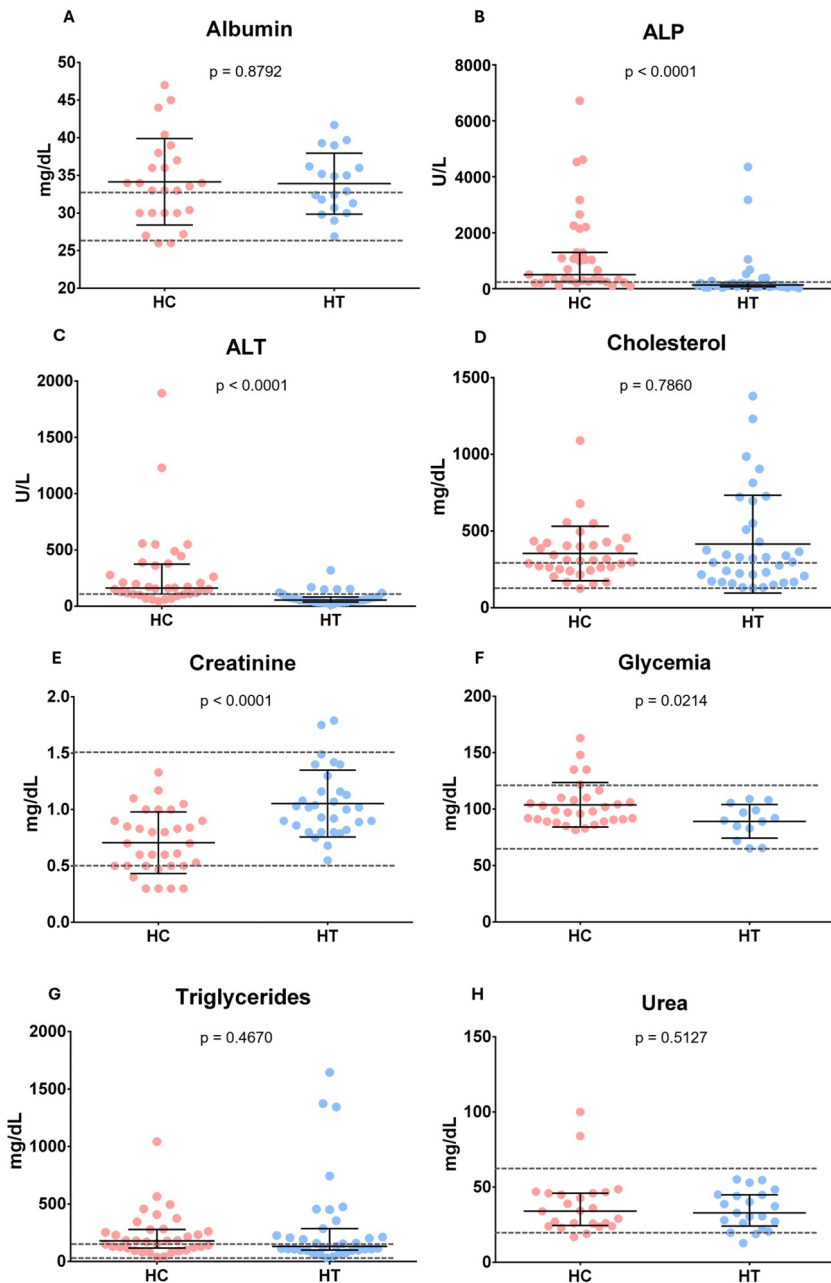


Fig. 4. Comparison of serum biochemistry analytes between dogs with hypercortisolism (HC) and hypothyroidism (HT). Each dot represents an individual dog. Horizontal lines indicate each group's mean and respective standard deviation represented by the error bars. (A) albumin, (B) alkaline phosphatase, (C) alanine aminotransferase, (D) total cholesterol, (E) creatinine, (F) glycemia, (G) triglycerides, and (H) urea. Dotted lines represent the respective reference limit of each parameter. Dashed lines represent the reference limit of each parameter.

Table 1. Comparison of complete blood count parameters between dogs with hypercortisolism or hypothyroidism included in the study. Results are presented as mean $\pm$ standard deviation or median (minimum–maximum), depending on parametric or non-parametric data distribution, respectively. Significant differences ($p < 0.05$) are marked in bold

Parameter	Hypercortisolism	Hypothyroidism	p-value	Reference Range
Erythrocyte ($\times 10^6/\mu\text{L}$)	6.7 $\pm$ 0.9	6 $\pm$ 1	0.0106	5.5-8.5
Hemoglobin (g/dL)	15.7 $\pm$ 2.3	14 $\pm$ 2.3	0.0039	12-18
Hematocrit (%)	46 $\pm$ 6	41.5 $\pm$ 6.7	0.0029	37-55
MCV (fL)	69.3 $\pm$ 5.4	69 $\pm$ 5.4	0.7973	60-77
MCHC (%)	33.6 $\pm$ 1.8	33.9 $\pm$ 2.1	0.9632	32-36
Platelets ($\times 10^3/\mu\text{L}$)	438.9 $\pm$ 163.2	401.6 $\pm$ 202.9	0.4245	200-500
Leukocyte ($\times 10^3/\mu\text{L}$)	11.5 $\pm$ 4.3	10.3 $\pm$ 3.4	0.1204	6-17
Neutrophil seg. ($\times 10^3/\mu\text{L}$)	9.3 $\pm$ 3.7	7.56 $\pm$ 2.8	0.0196	3-11.5
Neutrophil band ($\times 10^3/\mu\text{L}$)	0 (0 – 0.3)	0 (0 – 0.21)	0.0523	0-0.3
Eosinophil ($\times 10^3/\mu\text{L}$)	0.1 (0 – 1.2)	0.4 (0 – 1.5)	0.0005	0.1-1.25
Lymphocyte ($\times 10^3/\mu\text{L}$)	1 (0.07 – 7.5)	1.7 (0.8 – 4.6)	<0.0001	1.0-4.8
Monocyte ($\times 10^3/\mu\text{L}$)	0.6 (0 – 2.9)	0.4 (0 – 1.8)	0.0469	0.15-0.35

MCV: mean corpuscular volume; MCHC: mean corpuscular hemoglobin concentration

Table 2. Comparison of serum biochemistry parameters between dogs with hypercortisolism or hypothyroidism included in the study. Results are presented as mean $\pm$ standard deviation or median (minimum–maximum), depending on parametric or non-parametric data distribution, respectively. Significant differences ($p < 0.05$) are marked in bold

Parameter	Hypercortisolism	Hypothyroidism	p-value	Reference Range
Albumin (g/dL)	3.4 $\pm$ 0.6	3.4 $\pm$ 0.4	0.8792	2.6-3.3
ALT (U/L)	162 (45 – 1892)	54 (13 – 319)	< 0.0001	<120
ALP (U/L)	505 (93 – 6722)	135 (26 -4356)	< 0.0001	<156
Creatinine (mg/dL)	0.7 $\pm$ 0.3	1.1 $\pm$ 0.3	< 0.0001	<1.4
Urea (mg/dL)	38.1 $\pm$ 19.4	34.8 $\pm$ 12.7	0.5127	21-60
Glucose(mg/dL)	103.9 $\pm$ 19.7	89.2 $\pm$ 14.9	0.0214	65-118
Total Cholesterol (mg/dL)	309 (126 – 1090)	310 (130 – 1380)	0.7860	135-270
Triglycerides (mg/dL)	179 (40 – 1043)	132 (32 – 1645)	0.4670	32-138

Table 3. Odds ratio (OR) and respective 95% confidence intervals (CI) for common abnormalities in complete blood count and serum biochemistry among dogs with hypercortisolism or hypothyroidism. Significance level was assumed only if the 95% CI did not cross the null value 1 (bold)

Parameter	OR	95% CI	p-value
Anemia as evaluated by erythrocyte count in dogs with HT	6.07	1.77 – 20.8	0.0022
Anemia as evaluated by hemoglobin concentration in dogs with HT	5.14	1.01 – 26.2	0.0329
Anemia as evaluated by hematocrit concentration in dogs with HT	7.2	0.82 – 63.2	0.0428
Increased hematocrit in dogs with HC	8.26	0.97 – 70.6	0.0331
Neutrophilia in dogs with HC	5.86	2.04 – 16.9	0.0006
Lymphopenia in dogs with HC	7.34	2.15 – 24.9	0.0006
Eosinopenia in dogs with HC	4.18	1.54 – 11.4	0.0041
Increased serum ALT activity in dogs with HC	18.05	4.59 – 70.9	< 0.0001
Increased serum ALP activity in dogs with HC	14.48	3.67 – 56.9	< 0.0001
Creatinine below the reference range in dogs with HC	12.16	0.64 – 229	0.0534

HT: hypothyroidism; HC: hypercortisolism; ALT: alanine aminotransferase; ALP: alkaline phosphatase