Research Article

Asssessment of Whole Blood Parameters in Healthy Cats Under Enviromental Cigarette Smoke Exposure

Mehmet Ali YENIOĞLU[1], Yasin PARLATIR[2*]

[1] Özel Kuşcağız Veterinary Clinic, Kuşcağız & Keçiören Ankara, Türkiye

[2]Department of Internal Medicine, Kırıkkale University, Yahşihan & Kırıkkale, Türkiye

ORCID : 0009-0006-4652-0636
ORCID : 0000-0002-6210-8979

***Corresponce:**
Yasin PARLATIR
Kırıkkale University, Veterinary Faculty, Department of Internal Medicine, Şehitler Campus 71450 Yahşihan/Kırıkkale

Phone : 0 533 931 96 06
E- mail : yasinparlatir@kku.edu.tr
Doi : 10.5281/zenodo.23413635

Abstract

The study aimed to evaluate whole blood parameters in healthy cats exposed to environmental tobacco smoke. Because humans and pets share living spaces, the potential effects of tobacco smoke on pets are becoming increasingly important. The study compared healthy domestic cats exposed to smoke (ETS) with those not exposed (NE). It is known that tobacco smoke has toxic, mutagenic, and carcinogenic effects on living organisms through various exposure routes classified as first-, second-, and third-hand smoke. According to the study's findings, the mean corpuscular hemoglobin (MCH) level in the ETS group was found to be statistically significantly higher than that in the control group ($p=0.017$). Additionally, red blood cell distribution width (RDW) and mean platelet volume (MPV) were found to be significantly lower in the ETS group than in the control group ($p = 0.039$ and $p = 0.041$, respectively). No statistically significant differences were observed between the groups regarding other complete blood count parameters (RBC, HGB, HCT, MCV, MCHC, WBC, LEN, MON, GRAN, PLT, PDW, PCT). In conclusion, this study demonstrated that environmental cigarette smoke exposure in healthy cats can lead to limited but statistically significant changes in complete blood count parameters. In particular, the differences in MCH, RDW and MPV values highlight the need for further research to investigate cats' hematological responses to environmental cigarette smoke. These findings highlight the potential risks of environmental tobacco smoke exposure to pet health and underscore the need for more sensitive biomarkers and long-term follow-up studies..

Keywords: Environmental cigarette smoke, cat, whole blood, passive smoking, Hematology

Introduction

Humans and companion animals increasingly share the same living environments, resulting in exposure to common environmental health risks. Among these, tobacco smoke remains one of the most important and preventable causes of disease worldwide. Tobacco smoke exposure has been associated with the development of numerous pathological conditions, disease progression, delayed recovery, reduced treatment efficacy, and increased mortality (Max et al., 2012; Lindsay et al., 2016; Onor et al., 2017).

There is no safe level of tobacco smoke exposure. Its harmful effects extend beyond carcinogenesis and involve multiple organ systems, including the respiratory, cardiovascular, nervous, endocrine, and immune systems (Lindsay et al., 2016; Tan et al., 2021). Tobacco smoke exposure is commonly classified into three categories: first-hand smoke (direct exposure of the smoker), second-hand smoke (sidestream smoke inhaled by nearby individuals),

and third-hand smoke, which results from residual tobacco-related contaminants persisting on surfaces and in the environment after smoking has ceased (R. Baker & Proctor, 1990; Woodward & Al-Delaimy, 1999). Exposure to second-hand and third-hand smoke is collectively referred to as environmental tobacco smoke.

Companion animals living in smoking households are continuously exposed to enviromental tobacco smoke and may therefore experience adverse health effects similar to those reported in humans. While the consequences of passive smoking have been extensively investigated in human populations, relatively few studies have focused on companion animals despite their prolonged and close contact with smokers (Puzycki et al., 2018). Nevertheless, experimental and veterinary studies suggest that tobacco smoke exposure may adversely affect animal health (Hutchinson, 2017).

One of the most consistently reported effects of tobacco smoke exposure in humans is the alteration of hematological parameters. Both active and passive smoking have been associated with increased total leukocyte (white blood cell; WBC) counts, reflecting tobacco smoke-induced systemic inflammation (Ronchetti et al., 1990; Bridges et al., 1993; Panagiotakos et al., 2004). However, whether similar hematological changes occur in companion animals remains poorly understood.

Given the widespread prevalence of tobacco use and the lifelong exposure of many pets to environmental tobacco smoke, further investigation of its effects on companion animals is warranted. Therefore, the aim of the present study was to evaluate the impact of chronic tobacco smoke exposure on hematological parameters in clinically healthy domestic cats living in smoking households. By identifying potential hematological alterations associated with tobacco smoke exposure, this study seeks to contribute to the growing body of evidence regarding the health consequences of environmental tobacco smoke in veterinary medicine.

Material and Method

Study Cohort

A total of 40 clinically healthy domestic cats without any apparent clinical signs or health complaints were included in the study. According to owner-reported anamnesis, 20 cats that were not exposed to tobacco smoke and 20 cats that were regularly exposed to tobacco smoke were selected. These animals comprised the study population.

Clinical Examination Protocol

The study population consisted of cats presented to the Internal Medicine Clinic of the Animal Hospital, Faculty of Veterinary Medicine, Kırıkkale University, for routine health examinations and vaccination purposes. Prior to vaccination or the performance of any diagnostic procedures, all animals underwent a comprehensive clinical examination.

During the clinical evaluation, body temperature, respiratory rate, and heart rate were recorded. Subsequently, peripheral lymph nodes were systematically examined, and capillary refill time was assessed in each animal. Temperament and responsiveness to environmental stimuli were also evaluated. Dermatological examination was performed to assess skin integrity and to determine the presence or absence of pruritus. Thoracic auscultation was conducted to evaluate cardiac and pulmonary sounds, and particular attention was given to the detection of any pathological auscultatory findings. In addition, mucosal membranes were examined, and normal mucosal coloration was confirmed.

Only cats with clinical parameters within established reference ranges were included in the study. Additional inclusion criteria comprised the absence of lymphadenopathy, gastrointestinal signs such as diarrhea and vomiting, respiratory signs including coughing, exercise intolerance, and any abnormal cardiac or pulmonary sounds detected during auscultation. Thus, only clinically healthy cats with no evidence of systemic disease were enrolled in the study.

Cats Not Exposed Cigarette Smoke (NE)

Information regarding tobacco smoke exposure was obtained through owner-reported anamnesis. Owners were asked whether they or any other household members smoked within shared living spaces or in areas directly accessible to the cat. Additionally, information was collected concerning the cat's lifestyle, including whether it visited other households, was allowed outdoors, or was temporarily cared for by other individuals. In cases where the cat was entrusted to another caregiver, the smoking status of those individuals was also recorded.

Based on these assessments, cats were assigned to the non-exposed group only if no history of tobacco smoke exposure could be identified across all evaluated environments. Accordingly, cats with no direct or indirect contact with tobacco smoke in their primary residence or in any other regularly visited setting were included in the non-exposed (control) group.

Cats Exposed Cigarette Smoke (ETS)

Cats presented for routine vaccination and general health examinations were classified as tobacco smoke-exposed based on information obtained from owner-reported anamnesis. Animals were included in the exposed group when the owner or other household members regularly smoked within shared living

environments. Exposure was considered present regardless of whether smoking occurred directly in the cat's immediate vicinity, provided that tobacco products were consumed within areas shared by the cat. Furthermore, cats that were temporarily housed in other residences, entrusted to caregivers, or had regular contact with environments where smoking occurred were also classified as exposed.

Accordingly, cats with a history of potential exposure to environmental tobacco smoke through either second-hand smoke or third-hand smoke were assigned to the tobacco smoke-exposed group. This classification was based on the presence of tobacco smoke exposure in any environment frequented by the animal, including the primary household and other regularly visited locations.

Collecting Samples and Laboratory Analyses

For hematological assessment, whole blood samples were collected from cats in both the exposed and control groups via venipuncture of the cephalic vein (vena cephalica antebrachii). Blood was drawn aseptically according to standard procedures and placed into EDTA-containing tubes (2 ml) to prevent coagulation prior to laboratory analysis.

Whole blood samples collected in EDTA-anticoagulated tubes were subjected to hematological analysis. Complete blood count parameters were determined within 30 minutes of sample collection using an automated hematology analyzer (Mindray BC-5000, China) in accordance with the manufacturer's recommendations.

Statistical Analyses

Statistical analyses were performed using Jamovi software (version 2.6; Australia). The threshold for statistical significance was set at $p<0.05$. Data distribution was assessed using the Shapiro-Wilk test to evaluate normality. Variables demonstrating a normal distribution were expressed as mean ± standard deviation (SD), whereas non-normally distributed variables were presented as median and interquartile range (IQR). Comparisons between the tobacco smoke-exposed and control groups were conducted using the Student's t-test for parametrically distributed data and the Mann-Whitney U test for non-parametric data.

Results

The study evaluated the complete blood count results obtained from the SE and SDE groups. When the WBC, LEN, MON, and GRAN values were examined, no statistically significant differences were found between the SE and SDE groups. It was observed that the mean values for all parameters were similar across the groups (Table 1).

Table 1. Results of Leukogram

	SE		SDE		
	Mean (Min-Max)	**Median (IQR)**	**Mean (Min-Max)**	**Median (IQR)**	P Value
WBC	10.5 (3.00-18.00)	10.2 (7.78)	10.3 (4.10-17.50)	9.70 (5.22)	0.797
LEN	3.52 (0.90-9.30)	3.17 (3.55)	2.73 (0.50-7.50)	1.80 (3.55)	0.144
MON	0.35 (0.08-1.30)	0.25 (0.39)	0.39 (0.10-2.10)	0.25 (0.22)	0.662
GRAN	6.66 (1.30-14.0)	6.45 (6.04)	7.19 (2.30-15.10)	6.55 (7.38)	0.695

The data on RBC, HGB, HCT, MCV, MCH, MCHC, and RDW values for the SE and SDE groups were analyzed. No statistically significant differences were detected between the groups in RBC, HGB, HCT, and MCV values. In the SDE group, the mean values of RBC, HGB, HCT, and MCV were higher than those in the SE group, but no statistically significant difference was observed. Similarly, it was found that the MCHC value had a higher mean in the SDE group but did not show a statistically significant difference. For the MCH value, the mean in the SDE group was higher and statistically significant, while for the RDW value, the mean was lower than that of the SE group and statistically significant ($p<0.05$). Results was shown on table 2

Table 2. Results of Eritrogram

	SE		SDE		
	Mean (Min-Max)	**Median (IQR)**	**Mean (Min-Max)**	**Median (IQR)**	**P Value**
RBC	9.30 (6.23-12.10)	9.29 (2.17)	9.54 (5.96-13.30)	9.34 (2.08)	0.718
HGB	13.8 (9.10-18.2)	14.1 (3.03)	15.20 (10.4-19.7)	15.4 (4.30)	0.093
HCT	44.1 (27.60-64.10)	45.2 (14.4)	46.0 (20.4-66.4)	45.2 (16.2)	0.626
MCV	47.1 (38.9-57.6)	46.9 (9.57)	48.2 (34.3-60.6)	46.9 (7.99)	0.626
MCH	14.8 (13.1-20.5)	14.7 (1.25)	16.0 (13.0-21.5)	16.1 (2.27)	**0.017**

MCHC	32.0 (27.1-51.0)	32.1 (6.00)	34.1 (26.7-53.8)	33.9 (8.05)	0.365
RDW	16.1 (12.9-20.4)	15.6 (3.05)	14.6 (12.7-16.7)	14.8 (1.92)	**0.039**

The study's findings regarding PLT, MPV, PDW, and PCT are summarized in table 3. It was observed that PLT and PDW values were higher in the SDE group compared to the SE group; however, no statistical difference was found between the groups. Regarding PCT values, it was determined that the mean value in the SDE group was lower than that in the SE group. However, no statistically significant difference was found between the groups for PCT values. For MPV values, it was determined that the mean value in the SDE group was lower than that in the SE group and exhibited a statistically significant difference.

Discussion

The present study investigated the potential effects of environmental tobacco smoke exposure on hematological parameters in clinically healthy domestic cats. Given the increasing coexistence of humans and companion animals within shared indoor environments, understanding the biological consequences of passive tobacco smoke exposure in pets has become an important veterinary and public health concern. Tobacco smoke contains numerous irritant, pro-inflammatory, mutagenic, and carcinogenic compounds that may affect both humans and animals through second-hand and third-hand exposure pathways (Baker et al., 2004; Matt et al., 2011; Ferrante et al., 2013).

No significant differences were observed between tobacco smoke-exposed and non-exposed cats with respect to leukogram parameters, including WBC, lymphocyte, monocyte, and granulocyte counts. Although active and passive smoking have been associated with leukocytosis in humans, all cats enrolled in the present study were clinically healthy and free of overt inflammatory or infectious conditions, which may explain the absence of detectable leukocytic changes (Ronchetti et al., 1990; Bridges et al., 1993; Panagiotakos et al., 2004). Furthermore, exposure classification was based on owner-reported anamnesis, preventing objective assessment of exposure intensity and duration. Therefore, the lack of significant leukogram alterations should not be interpreted as evidence of the absence of biological effects.

Among erythrogram parameters, RBC, HGB, HCT, MCV, and MCHC did not differ significantly between groups. However, these variables tended to be higher in tobacco smoke-exposed cats, and HGB values approached statistical significance. Carbon monoxide exposure is known to impair oxygen transport through carboxyhemoglobin formation and may stimulate compensatory erythropoietic responses during chronic exposure (Alkhedaide, 2020). Although these trends were not statistically significant, they may suggest subtle effects of environmental tobacco smoke on the feline erythroid system.

The most notable erythrogram findings were the significantly increased MCH and decreased RDW values observed in tobacco smoke-exposed cats. MCH reflects the average hemoglobin content of erythrocytes, whereas RDW represents variability in erythrocyte size (Fava et al., 2019). The biological significance of these findings remains uncertain; however, they suggest that environmental tobacco smoke exposure may be associated with alterations in erythrocyte indices even in clinically healthy animals. Given that both parameters may be influenced by age, nutritional status, physiological variation, and analytical factors, these findings should be interpreted cautiously and confirmed in larger studies.

Evaluation of platelet parameters revealed no significant differences in PLT, PDW, or PCT values. In contrast, MPV was significantly lower in the tobacco smoke-exposed group. MPV is considered an indicator of platelet size and production dynamics and has been associated with inflammatory and vascular processes in human smokers (Loffredo et al., 2025). However, because other platelet indices remained unchanged, the isolated reduction in MPV cannot be conclusively interpreted as evidence of platelet activation or clinically relevant hemostatic dysfunction. Nevertheless, this finding may indicate subtle alterations in platelet kinetics associated with environmental tobacco smoke exposure.

The present findings should be interpreted within the context of previous studies demonstrating that nicotine and cotinine concentrations in biological samples from cats and dogs correlate with household smoking exposure (Bertone et al., 2002; Groppetti et al., 2023). In addition, passive smoke exposure has been associated with several neoplastic diseases in companion animals, including lymphoma in cats and respiratory tumors in dogs (Reif et al., 1992; Pérez et al., 2014; Gervásio et al., 2021). Unlike those studies, the current investigation focused on clinically healthy cats and evaluated potential hematological alterations before the development of overt disease, thereby providing insight into possible early biological effects of environmental tobacco smoke exposure.

Several limitations should be acknowledged.

First, exposure assessment relied solely on owner-reported information and was not confirmed by biomarkers such as cotinine or nicotine. Second, the relatively small sample size limited statistical power and prevented subgroup analyses according to age, breed, and sex. Finally, the cross-sectional design precludes causal inference. Future studies should incorporate larger and more balanced populations, objective exposure biomarkers, and longitudinal follow-up to better characterize the hematological and clinical consequences of environmental tobacco smoke exposure in cats.

Overall, environmental tobacco smoke exposure was not associated with significant alterations in leukogram parameters; however, significant differences were detected in MCH, RDW, and MPV values. These findings suggest that chronic exposure to tobacco smoke may be associated with subtle hematological changes in otherwise healthy cats. From a clinical perspective, veterinarians should consider household smoking status during routine anamnesis and inform pet owners about the potential risks of second-hand and third-hand tobacco smoke exposure to companion animals.

Ethical Approval

This study was approved ethical status by the Kırıkkale University Local Ethics Committee on Animal Experiments (Decision Number: 2026/03/41)

Conflict of Interest

The outhors declared that there is no conflict of interest.

Authors' Contributions

This research was designed by MAY and YP. In Data collection adn processing part was made by MAY and YP. Analysis were made by YP. Literature review protocols were realised by MAY and YP. The article was written by MAY and YP.

Funding

There is no funding support on this research.

Acknowledgements

This manuscript was prepared of the first author's master of thesis.

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