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Epidemiology of dog bites in the West Pomeranian Province based on data from the District Veterinary Inspectorate in Szczecin, 2021–2023

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Abstract

Introduction and Objective. One of the most frequently described risks associated with the relationship between humans and dogs is dog bites which, according to the WHO, remain a global public health problem. The aim of the study is to analyze dog bite cases recorded by the District Veterinary Inspectorate in Szczecin between 2021–2023.

Materials and Method. A total of 321 cases were studied, including breed, age, gender, and vaccination status of the dog, as well as the age of the victims and their relationship with the dog. In addition, aggression type, incident location and circumstances were taken into account.

Results. The most common perpetrators of bites were mixed breeds (52.00%) and German Shepherds (9.70%). Males bit more than twice as often as females, even though females are registered twice as often as males in the Polish Kennel Club. Adult dogs (4–8 years old) followed by the youngest individuals (< 2 years old) bit most frequently. Most bites occurred outside the property (52.60%), when the victim was near the dog (40.57%), and children accounted for 34.00% of all victims. The most common type of aggression was defensive (33.33%). Breed, age, and gender of the dog, as well as relationship with the victim, significantly influenced the occurrence of bites ($p < 0.05$).

Conclusions. The results emphasize the importance of educating the public about preventive behaviour towards dogs in order to decrease the risk of dangerous incidents.

Key words

behaviour, epidemiology, aggression, dogs, bites and stings

INTRODUCTION

Dogs have been accompanying humans for a very long time, and their role in human life has changed along with the development of societies – from working animals, through guards and helpers, to companions in everyday life [1, 2]. Despite such a long history of coexistence, this relationship is not entirely safe. One of the most frequently described risks is dog bites which, according to the WHO, remain a global public health problem [3–6]. The average annual risk of receiving a dog bite requiring medical consultation is estimated at three to four cases per 1,000 population. Consequently, dog bites are among the top 12 causes of non-fatal injuries globally [7].

The consequences of such incidents can vary greatly [8]. In addition to the obvious, ones, i.e., physical injuries of varying severity, bacterial infections or zoonotic diseases often occur. Sometimes, there is also a strong psychological reaction, especially in children, who are particularly vulnerable to the long-term consequences of trauma. In areas with poor sanitation, the risk also includes rabies, a fatal disease [3–5].

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Understanding why bites occur is crucial if real preventive measures are to be implemented. Current research clearly shows that aggressive behaviour in dogs is not solely due to breed predisposition and, in many cases, has no connection to breed [5]. Furthermore, breeds stereotypically perceived as aggressive account for only a small proportion of incidents. A behaviour of a dog is influenced much more by environmental factors, upbringing, and individual characteristics, such as level of socialization, previous experiences, and temperament [9, 10]. However, some studies show that differences between breeds may persist, which means that the topic remains a subject of debate [11].

In addition to the environment, the health of the dog also plays an important role. Chronic pain, neurological disorders, endocrine diseases, or sensory problems can affect the response threshold and lead to aggressive behaviours that may seem 'unjustified' at first glance [9]. There are also known cases in which certain groups of drugs – especially those acting on anxiety, agitation, or impulsivity – modified the behaviour of the dog [12]. Therefore, any analysis of aggression should take into account both the situation and possible health factors.

Communication between humans and dogs is also important. Animals signal discomfort, fear, or aversion through a range of subtle behaviours – not only by growling

or barking, but primarily through body language. People who have little experience with dogs are often unable to read these signals correctly, which leads to conflict situations [13]. Children are particularly vulnerable – they have a natural tendency to invade a dog's personal space and do not recognize early signs of stress [8].

Publications on dog bites often report that most incidents involve large dogs or mixed breeds. At the same time, it is emphasized that the interpretation of such statistics requires caution – the number of individual breeds, their popularity, and the tendency of owners to report incidents, can significantly influence the observed results [14]. Incidents involving large dogs are recorded more often mainly because their bites more frequently require medical consultation. However, this does not mean that small dogs do not pose a threat – their bites can be just as serious, although they are not always included in statistics [5, 9].

The common conclusion of most authors is that education plays a key role – both for owners and the general public [3]. This includes understanding canine stress signals, proper socialization of the animal, and avoiding anthropomorphism, which often leads to misinterpretation of dog behaviour [5, 8, 10]. The literature also discusses the topic of safety rules in public spaces, such as keeping dogs on a leash, which could significantly reduce the number of incidents. There is also no shortage of discussion on legal regulations concerning certain breeds [7].

The current study analyzes bite incidents reported between 1 January 1 2021 – 29 September 2023, with the aim of determining the circumstances in which dog bites most often occur, and the characteristics of the dog and the situation which may increase their risk. The analysis included factors such as breed, age, and gender of the animal, the relationship between the dog and the victim, the location of the incident and the accompanying circumstances.

The results obtained in this study can be used to prepare recommendations for the prevention and management of dog bites that may ultimately improve the safety of residents and help dog owners reduce the risk of similar incidents in the future.

MATERIALS AND METHOD

The research material in this study consisted of documents provided by the District Veterinary Inspectorate in Szczecin. These documents contained information such as: breed, age, gender, vaccination, and micro-chipping status of the dog, and a detailed description of the incident, including the testimony of the animal's owner. However, due to legal regulations, they did not contain specific information about the victims.

Aggressive behaviour was determined, based on the analysis of the incident description. The following types of aggression were distinguished:

1) defensive (fearful) aggression – a defensive reaction resulting from fear or stress in the dog;
2) offensive (dominant or territorial) aggression – initiated to control resources or violate territory;
3) undefined aggression – cases in which there was insufficient information to assign a specific type of aggression.

To facilitate interpretation of the results, bite locations were grouped into 5 categories:

1) outside the home/in public, including all public places such as streets, squares, and dog parks;
2) at home – incidents within an apartment or house;
3) on the property, including gardens, yards, or areas guarded by dogs;
4) shared buildings/institutions, such as stairwells, shelters, veterinary offices, and grooming salons;
5) undefined, when there was no specific information about the location of the incident.

When analyzing the circumstances of the bite, 7 categories were identified:

1) near the dog (walking past the dog, entering the dog's territory, walking past the dog's territory, suddenly approaching the dog, running past the dog, being in the dog's vicinity, riding a bicycle);
2) separating fighting dogs (e.g. during a conflict with another dog);
3) play/interaction (while playing, helping a dog, attempting to hug, hugging, petting, touching a dog);
4) care/grooming/feeding (while caring for a dog, picking up a dog, catching a dog, feeding from one's hand, during a visit to the vet or the grooming salon).
5) defense/intervention (defending the owner, teasing the dog, patting/hitting the dog, leaning over the dog).
6) dog's sleep (when the dog was sleeping, stepping on the dog, sudden movement, loud behaviour).
7) other – no precise definition.

The data collected in this study covered the period from 1 January 2021 – 29 September 2023. Excel (Microsoft Inc., Redmond, WA, USA) and Statistica (version 13.3; Tibco Inc., Tulsa, OK, USA) were used for data collection and statistical analysis. The χ^2 test was applied to verify the effect of individual factors on dog bites. For some of them, the odds ratio (*OR*) of an event was determined with the following formula:

$$OR = \frac{S(A)}{S(B)},$$

where $S(A)$ is the probability of bite occurrence and $S(B)$ is the probability of an event occurring in the general population.

RESULTS

During the study period, 321 cases of dog bites were recorded in the area covered by the District Veterinary Inspectorate in Szczecin. It was found that the most common perpetrators of bites ($p \leq 0.05$) were mixed breeds (52.00%), followed by German Shepherds (9.66%). Other breeds accounted for a total of 38.32% of bite cases (Tab. 1). However, considering that mixed breeds are estimated to constitute 72.00% of the dog population, the *OR* was about 0.42, which meant that they were less likely to cause a bite than the average dog in the general population. In contrast, in the case of German Shepherds, which account for approximately 6.00% of the dog population, $OR \approx 1.68$, meaning they were more likely to bite.

Table 2 presents the most common breeds in Poland according to gender, but does not include all dogs in the population, only those registered with the Polish Kennel Club. Analyzing various causes of dog bites, it can be noted (Tab. 3) that male dogs bit more than twice as often as female

Table 1. Dog breeds responsible for bites during the study period

Breed	***n***	**%**
Mixed breed	167	52.02
German Shepherd	31	9.66
American Staffordshire Terrier	9	2.80
Maltese	8	2.49
Shih Tzu	7	2.18
French Bulldog	5	1.56
Jack Russell Terier	5	1.56
Miniature Schnauzer	5	1.56
Polish Hunting Dog	4	1.25
Beagle	4	1.25
American Pitbull Terrier, Akita, West Highland White Terrier, Labrador Retriever, Border Collie, Siberian Husky, Parson Russel Terier, Bernese Mountain Dog, Cocker Spaniel, Yorkshire Terrier, Dachshund (3 cases each)	33	10.23
Dobermann, Pomeranian, Italian Cane Corso, Polish Lowland Sheepdog, Bavarian Mountain Scent Hound, Miniature Pinscher, German Pinscher, Belgian Shepherd Dog (Malinois), Staffordshire Bullterrier (**2** cases each)	18	5.58
Rottweiler, Presa Canario, Caucasian Shepherd Dog, Shiba, St. Bernard, Hungarian Pointer, Pekingese, Tibetan Mastiff, Entlebuch Cattle Dog, Slovakian Hound, Old German Shepherd Dog, Ca De Bou, White Swiss Shepherd Dog, Boston Terrier, English Mastiff, Dalmatian, Rhodesian Ridgeback, Hovawart, Pitbull, Giant Schnauzer, Pug, Samoyed, Welsh Terrier, Kangal Shepherd Dog, Polish Hound (1 case each)	25	7.79
Total	**321**	**100.00**

Table 2. Popularity of selected dog breeds based on the Polish Kennel Club report

Breed	**2021**		**2022**		**2023**	
	males	females	males	females	males	females
Double Coat German Shepherd Dog	1365	3003	1307	2735	1337	2764
Old German Shepherd Dog	1071	1986	1105	2084	1107	2106
French Bulldog	1007	2128	1061	2232	1001	2165
Jack Russel Terrier	536	1195	651	1374	634	1410
American Staffordshire	485	667	546	729	503	717
Maltese	377	1049	407	807	383	1064
Rottweiler	299	525	299	525	295	528
Shih Tzu	255	476	264	528	265	524
Caucasian Shepherd Dog	170	267	183	311	145	197
Presa Canario	65	95	70	112	52	101
Kangal Shepherd Dog	42	55	34	54	30	51

dogs ($p \leq 0.05$), even though females are registered twice as often as males in the Polish Kennel Club (Tab. 2). In terms of age, the most frequent biters were dogs aged between 4–8 years, i.e., adult dogs. They were followed by the youngest individuals, under 2 years of age, while dogs between 2–4 years old bit the least frequently ($p < 0.05$).

Among dogs vaccinated and unvaccinated against rabies, the former were found to be the most common bite perpetrators (61.00%). Fortunately, no rabies virus was found in any of the dogs, whether vaccinated or not. Considering that unvaccinated dogs account for approximately 10–20% of the total population, the chance of being bitten by a vaccinated dog ranged from 0.17–0.39. Another factor analyzed in the present study was the type of aggression exhibited prior to the bite. Its most common form was defensive aggression (1 in 3 cases), especially caused by fear, although no statistically significant differences were found between the types of aggression.

Table 3. Other causes of dog bites

	n	**%**
Dog's gender		
Male	218	67.92
Female	101	31.46
Not determined	2	0.62
Dog's age (years)		
Below 2	82	25.54
2–4	60	18.70
4–8	98	30.52
Above 8	72	22.42
Not determined	9	2.80
Vaccination status		
Yes	196	61.05
No	123	38.31
Not determined	2	0.62
Aggression type		
Defensive	120	37.38
Offensive	91	28.35
Not determined	110	34.27

Table 4. Characteristics of dog bite victims

Characteristic	***n***	**%**
Victim's sex		
Female	117	36.64
Male	92	28.66
Not determined	112	34.89
Victim's age		
Adult	212	66.04
Child	109	33.96
Relation with a dog		
Unknown person	219	68.22
Known person	64	19.94
Owner	38	11.84
Direct interaction with a dog		
Yes	141	50.36
No	139	49.64

When analyzing the characteristics of bite victims (Tab. 4), no differences were observed between women and men in the frequency of bites (36.00% and 29.00%, respectively). In some cases, the gender of the victim was not specified. The number of women and men in the population was similar (51.00% and 49.00%, respectively). According to the analyzed data, statistically significantly more bites involved adults (66.00%) than children (34.00%). However, taking into account the census conducted by the Central Statistical Office in the given period, people under 18 years of age accounted for approximately 17.00% of the population of

Table 5. Incident location

Site	*n*	%
Outside the home / public	178	55.50
At home	66	20.60
On the property	49	15.30
Communal buildings/institutions	22	6.90
Not determined	6	1.87
Total	**321**	**100.00**

Table 6. Circumstances accompanying the bite

Incident category	Situations	*n*	%
Near a dog	Walking past a dog, entering a dog's territory, walking past a dog's territory, suddenly approaching a dog, running past a dog, being near a dog, riding a bicycle	99	40.57
Separating fighting dogs	When separating fighting dogs, during a conflict with another dog	40	16.39
Play/ interaction	While playing, while helping the dog, attempting to cuddle, cuddling, petting, touching the dog	34	13.93
Care/ grooming/ feeding	When caring for a dog, picking up a dog, catching a dog, feeding from your hand, during a visit to the vet, grooming salon	15	6.15
Defense/ intervention	Defense of the owner, teasing the dog, patting/ hitting the dog, leaning over the dog	16	6.56
Dog sleeping	While the dog was sleeping, stepping on the dog, sudden movement, loud behaviour, conflict over resources, other	28	11.48
Other		12	4.92
Total		**244**	**100.00**

the West Pomeranian Province. Hence, the following *OR* could be determined:

$$OR = \frac{0.34}{0.66} : \frac{0.17}{0.83} \approx 2.52,$$

which means that children were bitten approximately 2.5 times more often than adults.

It was also found that strangers to the dog were bitten most often (68.22% of cases), while people known to the dog were attacked 3 times less frequently (19.94% of cases). Dog owners were also bitten in some cases (11.84% of cases); however, no differences were found between bites involving direct or indirect interaction with the dog. In the analyzed sample (Tab. 5), most bites occurred outside the home or in public spaces (55.50%), with 20.60% taking place at home, 15.30% on private property, 6.90% in communal buildings or institutions, and 1.87% in unspecified locations ($p \leq 0.05$). The exact circumstances of the bite that occurred immediately before the incident were also taken into account (Tab. 6).

The most common behaviour leading to biting was presence in close proximity to a dog (40.57%). Another very frequent group of cases involved separation of 2 fighting dogs (16.39%). Bites were much less common during grooming and caring for a dog, such as touching the animal, feeding it by hand, petting, hugging, visiting the vet, etc. Each of these cases represented only a small percentage of the circumstances accompanying bites. Analysis confirmed statistically significant differences between groups ($p \leq 0.05$).

DISCUSSION

The results obtained in the present study confirmed that the problem of dog bites is multifactorial and should be considered in a broad social and behavioural context [6]. This phenomenon is observed worldwide, but its scale and specificity vary depending on local conditions, including legal regulations, dog ownership customs, and population density. Similar findings were obtained in other countries [5]. At the same time, it should be emphasized that a significant proportion of dog bites, especially those with mild symptoms, are not included in official statistics. This phenomenon causes a systematic underestimation of epidemiological data [3, 6].

Dog breed and bite risk. In the analyzed data, mixed breeds and German Shepherds were the most frequently identified perpetrators of bites. Similar trends have been reported in numerous previous studies [14, 15]. However, it should be remembered that the frequency of dog bites largely reflects the structure of the animal population [5, 7]. In the present study, although mixed-breed dogs were responsible for most bites, the chance of being bitten by such an individual was lower (*OR* = 0.42), given their abundance in the total population. At the same time, bites by German Shepherds were more likely to occur (*OR* = 1.68). In the case of breeds perceived as dangerous, the percentage of incidents was relatively low, which has been confirmed by Boruta and Fiszdon [5] and Zaborski et al. [15]. This is due to both the smaller number of these dogs in the population and the obligation to obtain appropriate permits and increased control over these animals (*Journal of Laws,* No. 77, item 687; *Journal of Laws*, No. 111, item 724).

At the same time, some reports in the literature challenge the relationship between breed and aggression. Morril et al. [16] indicated that breed accounted for only about 9.00% of the variability in dog behaviour, whereas Hammond et al. [17] found no differences in levels of aggression between dogs covered by dangerous breed laws and other breeds. Similarly, Pet'ková et al. [2] showed that breeds classified as 'aggressive' did not exhibit higher levels of aggression than herding or mixed breeds, and, in certain aspects, behaviour stereotypically associated with aggression was even weaker in such dogs.

Dog gender as a risk factor. In the study group, male dogs were responsible for more than twice as many bites as females. This result is consistent with numerous previous reports [5, 8, 9]. The higher proportion of biting male dogs is most often explained by a greater tendency toward territorial and dominant behaviour. In addition, gender differences may result not only from hormonal factors, but also from different expectations and methods of socialization applied to dogs [2, 18].

However, it is worth noting that not all studies indicate a predominance of aggression in males. Scandurra et al. [19] emphasized the importance of situational context, while Wójcik and Powierża [20] showed a higher incidence of aggression in females among breeds classified as 'ancient'. In addition, McGreevy et al. [21] noted that castration does not always lead to a reduction in aggression – in some cases, an increase was observed, especially in female dogs.

Dog's age as a risk factor. Adult dogs (aged 4–8 years) constituted the largest group of bite perpetrators. The literature emphasizes that this is the period of the greatest physical stability and behavioural confidence, which may promote aggression in intervention situations [22]. Wallis et al. [18] indicated that the level of aggression reached its highest values in dogs aged 6–10 years, which was confirmed by extensive analyses carried out by Mikkola et al. [9]. Niazy et al. [22] also reported clear differences in aggression level between different age groups.

Type of aggression. The most common type of aggression observed in the current study was defensive aggression, particularly related to fear. This result is consistent with reports indicating fear-based behaviour as one of the most frequent mechanisms leading to biting [9]. Sun et al. [23], based on an analysis of microbiota and serotonin levels, determined that mildly defensively aggressive dogs had lower 5-HT concentrations, suggesting that defensive aggression (related to fear or defence) may be a key phenotype of aggressive behaviour. Tiira et al. [24] indicated that fear-caused aggression is very common and often confused with dominance aggression. This finding highlights the importance of proper early socialization and dog owner education related to the recognition of stress signs and discomfort in animals. In some situations, it can also affect improper dog training [7, 10].

It is not surprising that dogs vaccinated against rabies bit more often, as there were significantly more of them in the total population (61.00%). It should be noted that unvaccinated animals accounted for over a third of the cases studied. This means that the chance of being bitten by an unvaccinated dog ranged from $OR = 2.56$ to $OR = 5.75$. This is an alarming result, considering the requirement to vaccinate dogs over 3 months of age against rabies, as specified in Article 56 of the Act on Animal Health Protection and Combating Infectious Animal Diseases (*Journal of Laws* 2023, item 1075).

Bite victims – age, gender, and relationship with the dog. In the present study, as in many other studies, children were found to be a particularly vulnerable group of bite victims [6, 8], accounting for 34.00% of all cases, which is a clear over-representation relative to their share of the population. This result reflects global trends in this age group towards an increased risk of being bitten, which is usually explained by a lack of ability to correctly interpret the signals sent by the dog, and impulsiveness and frequent violation of the animal's space [4]. The non-significant difference in the proportion of bitten women and men in the current study (approximately 7.00%) was greater than that reported by Cianciara et al. [6] (about 2.00%).

In the study sample, most incidents involved people unknown to the dog (68.00%), which is consistent with the previous reports emphasizing an increased risk in situations where the dog perceives the person as an intruder [8]. At the same time, bites to dog owners (11.80%), most often associated with an attempt to break up a fight between dogs or restrain an agitated animal, were not a marginal phenomenon [25].

Incident location. Contrary to the results presented by Boruta and Fiszdon [5] and Zaborski et al. [15], most incidents in Szczecin took place outside the home (52.60%). This difference may be due to the urban nature of the study population, the greater number of interactions between unfamiliar dogs, or different practices related to walking animals.

Bite circumstances. The most frequently reported circumstance was simply passing a dog (18.00%), which indicates situations in which the attack occurs without provocation from humans, but in response to a violation of the animal's space [8]. Another common situation was attempting to separate fighting dogs (12.70%), which is one of the most risky interventions [10, 26]. Bites were much less frequent during grooming activities, although the increased risk in such situations may result from stress, possible pain, or lack of habituation [9].

Importance of education and preventive measures. The literature on dogs consistently emphasizes the importance of education as a key tool in reducing the risk of bites [3, 5, 7–9]. Programmes targeting children, especially those of school age, are considered one of the most effective forms of prevention. It is equally important to prepare owners, both in terms of understanding dog body language and recognizing signs of stress [13].

Based on the results obtained in the present study, it seems reasonable to consider introducing systemic solutions, such as mandatory training for dog owners, animal registration, or clarification of the rules regarding the use of leashes and muzzles in public spaces [7].

CONCLUSIONS

The current analysis shows that mixed breeds are most often responsible for dog bites, although this finding does not directly translate into a simple correlation between a dog's origin and aggression. This relationship is multi-layered and requires careful interpretation. Among purebred dogs, German Shepherds were involved in the most cases, which is probably due not so much to their predisposition as to their prevalence in the Polish population. As in other studies, most incidents involved adult dogs, usually between the ages of 4–8 years.

Minors were significantly more likely to be injured, especially when the dog had no previous contact with the person. The gender of the victim did not play a significant role, which indicates that not every demographic factor directly translates into the risk of being bitten. The circumstances of incidents were much more important as they allow us to understand the reason for the dog reacting aggressively in a given situation. They also show the ways in which similar incidents can be reduced in future.

The results obtained in the present study highlight the importance of further research into the factors contributing to aggression and the need for developing educational programmes aimed at both dog owners and the wider community. Appropriate knowledge and preparation can significantly reduce the number of dangerous situations.

REFERENCES

1. Benz-Schwarzburg J, Monsó S, Huber L. How dogs perceive humans and how humans should treat their pet dogs: Linking cognition with ethics. Front Psychol. 2020;11:584037. https://doi.org/10.3389/fpsyg.2020.584037
2. Pet'ková B, Skurková L, Florian M, et al. Variations in Canine Behavioural Characteristics across Conventional Breed Clusters and Most Common Breed-Based Public Stereotypes. Animals (Basel). 2024;14(18):2695. https://doi.org/10.3390/ani14182695
3. Dougas G, Gkova M, Mellou K. Public health implications of dog bite injuries in Greece. Discov Public Health. 2025;22(1):371. https://doi.org/10.1186/s12982-025-00771-8
4. Westgarth C, Provazza S, Nicholas J, et al. Review of psychological effects of dog bites in children. BMJ Paediatr Open. 2024;8(1):e000922. https://doi.org/10.1136/bmjpo-2020-000922
5. Boruta A, Fiszdon K. Pokąsania ludzi przez psy. Kwartalnik Policyjny. 2016;(3):49–55.
6. Cianciara D, Goryński P, Seroka W. Hospitalization for dog bites in Poland between 2006–2020. Ann Agric Environ Med. 2022;29(4):538–542. https://doi.org/10.26444/aaem/152183
7. Nilson F, Damsager J, Lauritsen J, et al. The effect of breed-specific dog legislation on hospital treated dog bites in Odense, Denmark—A time series intervention study. PLoS One. 2018;13(12):e0208393. https://doi.org/10.1371/ journal.pone.0208393
8. Gobbo E, Zupan Šemrov M. Risk factors for dog bites involving children. Vet Arh. 2022;92(5):609–616. https://doi.org/10.24099/vet.arhiv.2006
9. Mikkola S, Salonen M, Puurunen J, et al. Aggressive behaviour is affected by demographic, environmental and behavioural factors in purebred dogs. Sci Rep. 2021;11(1):9433. https://doi.org/10.1038/s41598-021-88793-5
10. Duncan-Sutherland N, Lissaman AC, Shepherd M, et al. Systematic review of dog bite prevention strategies. Inj Prev. 2022;28(3):288–297. http://dx. doi. org/10. 1136/injuryprev-2021-044477
11. Salonen M, Sulkama S, Mikkola S, et al. Prevalence, comorbidity, and breed differences in canine anxiety in 13,700 Finnish pet dogs. Sci Rep. 2020;10(1):2962. https://doi.org/10.1038/s41598-020-59837-z
12. Watanangura A, Meller S, Suchodolski JS, et al. The effect of phenobarbital treatment on behavioral comorbidities and on the composition and function of the fecal microbiome in dogs with idiopathic epilepsy. Front Vet Sci. 2022;9:933905. https://doi.org/10.3389/fvets.2022.933905
13. Törnqvist H, Höller H, Vsetecka K, et al. Matters of development and experience: Evaluation of dog and human emotional expressions by children and adults. PLoS One. 2023;18(7):e0288137. https://doi.org/10.1371/journal.pone.0288137
14. Bailey CM, Hinchcliff KM, Moore Z, et al. Dog bites in the United States from 1971 to 2018: a systematic review of the peer-reviewed literature. Plast Reconstr Surg. 2020;146(5):1166–1176. https://doi.org/10.1097/PRS.0000000000007253
15. Zaborski D, Kavetska KM, Sabatowicz K. Analysis of cases of dog bites in Stargard, Poland. Sci Papers Ser D, Anim Sci. 2024;67(1):346–352.
16. Morrill K, Hekman J, Li X, et al. Ancestry-inclusive dog genomics challenges popular breed stereotypes. Science. 2022;376(6592):eabk0639. https://doi.org/10.1126/science.abk0639
17. Hammond A, Rowland T, Mills DS, et al. Comparison of behavioural tendencies between "dangerous dogs" and other domestic dog breeds – Evolutionary context and practical implications. Evol Appl. 2022;15(11):1806–1819. https://doi.org/10.1111/eva.13479
18. Wallis LJ, Szabó D, Kubinyi E. Cross-sectional age differences in canine personality traits; influence of breed, sex, previous trauma, and dog obedience tasks. Front Vet Sci. 2020;6:493. https://doi.org/10.3389/fvets.2019.00493
19. Scandurra A, Alterisio A, Di Cosmo A, et al. Behavioral and perceptual differences between sexes in dogs: An overview. Animals (Basel). 2018;8(9):151. https://doi.org/10.3390/ani8090151
20. Wójcik A, Powierża K. The influence of breed, sex, origin and housing conditions on undesirable behaviors in ancient dog breeds. Animals (Basel). 2021;11(5):1435. https://doi.org/10.3390/ani11051435
21. McGreevy PD, Wilson B, Starling MJ, et al. Behavioural risks in male dogs with minimal lifetime exposure to gonadal hormones may complicate population-control benefits of desexing. PLoS One. 2018;13(5):e0196284. https://doi.org/10.1371/journal.pone.0196284
22. Niazy AF, Bawish BM, Matoock MY. Age, breed and sex are strongly correlated with personality traits in dogs. J Adv Vet Res. 2024;14(4):579–585.
23. Sun N, Xie L, Chao J, et al. Study on the Correlation Between Aggressive Behavior and Gut Microbiota and Serum Serotonin (5-HT) in Working Dogs. Vet Sci. 2025;12(6):526. https://doi.org/10.3390/vetsci12060526
24. Tiira K, Sulkama S, Lohi H. Prevalence, comorbidity, and behavioral variation in canine anxiety. J Vet Behav. 2016;16:36–44. doi:https://doi.org/10.1016/j.jveb.2016.06.008
25. Oxley JA, Christley R, Westgarth C. Contexts and consequences of dog bite incidents. J Vet Behav. 2018;23:33–39. https://doi.org/10.1016/j.jveb.2017.10.005
26. Westgarth C, Brooke M, Christley RM. How many people have been bitten by dogs? A cross-sectional survey of prevalence, incidence and factors associated with dog bites in a UK community. J Epidemiol Community Health. 2018;72(4):331–336. https://doi.org/10.1136/jech-2017-209330