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Distribution of blood groups in cats in Kyiv and Kyiv Oblast (Ukraine)

M. O. Malyuk, Y. Y. Dovbnia, V. V. Klymchuk, V. V. Honchar, N. I. Boiko, V. V. Solomon

National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine

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National University of Life
and Environmental Sciences
of Ukraine, Heroiv Oborony
st., 15, Kyiv, 03041, Ukraine.
Tel.: +38-096-214-99-31.

E-mail:
nikolai_malyuk@ukr.net

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There are numerous cat breeds, grouped according to the phylogenetic or geographic origin. A plethora of reports have been published regarding the distribution and prevalence of the blood groups in pedigree and non-pedigree cats, but in Ukraine such data have not been systematically generalized. Therefore, the objectives of our research were to study the distribution of the blood groups in cats according to their breed features and enumerate the percentage proportion of each group in relation to the general number of the examined cats, and also identify the blood group of both the donor and recipient. In this study, we present the data on the blood groups and breeds of cats that we came across in 2018–2023. For each breed of cats, we estimated the percentage of prevalence in Kyiv and Kyiv Oblast. The general number of patients in our statistical studies was 519. Having analyzed the obtained results and having grouped the animals according to the blood groups, we see that the blood groups A and B were most often found in mixed-breed cats, accounting respectively for 55.4% (250 cases) and 33.3% (18 animals) of the general number. Also, we should note that according to our studies, the other commonest breeds of cats were the Scottish Folds, in which the group A was found in 7.8%, 35 cases, and the group B in 22.2% and 14.8%, in 12 and 8 animals, respectively. The AB blood group system is the most important cat system, and identifying the blood group using specific methods is an important step towards avoiding or reducing the risk of side-effects in the recipient patient during transfusion. Inferring from our study, the AB system was found only in 14 animals over a five year period, most commonly in Scottish Fold, measuring 50.0%, or 7 individuals.

Keywords: cats; cat breeds; blood group; geographic and phylogenetic origin; tests.

Introduction

For centuries, various breeds of cats have been acknowledged and today they are classified by The International Cat Association, which recognizes 73 breeds (Silvestre-Ferreira & Pastor, 2010; Malyuk et al., 2023). The cat breeds can be grouped according to their phylogenetic and geographic origin. Studies revealed that cat breeds have developed from the Mediterranean, West European, Arabic, and Asian regions based on selection of certain phenotypes from adapted populations (Gurkan et al., 2005; Helm & Knottenbelt, 2010). For this reason, many cat breeds are still genetically close to the landrace cats, from which they were bred. By analyzing the molecular dispersion, a 2008 study revealed the genetic differentiation in the cat breeds originating from Europe, America, Eastern Africa, Mediterranean, and Asia (Lipinski et al., 2008; Bighignoli et al., 2010). The analysis of genetic differences in the global cat population indicated the differences in mitochondrial DNA (Kisielewicz et al., 2014) and single-nucleotide polymorphisms (Griot-Wenk & Giger, 1999). According to those results, the distribution of blood groups varies across cat breeds, and therefore according to the phylogenetic origin (Martinez-Sogues et al., 2020; Gavazza et al., 2021).

The AB blood group was first described for cats in 1981 (Auer & Bell, 1981). Blood groups differ depending on the specific antigens of erythrocytes (RBCs) on the erythrocyte membrane – group A cats have only A antigen, while group B cats have only B antigen (Kurushima et al., 2013). Cats with blood group A have low titers of weak IgG antibodies to B erythrocyte antigens, whereas all cats with the group B that are older than three months have high titers of strong IgM antibodies to A erythrocyte antigens (Bücheler & Giger, 1993; Birkenheuer et al., 2008; Binvel et al., 2021). Cats of AB type have no anti-A or anti-B antibodies (Bagdi et al., 2001; Binvel et al., 2021). The blood group A is the commonest group in felines worldwide, with the prevalence in most countries ranging

85% to 100% in non-pedigree cats (Birkenheuer et al., 2008; Sylvane et al., 2018). The distribution of blood groups in cats was found to vary depending on cat breed and geographic location (Forcada et al., 2007; Juvet et al., 2011; Fosset & Blais, 2014; Barrot et al., 2017).

Despite the fact that the AB system is the most significant system of cat blood, cross-match incompatibility and reactions to transfusion emerge despite a correct matching of the AB groups. This led to assumptions about the existence of other blood groups in cats (Knottenbelt et al., 1999; Karadjole et al., 2016). In 2007, the new (Mik) antigen was found on erythrocytes of four cats, and it was revealed that alloantibodies to those antigens, which do not belong to AB, are both natural (Tocci & Ewing, 2009) and produced after blood transfusion (Graipel et al., 2019).

Clinically, it is those aforementioned strong anti-A alloantibodies that are responsible for potentially lethal hemolytic reactions, the severity of which is more closely associated with titer of antibodies in the blood of group B recipients than with the amount of administered antigens (Giger & Bücheler, 1991; Nectoux et al., 2019). By contrast, weak anti-B alloantibodies in the blood of group A cats cause insignificant transfusion reactions that reduce the survival of the transfused erythrocytes (Mylonakis et al., 2001; Malik et al., 2005; Silvestre-Ferreira & Pastor, 2021).

The distribution of the cat blood groups varies depending on breed. Some breeds, such as Siamese, Tonkinese, and Oriental Shorthair, almost uniformly belong to type A independent of country (Griot-Wenk & Giger, 1995; Pennisi et al., 2015). Other breeds commonly have B type, for example, Turkish Van in Turkey (57.7–60.0%), Persian (24.0%), Devon Rex (43.0%), and British Shorthair (58.9%) in the United States (Bighignoli et al., 2010). As is known, Ragdolls typically (94%) have AB type, as confirmed by the recent study in Italy (Lipinski et al., 2008; Sacristán et al., 2019). The typing of cat blood through DNA testing was not entirely confirmed in the breed, because around 2.3% of the Ragdoll cats had discordance according to the blood group when comparing genotyping and

serological results, which requires further studies in this breed (Harvey et al., 2007).

At Pennsylvania University, a new erythrocyte antigen named Mik was discovered. Studies were conducted on several incompatible cross samples between the donor cats and a recipient cat named Mike, which were pre-matched according to the blood group. The yielded data suggested the presence of alloantibodies, produced against the new shared erythrocyte antigen that was called Mik. Estimates found that around 94% of the domestic shorthair cats have the erythrocyte antigen Mik, although natural anti-Mik alloantibodies, which were found in the three donor cats, occur rarely. Currently, studies of the blood groups in cats for the presence of the Mik-antigen are impossible; therefore, it has been suggested to conduct cross-matching of blood for compatibility in all cases of blood transfusion, even during the first transfusions, which are matched based on the blood group. This can help avoid potential transfusion reactions due to this antigen (Marenzoni et al., 2018; Nentwig et al., 2018; Malyuk et al., 2023).

It has to be noted that the immune system of recipient animals reacts to blood transfusion and its components even if a cross-match reaction was performed. Numerous studies have observed the recipient animals experiencing post-transfusion leukocytosis. We should also note that increase in the number of leukocytes in the experimental animals did not exceed the thresholds of physiological parameters (Singleton et al., 2009; Satake et al., 2011). Also, scientists found that following the transfusion of erythrocyte mass to recipient rabbits, there occurred increases in the contents of circulating immune complexes (CIC), as compared with the initial conditions during the period of studies, which was a good example of the activation of the humoral link of immunity (Yabsley et al., 2006; Sylvane et al., 2018).

Materials and methods

The experiments were conducted adhering to the requirements of the General Ethical Principles of Conducting Experiments on Animals, adopted by the First National Congress of Bioethics and the provisions of the European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes, and the Law of Ukraine on Protection of Animals from Abuse, and with permission of the Commission of Bioethics of the National University of Life and Environmental Sciences of Ukraine.

The studies were conducted in 2018–2023 at the scientific research laboratory Bank of Animal Blood of the Department of Surgery and Pathophysiology named after I. O. Povazhenko of the National University of Life and Environmental Sciences of Ukraine and at the scientific research center Vetmedservis.

The objectives of this study were the enumerations of the blood groups in cats and distribution of the groups in relation to cat breed peculiarities in Kyiv and Kyiv Oblast. The objects of the study were cats from Kyiv and Kyiv Oblast that had been admitted to the clinic and directly to the Animal Blood Bank to identify their blood groups.

The whole blood samples of the volume ranging 0.5 to 1.0 mL were collected into test tubes with ethylenediaminetetraacetic acid (EDTA) from the vein of the forearm. Then, the RapidVet-H (Feline) (manufactured by Agrolabo Sp., Italy) test was utilized to identify the blood groups. It is designed to identify the A, B, and AB groups in cats. The antiserum was lyophilized on test cards; it was well dissolved and mixed with whole blood of the patient. All group A erythrocytes react with a certain antiserum and cause the agglutination reaction; group B erythrocytes manifest with a specific antiserum; and all AB groups of erythrocytes cause agglutination in all cases. The agglutination pattern in test field A and test field B significantly vary due to different natures of utilized antisera.

The principle of the RapidVet-H (Feline) analysis is based on the agglutination reaction that occurs when erythrocytes, whose surface of the membrane bear group A, B, or AB antigens, interact with dried antiserum of a specific antigen applied to the card's test field.

Type A erythrocytes are characteristic for NeuGc2GD3, which forms glycolipid antigen on the membrane's surface. RapidVet-H (Feline) uses mice monoclonal antibodies that confirm the specificity to this antigen,

lyophilized on the test card. The antibody molecule gives it the ability to bind and attach blood-group-A-specific antigens. Type B erythrocytes are typical for NeuAc2GD3 and look like a neuraminic acid, represented by ganglioside and the absence of NeuGc, which is present in group A erythrocytes. A specific connective link was found to be the lectin from *Triticum vulgare*. RapidVet-H (Feline) uses the *Triticum vulgare* lectin to identify the blood group B. The total of 519 cats was analyzed.

Results

Over 2018–2023, at the scientific research laboratory Animal Blood Bank of the Department of Surgery and Pathophysiology named after I. O. Povazhenko of the National University of Life and Environmental Sciences of Ukraine, we conducted the first quantitative assessment of distribution of the blood groups in the cats in relation to their breed peculiarities in Kyiv and Kyiv Oblast.

The mean parameters of the distribution of the blood groups in cats in percentages (A, B, AB) in the period between 2018 and 2023 in Kyiv and Kyiv Oblast of Ukraine are presented below on the diagram, from which we can conclude that the most prevalent blood group in cats of the region is A group, comprising 86.9%. The second commonest is the B group, found in 10.4% of the animals, and the third group is AB, which accounted for 2.7% (Fig. 1).

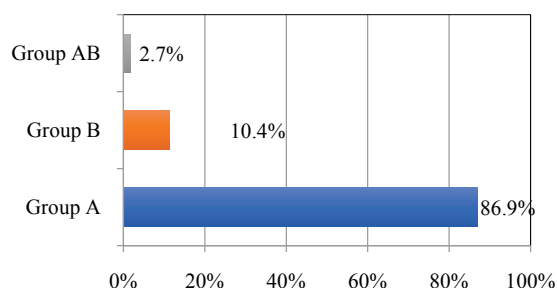


Fig. 1. Distribution of the blood groups in the cats of Kyiv and Kyiv Oblast of Ukraine

Therefore, inferring from the number of performed tests for identification of the blood groups of the cats during 2018–2023, the general number of the animals studied for the A, B, and AB blood groups was 519 (Table 1). Among the cats of various breeds, the A blood group was most often identified in mixed-breed cats, comprising 250 (55.43%), Scottish Fold – 35 (7.76%), British Shorthair – 35 (7.76%), Siamese – 22 (4.88%), Bengal – 14 (3.10%), Scottish Straight – 14 (3.10%), Maine Coon – 13 (2.88%), Scottish Straight – 11 (2.44%), Devon Rex – 8 (1.77%), Canadian Sphynx – 7 (1.55%), European Shorthair – 11 (2.44%), Abyssinian – 6 (1.33%), Kurilian Bobtail – 8 (1.77%), Persian – 5 (1.11%), Ragdoll – 5 (1.11%), Turkish Angora – 4 (0.89%), and Thai cat – 3 (0.67%). Among cats of different breeds, there also occurred the B blood group; in the period of 2018–2023, there were 54 such animals, most of them being mixed-breed – 18 (33.33%). This group was identified in 12 British Shorthair cats (22.22%), 8 times in Scottish Fold (14.80%), 6 Bengal cats (11.11%), and 5 Scottish Straight and Siamese, comprising respectively 9.26% of the general number of identified B group animals. As with the AB group, over the five-year study, we found 14 cases, including 6 mixed-breed (42.86%), 7 Scottish Straights (50.00%), and 1 Persian (7.14%).

Discussion

It should be noted that this is the first study on this theme to have been conducted in Ukraine. While processing the statistical material regarding the blood group in cats, we noted that the ratio of the blood groups in cats in Kyiv and Kyiv Oblast of Ukraine correlated with similar parameters in other countries: France, Italy, Japan, and Germany. In USA, Switzerland, Scotland, Finland, the percentage of cats with the group A accounted for 100%. In Australia, the percentage of cats with the blood group A was only 73%.

Blood of cats is classified into the groups. This is the most widely recognized system of the blood groups in cats, which consists of three groups: A, B, and AB. Due to the presence of natural antibodies, blood serum of cats contains no universal blood group. Concentration of natural antibodies in each group of cats varies.

Table 1

Distribution of the blood groups in the cats of different breeds in Kyiv and Kyiv Oblast (in 2018–2023)

Breed	A	%	B	%	AB	%	Number
British Shorthair	35	7.76	12	22.22	0	0	47
Scottish Fold	35	7.76	8	14.80	0	0	43
Scottish Straight	14	3.10	5	9.26	0	0	19
Abissinian	6	1.33	0	0	0	0	6
Devon Rex	8	1.77	0	0	0	0	8
Scottish Straight	11	2.44	0	0	7	50.00	18
Bengal	14	3.10	6	11.11	0	0	20
Kurilian Bobtail	8	1.77	0	0	0	0	8
Canadian Sphynx	7	1.55	0	0	0	0	7
Maine Coon	13	3.19	0	0	0	0	13
Turkish Angora	4	0.89	0	0	0	0	4
Persian	5	1.10	0	0	1	7.14	6
European Shorthair	11	2.44	0	0	0	0	11
Mixed-breed	250	55.43	18	33.33	6	42.86	274
Siamese	22	4.88	5	9.26	0	0	27
Thai cat	3	0.67	0	0	0	0	3
Ragdoll	5	1.10	0	0	0	0	5
Total	451	86.90	54	10.40	14	2.70	519

Worldwide, A is the dominating blood group in cats, whereas the percentage of those with the group B depends on the geographic position and relation to purebred animals. Kisielewicz et al. (2014) reported that the AB group in cats is quite rare. This was confirmed by our five-year research, which found 451 patients were in group A, confirming its prevalence in our region. The group B was found in 54 animals, the majority being mixed-breed cats, which may be attributable to our geographic position and accordingly to pedigree and non-pedigree crosses. Similar data pertaining to the distribution of the group B (11.2%), or 401 non-pedigree cats, were yielded in Central Italy by the scientists Auer et al. (1981).

Juvet et al. (2011), Barrot et al. (2017), Nectoux et al. (2019) indicated that the distribution of the B group in the populations of non-pedigree cats in Europe varied 0 to 30%, and in some countries, such as Greece and England, the prevalence was 20% and 30.5%, respectively, as stated by Forcada et al. (2007). Significant differences in the distribution of the B blood group were also detected among the regions inside the country, as indicated by Knottenbelt et al. (1999), for example, in non-pedigree cats in the UK, the prevalence ranged 7.9% in the north and 30.5% in the south.

Bagdi et al. (2001) carried out the first identification of the distribution of the blood groups in cats in Hungary, examining 100 cats of six breeds: European Domestic Shorthair, Persian, Abyssinian, Siamese, and British Shorthair. The blood group A was found in all cat breeds, comprising 100%. As with the blood group B, it occurred very rarely, only in Persian cats, and AB type was not found during the study. Inferring from our studies, we can see the similarity between results of our and the Hungarian research. Therefore, the A type is the dominant blood group in cats around the globe, whereas the percentage of cats with the B group depends on the geographic position and relation to purebred animals. The blood group AB is quite rare in cats. Certain blood groups have been found more prevalent in some breeds of cats. For instance, British Shorthair and Turkish Angora were often recorded to have the B blood group, whereas Siamese cats and Maine Coons often had the A group.

Cats with the AB blood group have no alloantibodies due to the presence of the both antigens on the surface of erythrocytes. Ideally, recipient cats with the AB blood group should receive blood from the AB blood group, but due to its rarity it is unlikely that the donor with the AB blood group will be available. Therefore, it is recommended that those cats receive the A blood group, because this blood can cause only insignificant reactions to incompatibility because of low number of antibodies to isoantigens of group A erythrocytes in plasma.

Having analyzed the literature sources, we may state that the study of the distribution of the cat blood groups was conducted for the second time in Canada, and for the first time in western Canada. The studies carried out

in Montreal by Fabrice et al. (2014) revealed that the distribution of the blood groups in landrace and pedigree cats equaled 95.2% for type A, 4.4% for type B, and 0.48% for type AB. Those data are similar to our estimates, because most of the cats we examined belonged to the A group.

Conclusion

For the first time, the distribution of the blood groups in cats was studied in Ukraine. We found that in Ukraine, the dominant blood group in cats is A, which comprised 86.9%, while the B group accounted for 10.4%, and the AB group made up only 2.7%. According to our studies, the A blood group prevailed in mixed-breed cats, British Shorthair, and Scottish Fold. The highest number of individuals with the B group were mixed-breed and British Shorthair, and AB the group occurred in Scottish Straight, mixed-breed, and Persian cats.

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