

Lymphoma in Border Collies

What is Lymphoma?

A cancer of the lymphatic system and lymph nodes is called lymphoma. The lymphatic system consists of lymph vessels, specialized lymphatic organs such as the tonsils and spleen, and lymph nodes. Lymphoma can affect one area of the body or spread throughout it.

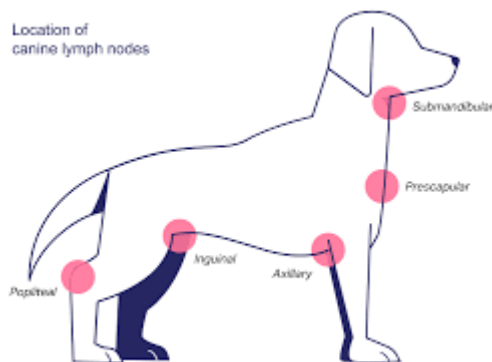


Figure 1 Lymph node locations in a canine (<https://www.imprimedicine.com/lymphoma-101>)

Mutations of white blood cells known as lymphocytes lead to the development of lymphoma. In general, healthy lymphocytes are the good guys because they fight infection and shield the body from dangerous diseases. On the other hand, when lymphocytes develop cancer, they alter and multiply, attacking various bodily regions.

Border collies have been identified as having a higher lymphoma risk than the general canine population. B-cell immunophenotype lymphomas are the most common type in Border Collies (84 to 91% of cases). In an earlier survey of lymphoma in Border Collies conducted in Australia, researchers (ref) found 28 instances of dogs that shared a female ancestor, indicating a possible heritable risk.

New Research in Border Collies

Research has indicated that canine lymphoma is likely a combination of environment and genetics. There have been several environmental risk factors identified previously which include exposure to herbicides, tobacco smoke, household chemicals, waste management proximity to industrial areas and geographic locations.

A recent study (Soh et al., 2023) looking for genetic risk variants for lymphoma in border collies utilised an expanded pedigree analysis which included 83,000 Border Collies of which there were 71 identified lymphoma cases. A common ancestor was identified for 54 cases.

Of these 71 dogs, 25 (35%) had B-cell lymphomas, 3 (4%) had T-cell lymphomas, and 43 (61%), had unknown type lymphomas. The average age at first diagnosis was 8.7 years

(SD 3.3). Figure 2 shows the distribution of ages at first lymphoma diagnosis. The age range at diagnosis was as low as 1 year and 11 months and as high as 15 years and 3 months, with the peak age at diagnosis being 9 years.

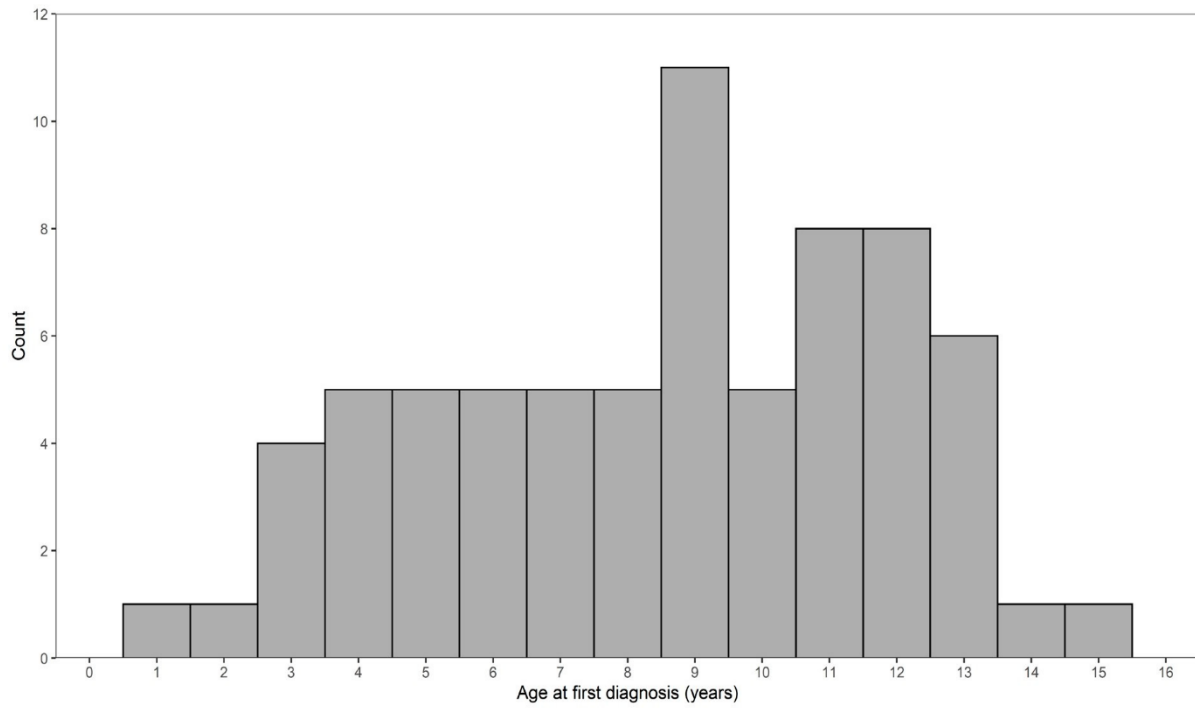


Figure 2 Distribution of age at first diagnosis for 71 lymphoma cases. (Soh et al., 2023)

From these 71 dogs, 54 had available pedigrees with 22 of these being genotyped. The 54 dogs with pedigrees can be traced back to a common, male ancestor (dog_811) born 1968 (Figure 3). Previous research identified a common ancestor for 28 cases. This dog (dog_67066) was an offspring of dog_811 and identified as a common ancestor in 52 cases. Pedigree analysis has shown full sibling littermates, parents and progeny and genetically related cases.

This recent study shows that 54 cases were linked to a common ancestor indicating that there is likely a heritable genetic component of the disease in this sample of ANKC registered border collies. The common ancestor dog_811 was also identified for many dogs carrying TNS (trapped neutrophil syndrome) and NCL (neuronal ceroid lipofuscinosis) mutations. Of note dog_811, has been identified as the fourth top contributing ancestor of dogs born between 2005-2015. This opens a possibility, that because its descendants were frequently bred and made substantial contributions to the gene pool, this may be the reason this dog appears so often. The overall familial connections and occurrences of lymphoma suggest that there is a genetic link regarding the risk factors.

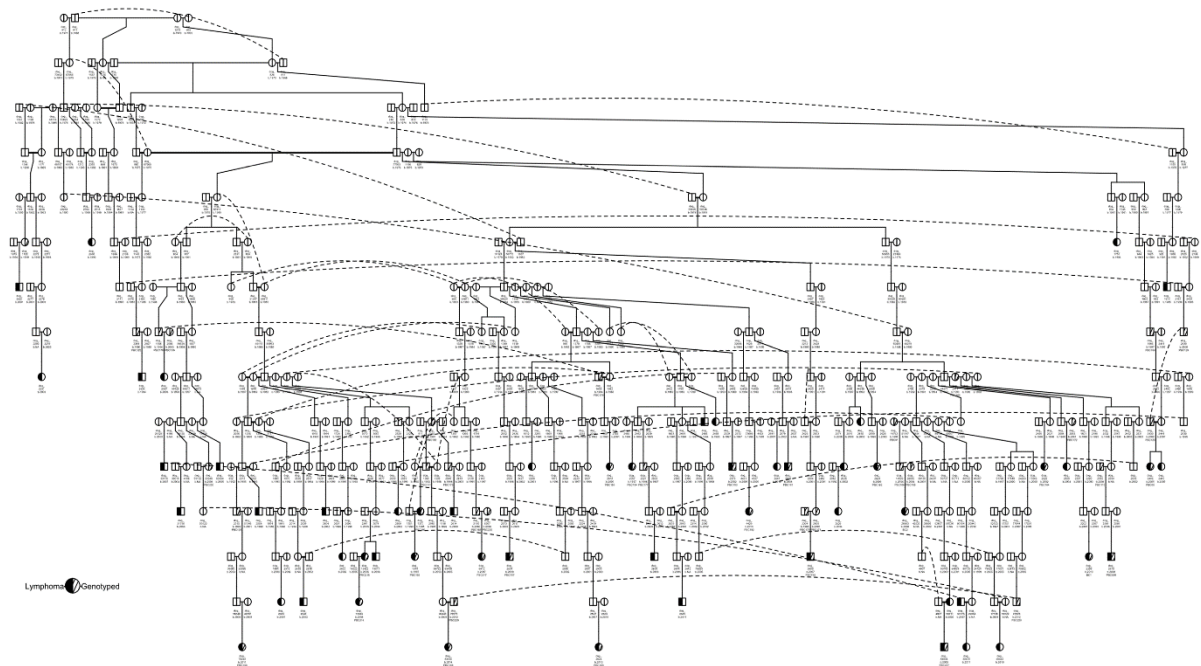


Figure 3 Pedigree of 54 lymphoma cases descending from dog_811. The most direct pathway for each lymphoma-affected dog to dog_811 is shown; some individuals may be related through other pedigree pathways but these pathways are not shown. Dotted lines connect instances where an individual is repeated in the pedigree. The year of birth and genotype ID, if available or relevant, is indicated below the dog ID for each dog.

The genome wide association study indicated that the genomic risk factors are a recessive trait. Chromosome 18 and 27 studies indicated that they may be involved in the genetic traits. Including previous studies, GWAS on canine lymphoma has been associated with chromosomes 2, 4, 5, 8, 11, 14, 18, 20, and 27. This implies that different breeds or breed clades have different genetic processes underpinning their risk of developing lymphoma, or that variations with varying frequencies in different breeds influence common carcinogenic pathways.

References

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- Soh, P.X.Y.; Hsu, W.T.; Khatkar, M.S.; Williamson, P. Evaluation of genetic diversity and management of disease in Border Collie dogs. *Sci. Rep.* 2021, 11, 6243.
- Soh, P. X. Y., Khatkar, M. S., & Williamson, P. (2023). Lymphoma in Border Collies: Genome-Wide Association and Pedigree Analysis. *Veterinary Sciences*, 10(9), 581. <https://doi.org/10.3390/vetsci10090581>