DOI 10.24425/pjvs.2026.3604

Original article

A retrospective analysis of canine hip dysplasia in Hovawart population in the Czech Republic

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Abstract

The aim of this study was to evaluate the occurrence of individual types of canine hip dysplasia during 25 years of breeding the Hovawart breed in the Czech Republic and to determine the effect of negative selection on the subsequent occurrence of canine hip dysplasia in the following generations of animals. During the study period, from 1998 to 2022, a total of 3,297 radiographs of Hovawart dogs were analysed. The study period was divided into 5 groups (1998-2002; 2003-2007; 2008-2012; 2013-2017 and 2018-2022) and the dogs were divided into three groups according to the severity of hip dysplasia (CHD-A, CHD-B and CHD-C/E). The results show that there was a statistically significant decrease in the incidence of the more severe form of dysplasia during the study years, from 20.54% in 1998-2002 to 1.91% in 2018-2022. In the last period studied, 2018-2022, the proportion of CHD-A in the Hovawart population that underwent radiographic examinations was 92.99%. It can also be noted that younger dogs (up to 2 years of age) had a lower percentage of incidence of the more severe form of dysplasia (7.32%) compared to dogs over 3 years of age (12.04%). This may be influenced by progressive degenerative changes in the joints that develop with age. The yeartoyear decrease in the incidence of dysplasia may indicate a positive effect of stricter selection of dogs entering the breeding programme in the Czech Republic.

Keywords: dogs, breeding, genetics, hip dysplasia

Introduction

Canine hip dysplasia (CHD) is a complex orthopaedic disorder and one of the most common non-traumatic orthopaedic disorders in dogs (Soo and Worth 2015). It is characterised primarily by laxity and incongruity of the coxofemoral joint, predisposing dogs to secondary osteoarthritis, joint pain and impaired mobility (Baldinger et al. 2020). CHD has been described in many breeds, but it generally affects medium- to large-breed dogs more severely (Janutta and Distl 2006, Ginja et al. 2009, Humphreys and McEwan 2015, Beier et al. 2023, Patrichi et al. 2023). However, the size of the dog is not always decisive. Several breeds show a high prevalence: German Shepherds, St. Bernards and Newfoundlands are especially often affected. This anomaly is also observed in Rottweilers, Boxers, Dogs and Bulldogs, but Greyhounds are free of this defect (Lyubchenko et al. 2021). Canine hip dysplasia is a multifactorial, polygenic developmental disorder. According to some studies, its heritability ranges from 20% to 70% (Alilovic et al. 2023), and up to 95% according to others (Kimeli et al. 2015). Hip dysplasia affects both hip joints in 89% of cases (Lyubchenko et al. 2021). Due to its significant genetic component, selective breeding programmes excluding affected dogs have been proposed and implemented in many countries to reduce the prevalence of hip dysplasia (Alves et al. 2021). CHD is influenced by genetic and external factors (Polat et al. 2021). Important external factors include obesity (Sallander et al. 2006), growth rate (Baldinger et al. 2020), excess dietary calcium and vitamin D, excessive hip joint use or injury at a young age (Kimeli et al. 2015), the number of puppies in the litter, and the mother‘s age (Ginja et al. 2010).

Radiographic screening remains the cornerstone of CHD diagnosis and management. It enables the identification of affected individuals and facilitates selective breeding to reduce disease prevalence. Several standardised scoring systems are employed globally, including those developed by the Orthopaedic Foundation for Animals (OFA), the British Veterinary Association/The Kennel Club (BVA/KC), and the International Cynological Federation (FCI) (Kimeli et al. 2015). The International Cynological Federation is the most popular in continental European countries and uses the following five categories to score CHD: A – no signs of CHD; B – near normal CHD; C – mild CHD; D – moderate CHD; and E – severe CHD. These grades are defined based on the values of the Norberg angle, acetabular depth, degree of subluxation and signs of secondary joint disease. The degree of CHD is important for selecting animals with the best quality hips for breeding (Santana et al. 2022).

Some authors suggest that breeders‘ awareness of CHD leads to reduced severity of the CHD in registered animals, resulting in improved outcomes for future generations (Freeman et al. 2013). Although screening programmes have been used for decades to reduce the prevalence of CHD, their success varies greatly between breeds and countries (Santana et al. 2022). This highlights the importance of continued evaluation and data collection to inform and refine breeding strategies. The aim of genotyping is to determine breeding values that represent the true genetic quality of a dog based on genetic information rather than phenotypic information (Verhoeven et al. 2012). Selecting dogs for breeding based on estimated breeding values may be more effective in reducing the prevalence of CHD than selection based solely on individual hip scores or ratings (Hedhammar 2020).

The aim of this study was to evaluate the occurrence of individual types of canine hip dysplasia during 25 years of breeding the Hovawart breed in the Czech Republic and to determine the effect of negative selection on the subsequent occurrence of canine hip dysplasia in subsequent generations of animals. A further aim was to confirm the hypothesis that the age of the dog influences the occurrence of individual types of canine hip dysplasia.

Materials and Methods

Data

This study analyses the results of hip dysplasia tests on a total of 3,297 dogs of the Hovawart breed (1,361 males and 1,936 females). The data were obtained from the public database of the Hovawart Club of the Czech Republic. The analysis includes the results of CHD examinations of the Hovawart breed in the Czech Republic for the last 25 years (1998 to 2022). In the Czech Republic, all individuals used for breeding Hovawart dogs must undergo CHD testing, and the results are published in a monitored database. Throughout the entire study period (1998–2022), the regulations regarding breeding and the requirements for CHD screening remained the same.

Scoring protocol

For the purposes of this study, CHD was evaluated according to the FCI, i.e. cate-gories CHD-A (no signs of hip dysplasia); CHD-B (near normal hip dysplasia); CHD-C (mild hip dysplasia); CHD-D (moderate hip dysplasia); CHD-E (severe dysplasia). Due to the low incidence of moderate and severe dysplasia, dogs were divided into three categories for subsequent evaluation:

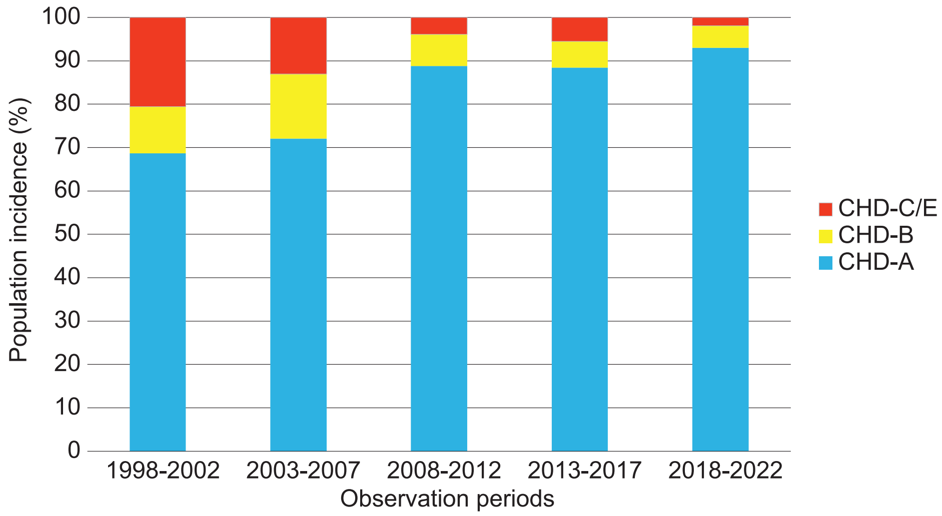

Fig. 1. Development of canine hip dysplasia (CHD) incidence in Czech Hovawart population between 1998 and 2022.

Table 1. Number of evaluated dogs for each observation period.

Period	Total	Female	Male	1-2 years of age	2-3 years of age	> 3 years of age
(years)	(n)	(n)	(n)	(n)	(n)	(n)
1998-2002	521	305	216	223	212	86
2003-2007	812	463	349	462	288	62
2008-2012	723	425	298	408	265	50
2013-2017	613	369	244	345	211	57
2018-2022	628	374	254	352	232	44

CHD-A, CHD-B and CHD-C/E. Hip radiographs were taken at a regular veterinary surgery. The radiographs were then sent to a single official judge in the Czech Republic for the entire observation period.

Data mangement

The observation period was divided into 5 homogeneous cohorts of 5 years (1998-2002; 2003-2007; 2008-2012; 2013-2017 and 2018-2022). All dogs in the study were further divided into 3 groups according to the age at which the CHD was detected, namely dogs 1-2 years of age, dogs 2-3 years of age and dogs older than 3 years of age.

The results were processed using the R statistical program (R Core Team: R 2022). Associations were analyzed using a generalized linear model (GLM) with a Poisson distribution and log link function. Given the exploratory aim of the study and the descriptive nature of the dataset, associations between variables were analysed using bivariate Poisson regression models without adjustment for additional covariates. The null hypothesis of equality of CHD incidence rates was rejected at a significance level of p=0.05.

Results

In this study, a total of 3,297 hip radiographs were examined. The number of dogs screened for hip dysplasia was generally high during the observation period, reaching its peak in the second period, as shown in Table 1. A similar trend was also observed for the sex of the dogs.

A higher proportion of female (58.7%) than male (41.3%) dogs were screened for hip dysplasia. This trend remained consistent throughout the observed period.

Dogs screened for hip dysplasia were aged between 1 and 6 years. The largest proportion of screened dogs were in the 1-2 year age range (54.3%), followed by the 2-3 year age range (36.6%), and then the over 3 years age range (9.1%).

The results of the monitoring clearly confirm the positive development of CHD in the Hovawart breed in the Czech Republic during the observed period, and there was a significant improvement in the examined dogs. It can be noted that there was not only an increase of CHD-A dogs in the population, but also a significant decrease in the incidence of dogs with CHD-C/E (Fig. 1).

At the beginning of the monitoring period, 1998-2002, the proportion of CHD-A dogs was 68.71%

and 20 years later, in the latest monitoring period, 2018-2022, the proportion was 92.99%, which represents an increase of 24.28% of unaffected individuals in the population. The most significant increase in the proportion of individuals with CHD-A results occurred between 2003-2007 and 2008-2012, when this proportion increased by 16.76%, and this difference was statistically significant (Table 2). A further increase in the proportion of individuals with CHD-A occurred between 2018 and 2022, with an increase of 4.19% and 4.57% compared to the periods 2008-2012 and 2013-2017, respectively, and these differences were also statistically significant. As regards the CHD-C/E Hovawart population, the greatest reduction occurred between the periods 2003-2007 and 2008-2012 with 9.18% and then between the periods 1998-2002 and 2003-2007 with 7.49%, and these differences were also statistically significant.

The effect of the age of the Hovawart dogs at the time of CHD testing over the entire study period (1998 to 2022) is shown in Table 3. The results showed that the youngest category of dogs (1-2 years old) had the highest frequency of CHD-A (84.19%). Lower frequencies were found in 2-3 year old dogs (80.13%) and dogs older than 3 years of age (78.93%). Thus, there is a downward trend in the frequency of dogs with CHD-A with increasing age. The opposite trend is then observed for the frequency of CHD-C/E, where the lowest frequency (7.32%) was found in the youngest category of dogs and this frequency decreased with age. On the other hand, no significant differences between age groups were found for CHD-B. The effect of age is also influenced by a number of external factors, and it is therefore necessary to take into account that, as individuals age, the possibility of potential damage increases, particularly with regard to external factors and also as a result of the possible progression of osteoarthritis.

Discussion

It is important to note the limitations of this study. Although we used a large dataset, it may not reflect the true prevalence of CHD, since it only includes data on dogs whose radiographs were assessed by an official Hovawart breed judge. This introduces selection bias, as the sample does not represent all Hovawarts in the Czech Republic, the dataset primarily comprises dogs selected for breeding purposes.

At the beginning of the study period (1998-2002), 20.54% of Hovawarts in the Czech Republic were found to have moderate to severe CHD. Twenty years later, during the most recent study period (2018-2022), this proportion had fallen to 1.91%, representing an 18.63% reduction in the prevalence of moderate to severe CHD. According to our results, the prevalence of canine hip dysplasia in the Hovawart population in the Czech Republic has decreased over the years. This positive trend is probably due to the strict selection of sires with regard to CHD, whereby only males with CHD-A and females with CHD-C or lower could be used for breeding. Some studies suggest that increased awareness among breeders is also leading to a decrease in the incidence of CHD (Freeman et al. 2013).

The prevalence of CHD differed markedly between breeds. A study conducted in the United States and Canada (Loder and Todhunter 2017) found that FCI Group 2 (Pinscher, Schnauzer, Molossoid, and Swiss Mountain/Swiss Cattle dogs) had the highest prevalence of moderate to severe CHD (20.4%); and the highest prevalence was in the Bulldogs (77.7%) and the lowest in the Italian Greyhounds (0.0%). The French study (Baldinger et al. 2020) found that Cane Corsos had the highest prevalence (49.9%) of moderate to severe CHD, while Siberian Huskies and Alaskan Malamutes had the lowest prevalence (6.0% and 6.6%, respectively).

Our study observed a lower frequency of moderate to severe cases of CHD in younger dogs. Similar results have been described by the authors of previous studies (Smith et al. 2006, Miqueleto et al. 2013), who hypothesised that dogs with a higher frequency of CHD are generally older. However, the influence of age may not be the only factor in the exacerbation of CHD in dogs, and some authors (Kimeli et al. 2015) have suggested that the condition of the individual, injuries, or the composition of the dog‘s diet may also be a cause of exacerbation. The higher incidence of CHD in older dogs may also be due to increased work or sporting activity (Bockstahler et al. 2007, Loder and Todhunter 2017).

Dysplasia is a very relevant problem in pedigree dog breeding in relation to genetic inheritance (Nadejda et al. 2019). Early diagnosis of this pathology and determination of its severity, as well as the use of this data in breeding to genetically control the transmission of dysplasia, are of particular importance (Lyubchenko et al. 2021). While selection based on phenotypic traits appears effective in the Czech Republic, many experts recommend combining it with genetic selection for enhanced results (Woolliams et al. 2011, Baba et al. 2019).

Conclusion

A retrospective analysis of hip dysplasia in the Hovawart population in the Czech Republic over a 25-year period revealed a substantial and consistent reduction in the prevalence of CHD. The proportion of CHD-free dogs (CHD-A) increased markedly, while the incidence of moderate to severe dysplasia (CHD-C to E) decreased significantly. These improvements are likely the result of stringent breeding practices, particularly the selective use of dogs based on their hip score. Although a slightly higher frequency of hip dysplasia was observed in older dogs, this may be influenced by external factors such as physical activity, injury, or nutrition. The findings highlight the effectiveness of phenotype-based selection in reducing CHD prevalence. However, integrating genetic screening into breeding programmes could further enhance control over CHD transmission in the Hovawart population.

Author Declaration

Ethics Approval

Experimental procedures and animal care conditions followed the recommendations of European Union Directive 86/609/EEC and were approved by the Expert Committee for the Protection of the Welfare of Experimental Animals of the Mendel University in Brno. Name of the Ethics Committee: The Ethics Committee of the Expert Committee for the Protection of the Welfare of Laboratory Animals of the Mendel University in Brno. Approval code: 16OZ27083/2014-17214. Approval date: 20 May 2019.

Use of generative artificial intelligence

The authors declare that no generative artificial intelligence (AI) tools were used in the writing, editing, analysis, interpretation of results, or preparation of this manuscript.

Conflict of interest

The authors declare that they have no conflict of interest.

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