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Prevalence of hip dysplasia in dogs according to official radiographic screening in Croatia

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ABSTRACT

The subject of this study was to detect the prevalence of hip dysplasia according to official radiographic screening between 2001 and 2009. The overall number of dogs tested for HD was 5381, belonging to 137 breeds. In 2001 the number of dogs evaluated was 403, and in 2009 this number rose to 856, which is an increase of 212.40%. In 2001 the number of breeds evaluated was 48, and in 2007 this number rose to 79 breeds, which is an increase of 164.58%. In the overall sample there were 2125 (39.5%) males and 3256 (60.5%) females. The mean age was around 24 months. According to the FCI scale, C, D and E grades are interpreted as dysplastic hips. In our sample 4372 (81.25%) dogs were found to be free of dysplasia (A, B), while HD was found in 1009 (18.75%) dogs. In the period between 2001 and 2009 there was a visible trend of a reduction in the number of dogs with dysplasia. There was a significant difference ($P < 0.05$) between 2001 on the one hand and 2005 and 2006 on the other. In 2001 there were 27.79% of dogs with dysplasia, while in 2005 this number fell to 14.81% and in 2006 to 14.51%. There was no statistical significance in the prevalence of HD in males and in females ($P = 0.20$). The difference in age, however, was significant, and dogs with dysplasia were older on average ($P < 0.05$). The results of our study show that the programme of selection on the basis of radiography of hips should be continued in order to improve the quality of purebred dog breeds in Croatia.

Key words: hip dysplasia, prevalence, dog, radiography, Croatia

Introduction

Malformation in the development of the hip joint in dogs is called hip dysplasia (HD). This condition was first described by SCHNELLE (1935). Today it is generally

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accepted that dysplastic changes of hips are diagnosed by radiological examination, and are classified as a normal finding or dysplasia of a varying degree. Many studies have confirmed that hip dysplasia has a polygenetic hereditary aetiology, conditioned by environmental factors (WILLIS, 1992; SWENSON et al., 1997; LEPPÄNEN and SALONIEMI, 1999). Heritability is assessed in a range of 0.1 to 0.6 in populations of different dog breeds (LINGAAS and KLEMENTSDAL, 1990; TOMLINSON and McLAUGHLIN, 1996; SWENSON et al., 1997; WOOD et al., 2002). The polygenetic trait of HD is the reason why the reduction in the incidence of this disease is slow (LEIGHTON, 1997). Dysplastic dogs have a high risk of having offspring with dysplastic hips (HEDHAMMAR et al., 1979; KELLER, 2006). The frequency of HD is smaller in offspring of parents with certifiably good hip joints, and greater in those of parents with dysplastic hips or parents whose hips were not evaluated (SWENSON et al., 1997; AUDELL, 2000). Radiological examination of hips in various dog breeds is done with the purpose of assessing and determining the genetic carriers for hip dysplasia and removing such dogs from breeding. For the above reason, cooperation between breeders, kennel clubs and veterinarians is very important. Through correct selection, based on radiological evaluation of the hips, the incidence of this disease can be reduced. In present-day circumstances selection in breeding based on exclusion of dogs with signs of hip dysplasia is the only way to reduce the level of genetic incidence of hip dysplasia in dogs. Radiological examination is a currently the accepted means of assessment of the presence of hip dysplasia and a document which provides the basis upon which it is possible to contribute to the reduction of the frequency of this disease (RETTENMAIER et al., 2002; VAN HALEN et al., 2005; JANUTTA and DISTL, 2006; KELLER, 2006). In many countries in the world good results were achieved in the reduction of the HD frequency in breeding of various dog breeds (KANEENE et al., 1997; RETTENMAIER et al., 2002; KANEENE et al., 2009). In Croatia the veterinary profession, in various forms, shares the responsibility with the Croatian Kennel Club in achieving the best possible results in reducing the incidence of HD and improvement of the average quality of purebred dog breeds.

The aim of our study was to determine the prevalence of hip dysplasia in the period between 2001 and 2009 on the basis of radiological examination, and to analyse the frequency and changes in selected dog breeds in Croatia. We determined the efficiency of the selection programme in Croatia by monitoring the global prevalence of HD in purebred dog breeds and by analysing the distribution of HD by breed, sex, age and grade of the disease.

Materials and methods

The data from the archives of the Department of Radiology, Ultrasound Diagnostics and Physical Therapy of the Faculty of Veterinary Medicine of the University of Zagreb in

the period from 2001 to 2009 were used in the study. In this period 5381 dogs belonging to 137 breeds were examined for HD. Mixed breeds were not included in the sample, and German Shepherd dogs were left out of the pure breeds. The reason for the exclusion of the German Shepherd is that the evaluation of hips of these dogs was not performed in the entire observation period in our Department.

Before scanning, all the dogs were identified by checking the number in their microchip or the tattoo number. Radiographs were performed at our Department or were sent to us from veterinary clinics from other parts of Croatia. The dogs were sedated or anaesthetized during the radiography. The radiographs used satisfy all criteria for the correct interpretation of hips in dogs. The hips and the pelvis were well positioned in a dorso-ventral projection. Care was taken about the symmetry of the obturator foramina and extension of the hind extremities to enable the precise evaluation of the femoral head and neck area. Selection of the conditions for the hip screening was optimal. The screened breeds were subject to mandatory screening of the hips, in accordance with the nomenclature of the FCI (Fédération Cynologique Internationale) and Regulations on Professional Work of the Croatian Kennel Club. These breeds must have a normal radiological finding. This is a condition for access to the breeding examination, and on this basis the selection is done. Radiographs from the archives which had not been adequately done, radiographs of dogs with a pelvic trauma or with other medical reasons were not used. The age for screening of hips for various dog breeds was determined according to the FCI protocol. The minimal age for an official radiological examination of the hips is 12 months, except for some of the giant breeds for which the minimal age is 18 months. Dogs screened at an age younger than 12 months were given a preliminary finding.

The assessment of hip changes and the final evaluation was done by three radiologists, one of whom had more than 20 years' experience and two more than 30 years' experience. Radiographs of the hips were evaluated according to the FCI scale of 5 grades of hip dysplasia (A = no signs of HD, B = findings near normal, C = mild signs of HD, D = moderate signs of HD, E = severe HD). According to the FCI scale hips assessed as having C, D and E grades were considered dysplastically changed (BRASS, 1989; COOPMAN, 2008). During the radiological analysis both hips were evaluated, but a definitive evaluation was given for hips with more severe dysplastic changes (SWENSON et al., 1997).

Statistical analysis was performed using the statistics package STATISTICA 8.0. Significant differences between categorical variables were analysed using the Chi-square test. The level of statistical significance between variables was set at the level of $P < 0.05$.

Results

Out of 5381 examined dogs, HD was diagnosed in 1009 dogs (18.75%). The frequency of HD varies in different dog breeds. The most frequent breeds in which the hips were evaluated, frequency of HD and distribution by sex are given in Table 1. HD was most frequently diagnosed in English Bulldogs (81.33%), and least frequently in Rhodesian Ridgebacks (3.33%).

Table 1. Hip dysplasia (HD) prevalence in the most often examined dog breeds (more than 50 examined dogs) and distribution by sex

Breed	No. of examined dogs	M/F*	Dogs with HD	M/F*
	N	N	N (%)	N
Labrador Retriever	665	225/440	110 (16.54)	41/69
Golden Retriever	488	192/296	111 (22.7)	47/64
Rottweiler	455	175/280	51 (11.21)	26/25
Croatian Mountain Dog	410	177/233	118 (28.78)	54/64
American Staffordshire Terrier	398	173/225	81 (20.36)	36/45
Belgian Shepherd Dog-Malinois	290	141/149	11 (3.72)	8/3
Doberman	233	86/147	9 (3.86)	2/7
German Boxer	202	60/142	45 (22.25)	14/31
Yugoslavian Shepherd Dog-Sharplanina	163	62/101	67 (41.10)	21/46
Great Dane	119	47/72	19 (15.97)	9/10
Bernese Mountain Dog	110	29/81	15 (13.64)	2/13
Dogue de Bordeaux	102	40/62	40 (39.22)	14/26
German Short-haired Pointing Dog	100	46/54	3 (30.00)	0/3
English Bulldog	75	37/38	61 (81.33)	33/28
Dogo Argentino	79	28/51	36 (45.57)	12/24
Border Collie	65	29/36	6 (9.23)	4/2
Samoyed	64	21/43	8 (12.50)	3/5
Rhodesian Ridgeback	62	31/31	2 (3.33)	2/0
Bullmastiff	51	21/30	26 (50.98)	8/18
Caucasian Shepherd Dog	51	22/29	22 (43.13)	10/12

*male/female

Table 2. Number of examined dogs and breeds by sex and year

Year	No. of dogs	No. of breeds	Male		Female	
			N	%	N	%
2001	403	48	134	33.25	269	66.74
2002	451	57	176	39.02	275	60.98
2003	522	65	203	38.88	319	61.12
2004	426	61	172	40.38	254	59.62
2005	466	64	175	37.55	291	62.45
2006	689	68	290	42.09	399	57.91
2007	742	79	294	39.62	448	60.38
2008	826	78	316	38.26	510	61.74
2009	856	73	365	42.64	491	57.36
Total	5381		2125	39.5	3256	60.5

The number of examined dogs and breeds by sex and year is presented in Table 2. There is a general tendency of increase in the overall number of examined dogs from 2001 to 2009. At the same time there was an increase in the number of breeds in which there was the need for a radiological evaluation of hip conditions. The overall number dogs examined in 2001 was 403, and in 2009 it was 856 - an increase of 212.40%. The smallest number of examined breeds was in 2001 - 48 in all, and the greatest was in 2007 - 79 breeds. The increase of the number of breeds is 164.58%.

In the overall sample, 2125 (39.5%) males and 3256 (60.5%) females were examined. The distribution according to sex was homogeneous in all the years of observation. Percentage-wise the representation of males was between 33.25% and 42.64%, and of females between 57.36% and 66.74% (Table 2).

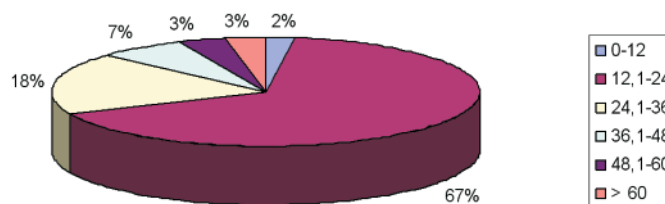


Fig. 1. Breakdown of dogs examined by age in the overall sample

The age range of the examined dogs was between 6 and 152 months. The mean age was 23.86 months and the median age was 19.4 months. The greatest number of examined dogs was in the age range from 1 to 2 years (67%), followed by 2 to 4 years (25%), 4 to 5 years (3%), more than 5 years (3%) and less than 1 year (2%) (Fig. 1).

Table 3. Percentage of grades of HD in the overall sample

HD grade	N	%
A	4139	76.92
B	233	4.33
C	393	7.31
D	288	5.35
E	328	6.09
Total	5381	100.00

Table 4. Number of dogs free of hip dysplasia (HD) and with HD by year

Years	No. of examined dogs	Dogs without HD		Dogs with HD	
		N	%	N	%
2001	403	291	72.21	112	27.79
2002	451	348	77.16	103	22.84
2003	522	412	78.93	110	21.07
2004	426	345	80.99	81	19.01
2005	466	397	85.19	69	14.81
2006	689	589	85.49	100	14.51
2007	742	609	73.73	133	26.27
2008	826	670	81.11	156	18.89
2009	856	711	83.06	145	16.94
Total	5381	4372	81.25	1009	18.75

The analysis of frequency of hip dysplasia in the overall sample shows that HD-A was diagnosed in 76.92% of cases, HD-B in 4.33%, HD-C in 7.31%, HD-D in 5.35% and HD-E in 6.09% of cases (Table 3). In our sample, 4372 (81.25%) of the dogs were diagnosed as having no dysplasia (A and B), while dysplasia was found in 1009 (18.75%) dogs (C, D, E) (Table 4).

In the period between 2001 and 2009, there is a perceptible trend of increase of the number of dogs without dysplasia in the overall number of dogs examined. The proportion of dogs with dysplasia was the greatest in 2001. Until 2006 this proportion had been falling, but in 2007 it started to grow again - to a level comparable to 2001 - and

then decreased again, remaining however at a higher level than in 2005 and 2006. There is a significant difference ($P < 0.05$) between 2001 and 2005 and 2006. In 2001 there were 27.79% dogs with HD, in 2005 there were 14.81% and in 2006 14.51% (Table 4). In 2007 we observed a significant increase of dogs with dysplasia (26.27%). This sudden increase of frequency was then followed by an equally sharp decrease in the number of dogs with dysplasia, to 16.94% in 2009. However, this number is still higher than the percentage in 2006, so overall we detected a slight trend of an increase in the number of dogs with dysplasia (Fig. 2).

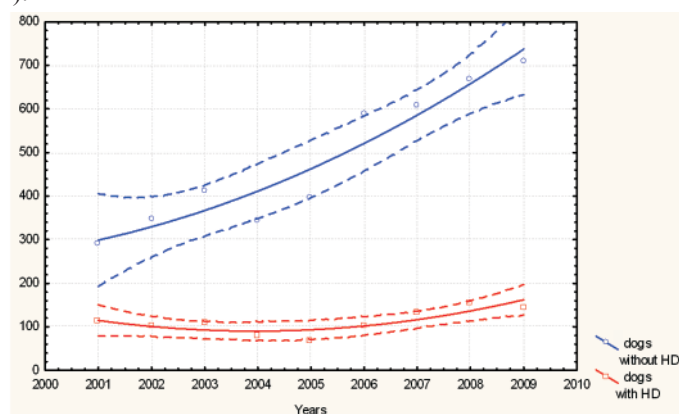


Fig. 2. Number of dogs free of dysplasia and those with dysplasia in the period 2001-2009

Analyzing the group with diagnosed dysplasia, there were 393 dogs with grade C (38.95%), followed by 327 with grade E (32.41%) and 289 with grade D (28.64%).

Comparing the grade of HD within the group of dogs with dysplasia from 2001 to 2009, it is perceptible that an even percentage for each severity grade of dysplasia was present in all years except in 2004 and 2007 ($P < 0.05$). A significant difference was found in grades D and E in those two years. In 2004 there were the fewest with grade D (19.75%), while the greatest number with this grade was observed in 2007 (41.35%). Also, a difference was observed between these two years with respect to grade E. In 2004 there was the greatest number of dogs with grade E (46.91%), while this grade comprised the smallest number of dogs in 2007 (25.56%) (Table 5).

Table 5. Number of dogs with hip dysplasia (HD) according to HD grade by year

Years	No. of examined dogs	HD -C		HD-D		HD-E	
		N	%	N	%	N	%
2001	112	42	37.50	36	32.14	34	30.36
2002	103	44	42.72	28	27.18	31	30.10
2003	110	33	30.00	36	32.73	41	37.27
2004	81	27	33.33	16	19.75	38	46.91
2005	69	23	33.33	19	27.54	27	39.13
2006	100	44	44.00	20	20.00	36	36.00
2007	133	44	33.08	55	41.35	34	25.56
2008	156	74	47.45	40	25.64	42	26.92
2009	145	62	42.76	39	26.90	44	30.34
Total	1009	393	38.95	289	28.64	327	32.41

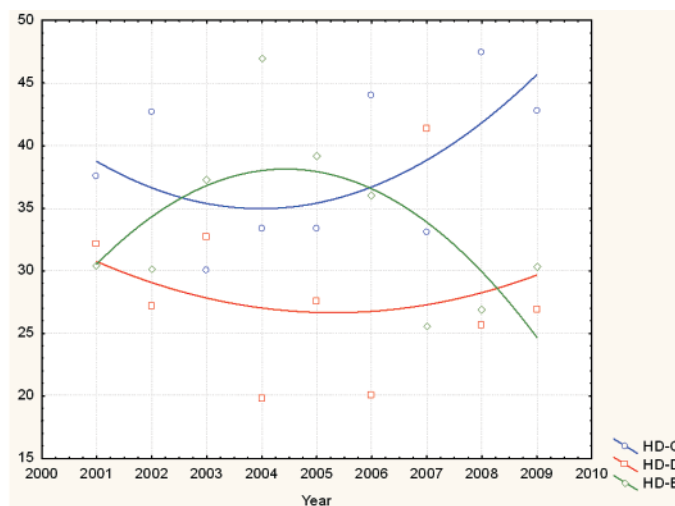


Fig. 3. Percentage of HD grade (C, D, E) in dogs with hip dysplasia in the period 2001-2009

The analysis of HD frequency in the observed time period showed that the frequency of mild grade dysplasia (C) has been increasing since 2004, and there is a decrease in severe grade dysplasia (E). The frequency of moderate grade dysplasia (D) is relatively stable (Fig. 3).

The difference by sex and age was tested in the overall sample of dogs examined, those with dysplasia and those without it. There was no difference in sex between those who had and those who did not have dysplasia ($P = 0.20$). A difference in age was visible, however, with dogs having dysplasia being older on the average ($P < 0.05$). Within the overall number of examined dogs the greatest number with dysplasia was in the age group of 48 - 60 months (23.89%), while the smallest number (18.19%) was in the age group of up to 1 year (Table 6).

Table 6. Prevalence of hip dysplasia (HD) by age and sex

Age in months	No. of dogs N	Dogs with HD		M/F*
		N	%	N
0-12	122	22	18.19	12/10
12.1-24	3550	619	17.43	246/373
24.1-36	986	213	21.61	84/129
36.1-48	370	80	21.62	37/43
48.1-60	181	43	23.89	21/22
>60	1	32	18.82	15/17
Total	5381	1009	18.75	415/594

*male/female

A cross-analysis of age with the grade of dysplasia showed that there is a difference in age between dogs with grades A (mean age 23.64, median age 19.20) and B (mean age 22.78, median age 18.30), compared to grades D (mean age 26.35, median age 22.20) and E (mean age 25.46, median age 20.30). The diagnosis of HD-A and HD-B were more often observed in younger animals (Table 7).

Table 7. Age of dogs (in months) by hip dysplasia (HD) grade

Grade of dysplasia	No. of dogs	Mean	CI 95%		Mode	Frequency of mode	Min.	Max.	Median
			lower	upper					
A	4139	23.64	23.23	24.05	14.00	83	8.00	152.00	19.20
B	233	22.78	21.11	24.45	18.00	6	8.00	81.50	18.30
C	393	24.11	22.83	25.39	13.00	10	10.50	90.50	20.00
D	288	26.35	24.64	28.04	20.10	7	11.30	122.00	22.20
E	328	25.46	23.90	27.02	Multiple	7	6.00	86.70	20.30

Discussion

Control of breeding and restrictive programmes in the control of HD prevalence are very useful methods which have been applied in many countries for almost 40 years (GIBBS, 1997; LEPPÄNEN et al., 2000). All official programmes are based on a radiological evaluation of the hips (BRASS, 1989; CORLEY, 1992; GIBBS, 1997; LEPPÄNEN et al., 2000). Selection is based on radiological phenotype observations and in such a way the genotype traits are determined. Such programmes cause the reduction of genetic variation, which can lead to other medical problems (BOUW, 1982). The evaluation of hips by the FCI scale is most frequently used in continental European countries (JANUTTA and DISTL, 2006). Croatia also employs HD control by the FCI scale. The mandatory radiography of hips and a commitment to the programme of selection is very important for the reduction of incidence of HD and the improvement of the quality of purebred dog breeds. Dogs in which HD has been diagnosed have a high risk of having dysplastic offspring (KELLER, 2006), and therefore such dogs should be excluded from breeding.

The results of our study of the frequency of HD in the period 2001 - 2009 show that the cooperation of the veterinarian profession and the Croatian Kennel Club is successful. An indicator of this cooperation is the increased number of evaluated dogs and an increase in the number of purebred breeds in which hip radiography is mandatory. This number is variable because, along with the commonly most numerous breeds, a smaller number of new breeds are regularly introduced, which also need control of their hips. In all, 5381 dogs belonging to 137 breeds were tested for HD. In this sample there were 2125 (39.5%) males and 3256 (60.5%) females. As in other studies, there were more females than males in the overall sample (RETTENMAIER et al., 2002; WOOD et al., 2002). In our study the age of evaluated dogs was between 6 and 152 months, i.e. the mean age was 23.86 months and median age was 19.4 months. The number of dogs examined in our study correlates by age with the results of other authors so that COOPMAN et al. (2008) in their study state that the median and mean ages of the dogs were 19 months and 23 months, respectively, and 60% of the sample were female dogs. RETTENMAIER et al. (2002) analysed a sample of 2885 dogs of 116 various breeds. The age range of the dogs was 3 to 221 months and the median age was 48 months.

The incidence of HD in different dog breeds varies from country to country. There are differences in the popularity of individual breeds in various countries, as well as greater or lesser success in the control of HD in various dog breeds (LEPPÄNEN and SALONIEMI, 1999; GENEVOIS et al., 2008). In the control of HD incidence with the aim of increasing the average quality of normal dogs in breeding, the reduction in the number of dogs with dysplastic hips is seen as a success. Significant improvements in breeding also result in an increase in the frequency of milder grades of hip dysplasia, and a decrease in severe grades (KELLER, 2006; KANENNE et al., 2009). The analysis of the frequency of HD in

our study in the period 2001 - 2009 showed a trend of increase of dogs free of dysplasia in the overall number of controlled dogs. The best results of the decrease in the frequency of HD were obtained in 2005 (14.81%) and 2006 (14.51%). After this, there was another peak value of HD observed in 2007 (26.27%), followed by a new decrease. GINJA et al. (2009) report similar observations of a reduction of frequency in 2004 and 2005. On the basis of our knowledge we were not able to explain this phenomenon.

The monitoring of the frequency of HD in various time frames in many countries showed improvements (WOOD et al., 2002; KELLER, 2006; GENEVOIS et al., 2008). It is therefore important in which time frame the evaluation of the frequency of HD is being done. In the programme of the control of HD it was observed that at the beginning of the implementation of the programme there was a visible and marked improvement, while later the improvement was slower, but continuous (LEIGHTON, 1997). In accordance with the above observations FLÜCKIGER et al. (1995) in their paper state a frequency of 42% of HD in a sample taken from the time frame 1970 to 1994. RETTENMAIER et al. (2002) state the figure of 19.7% of dysplastic dogs in purebred dogs in the period from 1991 to 1995. COOPMAN et al. (2008) in their research state that HD was observed in their overall sample in one of five dogs, while this ratio in the most popular breeds was one in four in the period between 2002 and 2006. In our sample, 4372 (81.25%) dogs were diagnosed as being free of dysplasia, while dysplasia (grades C, D, E) was confirmed in 1009 (18.75%) dogs.

GINJA et al. (2009) in their paper notice that the frequency of HD in males and females was similar ($P = 0.14$). Likewise, RETTENMAIER et al. (2002) did not find a significant difference between dysplastic male and female purebred dogs ($P=0.49$). The results of our study conform to the above, in that there is no significant difference in the frequency of HD by sex ($P = 0.20$). In humans, there is a pronounced predisposition in women towards hip dysplasia (FREIBERGER, 1987).

In our study we analysed the frequency of HD by age of the dogs which revealed a significantly greater prevalence of HD in older animals ($P<0.05$). The group of examined dogs free of HD (grade A and B) are younger compared to those with HD (grades C, D, E). Within the group of dogs with HD, a difference was observed in the age of dogs which have grade C compared to grade D. Grade C is on average found in younger animals. In brief, grades D and E were observed in older animals. These data confirm the basic definition of hip dysplasia as a progressive disease, as it is visible that the frequency and severity of the disease progresses with the age of the dog.

The analysis of the trend of frequency in the studied time frame shows that the frequency of the mild form of dysplasia (C) is on the increase, and at the same time, there is decrease of the frequency of the severe form (E). The frequency of the moderate grade of dysplasia (D) is relatively stable.

The results of this study should encourage dog owners, breeders and the Croatian Kennel Club to continue the implementation of the selection programme of purebred dog breeds on the basis of radiological examination of the hips, in order to further decrease the frequency of HD.

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SAŽETAK

Predmet ovog istraživanja bio je ustanoviti prevalenciju displazije kukova na temelju službenih rengenoloških pretraga između 2001. i 2009. godine. Ukupan broj pregledanih pasa na displaziju kukova bio je 5381, 137 različitih pasmina. Godine 2001. bila su ocijenjena 403 psa, a 2009. broj se povećao na 856, što je povećanje od 212,40%. Godine 2001. bilo je ocjenjivano 48 pasmina, a 2009. broj pasmina se povećao na 79, što je povećanje od 164,58%. U ukupnom uzorku bilo je 2125 mužjaka (39,5%) i 3256 ženki (60,5%). Srednja dob je bila oko 24 mjeseca. Prema FCI skali C, D i E stupnjevi smatraju se displastičnim kukovima. U našem uzorku 4372 (81,25%) pasa nisu imala displaziju (A,B), dok je displazija kukova bila dijagnosticirana u 1009 (18,75%) pasa. U razdoblju između 2001. i 2009. godine vidljivo je kretanje pada broja pasa s displazijom. Postoji statistički značajna razlika ($P<0,05$) između 2001. godine s jedne strane, i 2005. i 2006. godine s druge strane. Godine 2001. bilo je 27,79% pasa s displazijom, dok se 2005. taj broj smanjio na 14,81% te 2006. na 14,51%. Ne postoji statistički značajna razlika u prevalenciji displazije kukova u mužjaka i ženki ($P=0,20$). Razlika u dobi je, međutim, značajna te su psi s displazijom u prosjeku starije dobi ($P<0,05$). Rezultati našeg istraživanja pokazuju da program selekcije na temelju rengenološkoga snimanja kukova treba nastaviti da bi se poboljšala kvaliteta čistokrvnih pasmina pasa u Hrvatskoj.

Ključne riječi: displazija kuka, prevalencija, pas, rengenografija, Hrvatska
