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Observations and analysis of risk factors for GDV in a single institution: a case-control study

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Abstract

Objective

To evaluate/ determine the risk factors for dogs presented with Gastric Dilation- Volvulus (GDV) to a referral veterinary centre and to compare the results with those currently reported in veterinary literature.

Materials and Methods

The observational case-control study comprised a population of 215 dogs that attended the referral centre between 2000 and 2018. Medical records were searched for GDV and those matching the criteria were manually reviewed. A questionnaire was completed by the owners of the dogs involved in the study (both case and control populations) in order to gain further information that could be considered relevant to GDVs. In particular, information included the dogs' behaviour and the dogs daily activities.

Results

The study included 115 cases of GDV and 115 controls. Out of the GDV dogs 13% (15/115) were small breed dogs and the remaining 87% (100/115) either large or giant breeds.

The following risk factors for developing a GDV have been identified: Purebred dogs over 3 years old and either large of giant breeds, weighing > 30 kg. Foreign body ingestion, diarrhoea, and grass consumption were also associated to increase the likelihood in developing GDV. Behavioural temperament was not associated with developing GDV.

Clinical Significance

The findings support previously identified risk factors in the development of GDV, but characteristics related to the dogs temperament warrant further investigation. Knowledge of these results will further allow clinicians to make evidence-based recommendations to owners in attempting to prevent GDV in dogs. Furthermore this paper confirms that the risk of GDV in certain breeds and in certain conditions is always high and that GDV is still an extremely current disease.

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Introduction

Gastric Dilatation - Volvulus (GDV) is an acute and potentially fatal syndrome that mainly affects large deep-chested dogs, although occasionally it has been reported in small dogs and other species, including cats[1-5] guinea pigs[7,] monkeys[8] and humans[9] .Dilatation is supposed to precede torsion, though it has been reported that gastric torsion episodes may arise without prior dilatation[9]. Symptoms predominate due to rapid accumulation of gases and fluids within the gastric lumen leading to distension, increasing intraluminal pressure and stomach rotation; those in turn lead to dyspnoea, varying degrees of hypovolemic and/or septic shock, ventilation-perfusion mismatch, systemic inflammatory response syndrome (SIRS), coagulation malfunction and multiple organ dysfunction syndrome (MODS)[10-13], including ventricular arrhythmias and Disseminated Intravascular Coagulation (DIC)[14] . If left untreated, GDV can lead to severe impairment of venous return to the heart, diminished stroke volume, necrosis of the gastric wall and eventual fatality[15].

Although the exact aetiology of GDV is still unknown, numerous predisposing risk factors have been described[12,16]. Male, large and giant pure breed dogs[17,18], and deep chested dogs are at increased risk[19]. Other reported risk factors include increased age[18], low Body Condition Score (BCS)[17], nervous or a fearful temperament[17], stressful events occurring within 8 hours prior to the GDV episode[12], and a familial history of GDV[18]. Nutrition-related risk factors have also been identified, such as eating one meal per day, small food particles, rapid food ingestion[17,20] and eating only one type of food[14]. Some authors have suggested a relationship between GDV and weather conditions with one study reporting a higher incidence during winter months[21,] whereas another reported an increase in environmental temperature presented as a significant risk factor for GDV[16]. The association between GDV and physical activity remains controversial[15, 16.] Recently, a study on canine gut microbiome showed that microbiome in GDV patients was altered by an expansion of a minor lineage and was associated with specific alleles of both innate and adaptive immunity genes. These associations are consistent with the hypothesis that immune genes may play a role in predisposition to GDV by altering the gut microbiome[22].

The purpose of this epidemiological survey was to determine whether some of the most commonly claimed risk factors for GDV exist in northern Italy and to ascertain whether there are differences when comparing similar studies conducted, to date, in other countries.

Methods

The epidemiological case-control study was conducted at a single veterinary practice (between 2000 and 2018)

To meet the inclusion criteria dogs had to be older than 6 months of age, without previous prophylactic gastropexy. Dogs in the control group had never had a GDV episode. Owners of both GDV cases and control dogs should have completed and signed the questionnaire under direct supervision of the attending clinician.

All GDV dogs were recruited during their presentation to the centre for an acute episode of GDV. On the other hand, control dogs were selected randomly from patients brought into the centre for reasons other than GDV.

The questionnaire consisted of different sections including the owner's data, the dog's signalment (breed, age, BCS, sex, neutered/intact), the dog's temperament (shy, balanced, aggressive, or exuberant) as assigned by the owner. Two sections focused on the GDV and included treatments received, whether a previous episode had occurred, the time spent between physical activity and GDV presentation, the elapsed time between a meal and GDV, and the presence of a possible stressful situation before of the onset of the disease. The last part of the questionnaire included questions related to the dog's lifestyle and dietary habits. Both the owner and the veterinarian defined the BCS of the dog, choosing either skinny, thin, ideal weight, overweight, obese. Details of the physical activity performed by the dog during the day and correlation between physical activity and meal were documented. The owner was asked whether the dog was housed in kennels and whether it was used to long journeys. Finally the presence of vomiting/diarrhoea was investigated along with whether the dog was prone to ingesting grass or foreign bodies (TABLE 1).

Statistical Analysis

Statistical analysis, performed using statistical software R. Data was merged making non-dichotomous variables into dichotomous variables. For example, for the "food intake speed" parameter, the owner could choose between four answers: slow, normal, quick, voracious. The data was then grouped in slow/normal (Group 1) and fast/voracious (Group 2), using the Pivot tables. This procedure was carried out for all non-dichotomous variables (i.e. those variables for which the answer did not include a simple YES/NO but a scale of values). These variables were: the speed of food intake; temperament of the dog, type of feeding, position of the bowl, number of meals, type and frequency of physical activity, presence of episodes of vomiting and/or diarrhoea, tendency to eat foreign bodies, tendency to consume grass, stay in kennels, and whether it was used to long journeys.

Once all dichotomous variables were rendered, each parameter was entered in 2x2 contingency tables. For some variables, several 2x2 tables were created, for example 4 tables were created for physical activity including the possibility to carry out physical activity, the possibility to carry out physical activity before the meal, the possibility to carry out physical activity after the meal, possibility to perform physical activity before and after the meal.

From the 2x2 contingency tables the following values were calculated: OR, ES, OR MIN and OR MAX. OR is a statistical value that represents the relationship between sick and exposed subjects and the healthy and exposed subjects. It is calculated as (a/c)/(b/d), ie (cases/non-cases) exposed/(cases/non-cases) not exposed. (TABLE 2).

The values OR MIN and OR MAX indicate the confidence interval, that is, define how much the OR value represents the estimate of a real value. The confidence interval makes it possible to verify the statistical significance of the results: if it contains the value 1, the null hypothesis is satisfied (ie that there is no difference between exposed or non-exposed subjects to risk factors). If the confidence interval does not contain the value 1, the null hypothesis is rejected, i.e. the alternative hypothesis is accepted, which states that there is a difference between exposed and non-exposed subjects to the risk factor, so that the OR value is significant (TABLE 3).

After calculating the OR value of each variable, χ^2-tests were performed; p values of < 0.05 were considered statistically significant.

Results

In total, 86.9% (100/115) of dogs presented with GDV were large/giant breeds while only 13.1% (15/115) were medium/small breeds. Among the control dogs, 54.84% (85/155) were large-giant breeds and 19.35% (30/155) medium/small breeds. In total, 94.7% of GDV dogs and 81.7% of control dogs were purebred dogs. Out of 115 cases, 76 GDV dogs (66%) were male and 39 (34%) female. The control group consisted of 65 (56.5 %) male and 50 (43.4 %) female dogs. Most dogs were older than three years of age, 93% (108/115) of GDV dogs and 71.3% (82/115) of control dogs. Most dogs had a low to normal BCS, 90% of GDV dogs and 93% of control dogs respectively and 68.6% of GDV dogs (79 /115) and 65% (75/115) of control dogs were > 30 kg.

Table N° 1 : Summary of distribution of individuals variables

DOG N°	GDV	BREED	SEX	AGE (Years)	NEU-TERED	BODY WEIGHT KG	ATTITUDE	FOOD TYPE	N° MEAL PER DAY	FOOD AD LIBI-TUM	INTAKE OF FOOD TYPE (SPEED)	BOW-EL POSI-TION	BCS	PHISI-CAL ACTIVI-TY	FRE-QUENCY	TIME (Hours)	TIME IN BETWEEN PHYSICAL ACTIVITY AND MEAL	LONG TRIPS FRE-QUENCY	KEN-NEL	VOMIT	DIAR-RHEA	EATING GRASS?	EATING FOREIGHN BODIES?
1	Yes	bernese mountain dog	F	6	no	43	exuberant	dry mios-tened	2	no	fast	rised	2.5	walk	2	2	3 h before	regulary	no	occasional-ly	occasion-ally	sometimes	sometimes
2	Yes	german shepherd	F	8	no	36	balanced	dry mios-tened	2	yes	slow	soil	2.5	walk				occa-sionally	no	occasional-ly	occasion-ally	sometimes	sometimes
3	Yes	spinone	M	10	no	40	timid	dry mios-tened	2	no	fast	rised	4.5	walk	2			never	no	occasional-ly	never	sometimes	sometimes
4	Yes	german shepherd	M	11	no	40	timid	dry mios-tened	1	no	normal	soil	2	walk	2	1	1 h before, 12 h later	never	no	occasional-ly	occasion-ally	yes	yes
5	Yes	dalmatian	M	5	no	30	aggressive	dry	2	no	fast	soil	2.5	walk	more than 4			never	no	never	never	sometimes	yes
6	Yes	cross breed	M	6	yes	70	balanced	dry	2	no	fast	soil	2.5	walk	2			never	no	never	never	no	no
7	Yes	german shepherd	M	11	yes	40	timid	home-made	1	no	normal	soil	2.5	walk	more than 4			never	no	occasional-ly	occasion-ally	sometimes	sometimes
8	Yes	german shepherd	M	6	no	50	timid	dry mios-tened	1	no	voracious	soil	2.5	walk	more than 4			never	no	never	occasion-ally	sometimes	sometimes
9	Yes	german shepherd	M	9	no	40	exuberant	dry mios-tened	2	no	fast	soil	2.5	walk	1	1	4 h before, 4 h later	never	no	occasional-ly	never	sometimes	sometimes
10	Yes	great dane	F	3	yes	60	timid	home-made	2	no	voracoius	soil	2.5	walk	3		match	never	no	occasional-ly	occasion-ally	yes	yes
11	Yes	boxer	M	9	yes	40	balanced	dry mios-tened	1	no	voracious	soil	4.5	walk	3	1		occa-sionally	no	occasional-ly	never	yes	no
12	Yes	german shepherd	F	8	no	30	timid	home-made	1	no	slow	soil	2.5	walk		2	3 h before	never	no	occasional-ly	occasion-ally	sometimes	no
13	Yes	german shepherd	F	11	yes	25	balanced	dry mios-tened	1	no	normal	soil	2.5	living outside				never	no	occasional-ly	occasion-ally	sometimes	no
14	Yes	drathar	F	9	yes	23	timid	dry	1	yes	voracious	soil	2.5	run				occa-sionally	no	occasional-ly	never	yes	yes
15	Yes	dogue de bordaux	F	7	no	55	balanced	dry	2	no	fast	soil	2.5	walk	more than 4	1	half an h before, 4 h later	occa-sionally	no	never	occasion-ally	yes	yes
16	Yes	setter gor-don	M	2	no	36	balanced	dry	2	no	slow	soil	2	walk	1	5	1 h before, 3 h later	regulary	yes	never	never	no	no
17	Yes	great dane	M	6	no	74	exuberant	dry	2	no	voracious	soil	2	walk		5	2 h later	never	no	occasional-ly	never	yes	yes
18	Yes	briard	F	4	no	35	exuberant	dry	2	no	normal	soil	3.5	walk	more than 4	5		never	no	never	never	sometimes	sometimes
19	Yes	boxer	M	12	yes	30	exuberant	dry	1	no	fast	rised	2.5	walk	4	2	3 h later	never	yes	occasional-ly	never	sometimes	sometimes
20	Yes	german shepherd	F	11	yes	33	balanced	dry	1	no	normal	soil	2.5	living outside				never	no	never	never	yes	yes

21	Yes	boxer	M	5	no	34	exuberant	homemade	1	no	voracious	soil	2	run	4	2	2 h before, 2 h later	never	no	weekly	never	sometimes	no
22	Yes	german shepherd	M	2	yes	38	exuberant	dry	2	no	fast	soil	2.5	walk	3	1	half an h later	regulary	no	never	never	sometimes	no
23	Yes	german shepherd	M	8	no	40	exuberant	dry	3	no	fast	soil	2.5	run	3			never	no	occasionally	occasionally	yes	yes
24	Yes	curzar	M	8	no	25	exuberant	dry miostened	1	no	voracious	soil	2.5	run		4	1 h later	occasionally	no	occasionally	occasionally	yes	yes
25	Yes	chow chow	M	8	no	28	timid	homemade	1	no	slow	soil	2	nothing				never	no	never	never	yes	no
26	Yes	brie shepherd	M	8	yes	40	timid	dry miostened	2	no	fast	soil	3.5	walk	1	2	5 h before, 6 h later	never	no	never	never	yes	no
27	Yes	german shepherd	M	13	yes	40	timid	homemade	2	no	normal	soil	2.5	walk	2	3		never	no	weekly	occasionally	yes	yes
28	Yes	german shepherd	F	7	yes	40	balanced	homemade	1	no	normal	soil	2.5	run	more than 4		1 h before, 1 h later	never	no	occasionally	occasionally	sometimes	no
29	Yes	german shepherd	M	11	no	40	balanced	dry	2	no	voracious	soil	2.5	living outside				never	no	occasionally	occasionally	yes	no
30	Yes	samoiedo	F	15	yes	30	balanced	homemade	2	no	fast	soil	2.5	walk		1	few minutes	occasionally	no	occasionally	occasionally	no	no

31	Yes	ger-man shep-herd	F	6	no	33	ag-gress ive	dry	1	no	vora-cious	soil	2	living out-side	2		nev-er		nev-er	no	nev-er	some times
32	Yes	Shitz u	F	16	yes	6	bal-ance d	home made	1	yes	vora-cious	soil	3.5	walk	2	0.5	6 h be-fore, 4 h later	nev-er	no	week ly	occa-siona lly	no
33	Yes	ger-man shep-herd	F	11	no	38	bal-ance d	dry	1	no	nor-mal	soil	2.5	run	4	2	few minu tes	occa-siona lly	yes	nev-er	nev-er	yes
34	Yes	great dane	M	3	no	60	timid	dry mios-tene d	2	no	vora-cious	soil	2.5	living out-side				nev-er	no	week ly	occa-siona lly	yes
35	Yes	irish set-ter	M	8	no	30	bal-ance d	dry	1	no	vora-cious	soil	2	walk	3	5	8 h later	regu-lary	no	week ly	occa-siona lly	yes
36	Yes	grif-fin	M	14	yes	3	exu-bera nt	dry mios-tene d	2	yes	vora-cious	soil	2	walk	1		1	nev-er	no	occa-siona lly	occa-siona lly	no
37	Yes	ger-man shep-herd	M	8	yes	40	ag-gress ive	ca-salin go	1	no	vora-cious	soil	2.5	living out-side				nev-er	no	week ly	nev-er	no
38	Yes	great dane	M	7	yes	65	bal-ance d	dry	2	no	fast	soil	2.5	noth-ing				occa-siona lly	yes	occa-siona lly	occa-siona lly	some times
39	Yes	dobe rman n	M	6	yes	45	bal-ance d	dry mios-tene d	1	no	vora-cious	soil	3.5	living out-side				nev-er	no	occa-siona lly	occa-siona lly	yes

40	Yes	sharpei	F	11	yes	18	bal-anced	home-made	1	yes	slow	soil	2.5	walk	3	2		occa-sionally	no	never	never	no	yes	no
41	Yes	marem-ma sheep-dog	F	6	yes	37	exuber-ant	dry mios-tened	1	no	slow	soil	2.5	walk	more than 4		2 h later	never	no	occa-sionally	never	yes	no	yes
42	Yes	collie	M	10	no	25	bal-anced	home-made	1	yes	normal	soil	2.5	living outside				never	no	occa-sionally	occa-sionally	no	yes	yes
43	Yes	cross breed	M	2	no	40	bal-anced	dry	2	no	normal	soil	2.5	run		1		occa-sionally	no	occa-sionally	occa-sionally	yes	no	yes
44	Yes	german shep-herd	M	5	yes	40	bal-anced	dry mios-tened	1	no	fast	soil	2.5	walk	1	0.5		never	no	occa-sionally	occa-sionally	some-times	no	no
45	Yes	german shep-herd	M	7	no	37	timid	home-made	1	no	fast	soil	2.5	walk	1	2	1 h before, 1 h later	occa-sionally	no	occa-sionally	occa-sionally	some-times	no	no
46	Yes	german shep-herd	M	7	no	40	bal-anced	home-made	1	no	vora-cious	soil	2	walk	1			never	yes	occa-sionally	occa-sionally	some-times	yes	no
47	Yes	great dane	F	5	no	50	timid	dry	2	no	fast	soil	2	living outside				never	no	occa-sionally	never	yes	yes	yes
48	Yes	german shep-herd	F	8	yes	29	exuber-ant	dry	1	no	vora-cious	soil	2.5	living outside				never	no	occa-sionally	occa-sionally	yes	yes	yes
49	Yes	bernese moun-tain dog	F	3	yes	48	bal-anced	dry	2	no	vora-cious	soil	2.5	run	1	1	1-2 h before	never	no	occa-sionally	occa-sionally	some-times	some-times	some-times
50	Yes	german shep-herd	F	5	no	32	timid	home-made	1	yes	slow	soil	2.5	run				never	no	occa-sionally	never	some-times	some-times	some-times
51	Yes	german shep-herd	M	7	no	45	exuber-ant	home-made	2	yes	vora-cious	soil	2.5	run				never	no	never	never	some-times	some-times	some-times
52	Yes	napoli-tan mastiff	M	8	no	62	aggres-sive	home-made	1	yes	slow	soil	2.5	living outside				never	no	occa-sionally	never	yes	no	no
53	Yes	german shep-herd	M	7	yes	38	bal-anced	dry mios-tened	2	no	vora-cious	soil	2.5	walk	2		3 h later	never	no	occa-sionally	never	some-times	no	no
54	Yes	german shep-herd	M	9	yes	40	bal-anced	dry	1	no	normal	soil	2	walk	1	1		never	yes	never	never	some-times	no	no
55	Yes	dober-mann	M	6	yes	32	bal-anced	dry	2	no	slow	soil	2.5	walk	3	1		never	no	occa-sionally	never	some-times	no	no
56	Yes	cross breed	M	7	no	45	bal-anced	dry	1	no	fast	soil	2.5	living outside				never	no	occa-sionally	never	some-times	no	no
57	Yes	german shep-herd	M	10	no	33	exuber-ant	dry mios-tened	1	no	vora-cious	soil	2.5	living outside				never	no	weekly	never	some-times	no	no
58	Yes	boxer	M	12	yes	35	exuber-ant	home-made	1	no	fast	rised	2.5	walk		0.5	6 h before, 6 h later	regulary	no	occa-sionally	never	some-times	some-times	some-times
59	Yes	bobtail	M	11	no	40	timid	home-made	2	no	vora-cious	soil	2	run	3	4	4-5 h before	never	no	occa-sionally	never	some-times	no	no

60	Yes	boxer	M	7	yes	20	exuberant	homemade	1	no	voracious	soil	2.5	run	more than 4			never	no	occasionally	never	yes	no
61	Yes	english setter	M	13	yes	25	exuberant	dry miostened	1	yes	normal	soil	1.5	run	more than 4			occasionally	no	occasionally	occasionally	yes	yes
62	Yes	german shepherd	F	10	yes	27	exuberant	dry miostened	1	yes	slow	soil	2.5	living outside				never	no	never	never	yes	no
63	Yes	akita inu	M	9	yes	30	timid	wet	1	no	slow	soil	2.5	living outside				occasionally	no	occasionally	occasionally	yes	no
64	Yes	rhodesian ridgback	M	9	no	40	balanced	homemade	1	yes	slow	soil	2.5	nothing				never	no	occasionally	occasionally	yes	no
65	Yes	terranova	F	11	no	52	balanced	dry	2	yes	slow	soil	2.5	walk	1	3	3 h before	never	no	never	never	yes	yes
66	Yes	samoiedo	M	9	yes	35	balanced	dry miostened	1	no	voracious	soil	2	walk	3	2	1 h and a half later	occasionally	no	occasionally	occasionally	sometimes	no
67	Yes	chow chow	F	2	no	25	aggressive	homemade	1	yes	normal	soil	2.5	walk	2	1		never	no	never	never	no	no
68	Yes	boxer	M	1	no	35	aggressive	dry miostened	1	yes	fast	soil	4.5	nothing				never	no	never	never	no	no
69	Yes	napolitan mastiff	M	10	no	50	balanced	dry miostened	1	yes	normal	soil	2.5	run	2	1		occasionally	no	never	occasionally	sometimes	sometimes
70	Yes	italian hound	M	4	yes	18	balanced	dry miostened	1	yes	voracious	soil	2	nothing				never	no	never	occasionally	sometimes	sometimes
71	Yes	german shepherd	M	9	no	30	balanced	homemade	1	yes	fast	soil	3.5	nothing				never	no	never	never	no	no
72	Yes	schnauzer	M	6	no	40	timid	homemade	1	yes	normal	soil	2.5	walk		2	2 h bfore	regulary	no	occasionally	never	sometimes	sometimes
73	Yes	german shepherd	M	2	no	40	balanced	homemade	2	no	normal	rised	2.5	walk	2	3		regulary	no	never	never	yes	no
74	Yes	dobermann	M	8	yes	38	balanced	homemade	2	no	voracious	rised	2.5	living outside				never	rarely	never	never	no	no
75	Yes	cross breed	F	9	no	20	balanced	dry	1	no	fast	soil	1.5	living outside				occasionally	rarely	never	occasionally	sometimes	no
76	Yes	great dane	M	3	no	70	timid	dry	2	yes	slow	soil	2.5	walk		2		never	yes	occasionally	never	yes	no
77	Yes	saint bernard	M	6.5	no	70	balanced	dry	1	yes	voracoius	rised	3.5	walk	2	1		occasionally	no	never	never	yes	yes
78	Yes	great dane	M	7	no	70	balanced	dry	1	yes	voracious	soil	3.5	walk		2	3 h later	never	no	occasionally	occasionally	yes	no
79	Yes	german shepherd	M	5	no	42	exuberant	dry	2	yes	slow	rised	2.5	run	1	4	2 h be-fore, 2 h later	never	no	never	never	no	no

81	Yes	greyhound	F	10	no	30	timid	homemade	2	no	voracious	soil	2.5	run	more than 4	4		never	no	never	never	no	no	
82	Yes	dobermann	F	8	no	30	balanced	homemade	1	no	voracious	soil	2.5	walk	4	2	mezz'ora prima	never	no	weekly	occasionally	no	no	
83	Yes	brie shepherd	M	4	yes	40	balanced	dry	2	yes	slow	soil	2.5	living out-side				never	no	never	never	yes	no	
84	Yes	alaskan malamute	M	11	no	40	balanced	dry miostened	1	no	slow	soil	2	walk	3	2		regulary	no	occasionally	occasionally	some-times	yes	
85	Yes	terranova	M	9	no	60	balanced	dry	1	yes	normal	soil	2.5	walk	more than 4			never	no	occasionally	occasionally	some-times	no	
86	Yes	rottweiller	F	5	yes	40	balanced	homemade	2	no	fast	soil	2.5	living out-side				never	no	occasionally	never	some-times	yes	
87	Yes	cane corso	M	6	no	60	balanced	dry	1	yes	normal	soil	2	run	more than 4	4	half a h be-fore, 4 h later	regulary	no	occasionally	occasionally	yes	yes	
88	Yes	cross breed	M	6	no	30	balanced	dry	2	no	voracious	soil	2.5	run	more than 4	2		never	no	occasionally	occasionally	some-times	some-times	
89	Yes	boxer	F	7	no	20	timid	dry miostened	1	no	voracious	soil	2.5	walk				never	no	occasionally	never	no	no	
90	Yes	cross breed	M	12	yes	44	balanced	homemade	1	yes	normal	soil	2.5	run				regulary	no	never	never	some-times	no	
91	Yes	dobermann	F	7	no	30	balanced	dry	2	no	normal	rised	2	walk	1	1	3 h before	occasional-ly	no	occasionally	weekly	yes	no	
92	Yes	german shepherd	F	13	yes	26	timid	homemade	1	no	voracious	soil	2.5	walk	more than 4	3		never	no	occasionally	never	no	no	gdv last year, no surgery
93	Yes	great dane	M	9	no	75	balanced	dry miostened	3	no	normal	soil	2.5	living out-side				occasional-ly	no	never	never	yes	yes	
94	Yes	german shepherd	F	3	yes	44	aggressive	homemade	2	no	voracious	soil	2.5	run	more than 4			never	no	never	never	some-times	some-times	
95	Yes	cross breed	F	7	yes	26	exuberant	homemade	1	yes	voracious	soil	2	living out-side				regulary	no	never	never	some-times	some-times	
96	Yes	dobermann	M	10	no	35	balanced	homemade	2	no	normal	rised	2.5	living out-side				never	no	occasionally	occasionally	some-times	some-times	
97	Yes	german shepherd	M	5	no	40	exuberant	homemade	2	no	voracious	soil	2.5	walk	2	2	1 h later	occasional-ly	no	never	never	yes	yes	gdv 2 years later, no vet treatment
98	Yes	chow chow	M	11	no	30	balanced	dry miostened	2	no	voracious	soil	2.5	walk	1	0.5		never	no	occasionally	occasionally	some-times	no	
99	Yes	chow chow	M	13	no	30	aggressive	homemade	1	no	voracious	soil	2.5	run	more than 4	4	12 h later	occasional-ly	yes	occasionally	occasionally	some-times	some-times	
100	Yes	german shepherd	F	11	no	33	balanced	dry miostened	1	no	voracious	soil	2.5	run	3	3	1 h before, 4 h later	never	no	never	never	no	no	

101	Yes	great dane	F	4	no	50	timid	dry miostened	3	no	fast	soil	1.5	living out-side				never	no	occasionally	occasionally	yes	yes	
102	Yes	cane corso	M	7	no	40	balanced	dry	2	yes	normal	soil	3.5	walk	more than 4	1	1 h before, 1 h later	never	no	occasionally	never	yes	yes	
103	Yes	dachshund	F	12	no	10	aggressive	homemade	1	no	voracious	soil	2	walk	4		half a h before, half a h later	never	no	occasionally	never	no	no	
104	Yes	german shep-herd	M	11	no	35	balanced	homemade	1	yes	slow	soil	2.5	walk	more than 4	2		never	no	occasionally	never	sometimes	sometimes	
105	Yes	german shep-herd	M	12	no	35	aggressive	dry miostened	1	yes	voracious	soil	2.5	walk	1			never	no	occasionally	occasionally	sometimes	no	
106	Yes	bavarian hound	F	8	yes	20	aggressive	dry	2	no	voracious	soil	2.5	living out-side				never	no	never	occasionally	sometimes	no	
107	Yes	maremma sheep-dog	M	8	no	55	balanced	dry	2	yes	slow	soil	2.5	walk	3	3	1 h before	never	no	occasionally	occasionally	yes	no	
108	Yes	leonberger	M	9	no	70	balanced	homemade	2	no	fast	soil	2.5	run	1	1	2 h later	occasional-ly	yes	never	occasionally	yes	yes	
109	Yes	german shep-herd	M	6	no	40	timid	dry	2	no	normal	soil	3.5	walk	1	1	2 h before, 2 h later	never	no	occasionally	never	no	no	
110	Yes	italian hound	F	13	no	30	timid	homemade	1	yes	voracious	soil	2	walk	1	1	3 h later	never	no	never	never	sometimes	sometimes	
111	Yes	dobermann	M	8	no	30	exuberant	dry miostened	3	no	fast	soil	2.5	run	2	1	2 h before	never	no	occasionally	occasionally	sometimes	no	
112	Yes	great dane	M	2	no	70	timid	dry miostened	2	no	normal	soil	2	nothing				never	no	never	never	no	no	
113	Yes	dalmatian	M	5	no	20	balanced	dry miostened	2	no	voracious	soil	1.5	living out-side				never	no	occasionally	never	yes	yes	
114	Yes	german shep-herd	F	7	yes	35	timid	dry	1	no	voracious	soil	2.5	living out-side				never	no	never	never	no	no	
115	Yes	great dane	F	7	no	75	balanced	dry	3	no	slow	rised	2.5	living out-side				never	no	never	never	yes	no	
116	No	bernese moun-tain dog	M	2	no	45	balanced	dry	3	no	normal	rised	2.5	nothing				occasional-ly	no	never	occasionally	sometimes	no	
117	No	bernese moun-tain dog	M	4	yes	50	exuberant	dry	2	no	normal	soil	2.5	living out-side				occasional-ly	no	occasionally	occasionally	sometimes	no	
118	No	bernese moun-tain dog	M	3	yes	44	balanced	dry	2	no	normal	soil	3.5	walk	1	2	1 h before, 1 h later	occasional-ly	no	never	never	sometimes	sometimes	
119	No	bernese moun-tain dog	M	7	yes	45	balanced	dry	2	no	normal	soil	2.5	walk	2	1.5	1 h before	occasional-ly	no	never	never	no	no	grandma died for gdv

120	No	bernese mountain dog	M	1.5	no	40	balanced	dry miostened	3	no	normal	soil	2.5	run	more than 4			never	no	never	never	sometimes	sometimes
121	No	bernese mountain dog	M	4	no	52	balanced	dry	2	no	slow	rised	2.5	walk	more than 4	4	1 h before, 1 h later	occasionally	no	occasionally	occasionally	yes	yes
122	No	bernese mountain dog	F	7	yes	45	balanced	dry miostened	2	no	normal	soil	3.5	walk	1	1	3 h before	never	no	never	never	no	no
123	No	bernese mountain dog	F	7	yes	38	balanced	dry miostened	2	no	normal	soil	2.5	walk	1	1		occasionally	no	occasionally	never	no	no
124	No	bernese mountain dog	F	1	no	35	balanced	dry miostened	3	no	normal	soil	2.5	run	more than 4			never	no	never	never	sometimes	sometimes
125	No	bernese mountain dog	F	1.5	no	36	balanced	dry	2	no	normal	soil	2.5	walk	2	2	2 h before, 2 h later	occasionally	no	never	never	sometimes	sometimes
126	No	bernese mountain dog	F	3	no	36	balanced	dry miostened	2	no	normal	soil	2.5	walk	2	1	3 h before, 3 h later	occasionally	no	never	never	sometimes	sometimes
127	No	bernese mountain dog	F	2	no	41	balanced	dry miostened	2	no	fast	rised	2.5	walk	2	2	2 h before, 2 h later	occasionally	no	occasionally	occasionally	sometimes	sometimes
128	No	bernese mountain dog	F	3	no	50	exuberant	homemade	1	yes	normal	soil	2.5	walk		1	6 h before	never	yes	occasionally	occasionally	yes	yes
129	No	bernese mountain dog	F	1.5	yes	35	balanced	dry	3	no	normal	soil	2.5	walk	2	1	1 h before	never	no	occasionally	occasionally	sometimes	sometimes
130	No	argentine dogo	F	8	yes	50	balanced	homemade	2	no	normal	soil	2.5	walk	3	3	3 h before	occasionally	yes	never	never	no	no
131	No	great dane	M	8	no	60	exuberant	dry	2	yes	normal	rised	2.5	run	1		2 h later	occasionally	no	never	never	sometimes	sometimes
132	No	irish setter	F	8	no	20	balanced	dry	1	no	normal	soil	2.5	living outside				occasionally	yes	never	never	sometimes	sometimes
133	No	cross breed	F	1	no	25	exuberant	dry	2	no	normal	soil	2.5	run	1	2	3 h before	never	no	never	occasionally	sometimes	sometimes
134	No	boxer	M	4	no	36	balanced	dry	2	no	normal	soil	2.5	walk	3	1	half a h later	regulary	yes	occasionally	occasionally	sometimes	sometimes
135	No	akita inu	F	9	yes	40	balanced	dry	2	no	voracious	soil	2.5	walk	1	0.5	1 h later	occasionally	no	occasionally	occasionally	yes	yes
136	No	great dane	F	4	no	50	timid	dry	1	no	normal	soil	2.5	living outside				never	no	never	never	no	no
137	No	german shepherd	M	2	no	34	balanced	dry miostened	2	no	fast	soil	2.5	nothing				never	no	never	never	yes	yes
138	No	cross breed	F	10	yes	45	timid	dry miostened	1	no	normal	soil	2.5	walk	more than 4	2	suddenly after the meal	never	no	occasionally	never	sometimes	sometimes
139	No	german shepherd	F	8	yes	34	timid	dry miostened	1	no	fast	soil	3.5	living outside				occasionally	no	never	never	sometimes	no
140	No	rottweiler	M	2	no	46	balanced	homemade	1	yes	fast	rised	2.5	living outside			2 h later	never	no	occasionally	occasionally	sometimes	no

141	No	french bulldog	M	7	yes	12	balanced	homemade	1	no	normal	soil	2.5	living outside	1	0.5		regulary	no	occasional-ly	occasional-ly	yes	no
142	No	border collie	M	9	no	27	exuber-ant	dry mios-tened	2	yes	slow	soil	2.5	run	more than 4			never	no	occasional-ly	occasional-ly	some-times	no
143	No	boxer	M	1,5	no	25	exuber-ant	dry	2	no	slow	soil	2	walk	2	3	2 h later	never	no	never	occasional-ly	some-times	no
144	No	alaskan malamut	M	11	yes	55	balanced	dry	1	no	normal	soil	3.5	walk	1	0.5	5 h later	occasional-ly	no	occasional-ly	occasional-ly	some-times	no
145	No	greyhound	F	8	yes	20	balanced	dry	1	no	slow	soil	2.5	living outside				never	no	never	never	some-times	no
146	No	cross breed	M	8	yes	30	balanced	dry	1	no	normal	rised	2.5	living outside				never	no	never	never	no	no
147	No	rottweiler	M	11	no	60	balanced	dry	1	no	normal	soil	3.5	living outside				never	no	never	never	some-times	no
148	No	golden retriver	F	6	no	35	exuber-ant	dry	2	no	normal	soil	3.5	walk	1	1	2 h later	never	no	never	occasional-ly	some-times	no
149	No	alaskan malamut	M	3	no	39	aggres-sive	homemade	2	no	fast	soil	2.5	living outside				never	no	occasional-ly	never	yes	no
150	No	french bulldog	M	4	no	15	balanced	dry	2	no	fast	soil	2.5	walk	1	1	5 h later	never	no	occasional-ly	never	some-times	no
151	No	cross breed	M	10	yes	12	balanced	dry	2	yes	fast	soil	2.5	walk	1	0.5	3 h later	never	no	occasional-ly	never	some-times	no
152	No	dwarf dachshund	M	6	no	6,5	balanced	dry	1	yes	normal	soil	2.5	walk	1	1	1 h later	occasional-ly	no	occasional-ly	never	no	no
153	No	border collie	F	4	yes	25	exuber-ant	dry	2	no	normal	soil	2.5	living outside	1			never	no	occasional-ly	never	yes	no
154	No	beagle	M	11	no	23	balanced	dry	2	no	fast	soil	2.5	walk	4	0.25	half a h later	never	no	never	never	some-times	no
155	No	terranova	F	14	yes	40	balanced	homemade	1	no	vora-cious	soil	2.5	living outside				never	no	never	never	no	no
156	No	dobermann	M	13	no	55	balanced	homemade	1	no	vora-cious	soil	2.5	living outside				occasional-ly	no	never	never	no	no
157	No	maremma sheep-dog	M	14	no	65	balanced	homemade	1	no	slow	soil	2.5	living outside				occasional-ly	no	never	never	no	no
158	No	rottweiler	F	13	yes	40	balanced	homemade	1	no	fast	soil	2.5	living outside				occasional-ly	no	never	never	no	no
159	No	great dane	F	7	yes	65	balanced	dry	3	no	normal	soil	2.5	living outside	3			regulary	no	never	occasional-ly	no	no
160	No	great dane	M	5	no	70	balanced	dry	2	no	normal	soil	2.5	living outside	3			regulary	no	never	occasional-ly	no	no

161	No	cane corso	F	5	yes	65	aggressive	homemade	1	no	fast	soil	2.5	living outside				never	no	never	never	no	no
162	No	maremma sheep-dog	F	15	yes	50	balanced	homemade	1	no	normal	soil	2.5	living outside				never	no	never	never	no	no
163	No	beagle	M	8	no	20	balanced	dry	2	no	fast	soil	2.5	walk	1	2	2 h later	never	no	occasional-ly	occasional-ly	yes	no
164	No	golden retriver	F	8	yes	27	balanced	dry	2	no	normal	soil	2.5	walk	1	1	6 h later	never	no	never	never	no	no
165	No	cane corso	M	13	yes	37	balanced	dry	1	no	normal	soil	2.5	living outside				never	no	never	never	yes	no
166	No	cross breed	M	10	no	13	balanced	dry	1	yes	normal	soil	2.5	walk	2	0.5	suddenly after the meal	regulary	no	occasional-ly	occasional-ly	sometimes	some-times
167	No	border collie	F	12	yes	25	balanced	dry	1	no	normal	soil	2.5	walk	2	2	suddenly after the meal	occasional-ly	no	never	occasional-ly	sometimes	no
168	No	cross breed	F	13	yes	21	esuber-anteex	wet	1	no	vora-cious	soil	2.5	living outside	1	0.5	1 h before	regulary	no	never	never	sometimes	no
169	No	dobermann	M	2	no	57	timid	dry	2	no	normal	soil	2.5	living outside	2	0.5	2 h later	never	no	never	never	sometimes	no
170	No	bernese mountain dog	F	2	no	40	balanced	dry mios-tened	2	no	normal	soil	2.5	nothing				never	no	never	never	no	no
171	No	bernese mountain dog	F	1	no	40	balanced	dry mios-tened	2	no	normal	soil	2.5	walk	1	3	1 h before, 1 h later	occasional-ly	no	never	never	sometimes	no
172	No	bernese mountain dog	M	4	yes	50	balanced	dry	2	yes	slow	soil	2	walk	2	1	1 h before	occasional-ly	no	occasional-ly	occasional-ly	sometimes	no
173	No	bernese mountain dog	M	4	yes	40	balanced	dry	3	no	fast	soil	2.5	walk	1	3	2 h before, 2 h later	occasional-ly	no	never	never	sometimes	no
174	No	bernese mountain dog	M	2	no	50	balanced	dry mios-tened	3	no	normal	soil	2.5	walk	1	1	2 h later	occasional-ly	no	never	occasional-ly	no	no
175	No	bernese mountain dog	M	2	no	55	balanced	dry	3	yes	normal	soil	2.5	walk	1	1	2 h before, 2 h later	occasional-ly	no	never	never	sometimes	no
176	No	bernese mountain dog	M	3	yes	40	balanced	dry mios-tened	2	yes	slow	soil	1.5	walk	1	1		occasional-ly	no	occasional-ly	occasional-ly	sometimes	no
177	No	irish setter	F	8	yes	25	balanced	dry	1	yes	normal	soil	2.5	living outside				never	no	never	occasional-ly	no	no
178	No	english setter	F	8	yes	25	balanced	dry	1	yes	normal	soil	2.5	living outside				never	no	never	never	no	no
179	No	cross breed	F	6	no	15	balanced	dry	2	no	normal	soil	2.5	living outside	1	1	2 h later	occasional-ly	no	never	never	no	no
180	No	german shepherd	F	7	yes	43	balanced	dry	1	no	fast	soil	2.5	living outside				never	no	never	never	no	no

181	No	german shepherd	M	5	no	52	esuberanteex	dry	1	no	fast	soil	2.5	living outside			never	no	never	sometimes	no
182	No	golden retriver	M	1	no	32	balanced	dry	3	no	normal	soil	2.5	run	4	4	2 h later	regulary	never	sometimes	no
183	No	great dane	F	7	yes	60	balanced	dry	2	no	fast	rised	2.5	living outside	1	1	3 h later	never	occasionally	sometimes	no
184	No	czechoslovakian wolf	M	5	no	36	aggressive	dry mios-tened	1	no	fast	soil	2.5	living outside	2	2	2 h before	occasionally	occasionally	occasionally	no
185	No	labrador retriver	M	7	no	35	balanced	dry	2	no	fast	rised	3.5	walk	2	1	1 h before	never	occasionally	occasionally	no
186	No	german shepherd	F	8	yes	34	timid	dry mios-tened	1	no	fast	soil	3.5	living outside				occasionally	never	sometimes	no
187	No	leonberger	M	8	no	60	balanced	dry mios-tened	1	yes	slow	soil	2.5	living outside				occasionally	never	occasionally	no
188	No	cross breed	M	0.5	no	17	balanced	miscella-neous	2	no	slow	soil	2.5	walk	2	1	4 h later	never	never	no	no
189	No	german shepherd	M	9	no	33	balanced	dry	1	no	normal	soil	2.5	living outside	2		4 h later	occasionally	never	never	no
190	No	cross breed	M	2	no	11	balanced	dry	2	yes	normal	soil	2.5	living outside	3	2	3 h later	never	never	never	no
191	No	hound	M	3	no	23	timid	dry	2	yes	slow	soil	2.5	living outside	2	3	1 h before, 1 h later	never	never	occasionally	no
192	No	czechoslovakian wolf	F	1	no	23	exuberant	dry	3	no	fast	soil	2.5	walk	3	3	1 h later	occasionally	yes	weekly	occasionally	no	yes
193	No	english setter	M	1,5	no	22	exuberant	dry	2	no	voracious	soil	2.5	living outside				never	no	never	never	no	yes
194	No	pittbull	M	4	no	30	timid	dry	2	no	voracious	soil	2.5	living outside				never	no	never	occasionally	sometimes	no
195	No	german shepherd	M	0.58	no	28	balanced	dry	2	no	normal	soil	2.5	living outside				never	no	occasionally	never	yes	no
196	No	german shepherd	F	0.5	yes	18	exuberant	dry	2	no	fast	soil	2.5	living outside				never	no	never	occasionally	no	no
197	No	sharpei	M	15	no	18	aggressive	dry	1	yes	voracious	soil	2.5	walk	1	0.5	8 h before	never	no	never	never	no	no
198	No	labrador retriver	F	7	yes	28	balanced	dry	3	no	normal	soil	2.5	nothing				never	no	never	never	yes	no
199	No	husky	M	15	no	23	balanced	wet	1	yes	slow	soil	2.5	walk	3	2	2 h before	occasionally	no	never	never	no	no
200	No	weimaraner	M	1	no	26	exuberant	wet	2	no	voracious	soil	2.5	walk	4	0.25	2 h before	never	no	occasionally	occasionally	yes	yes

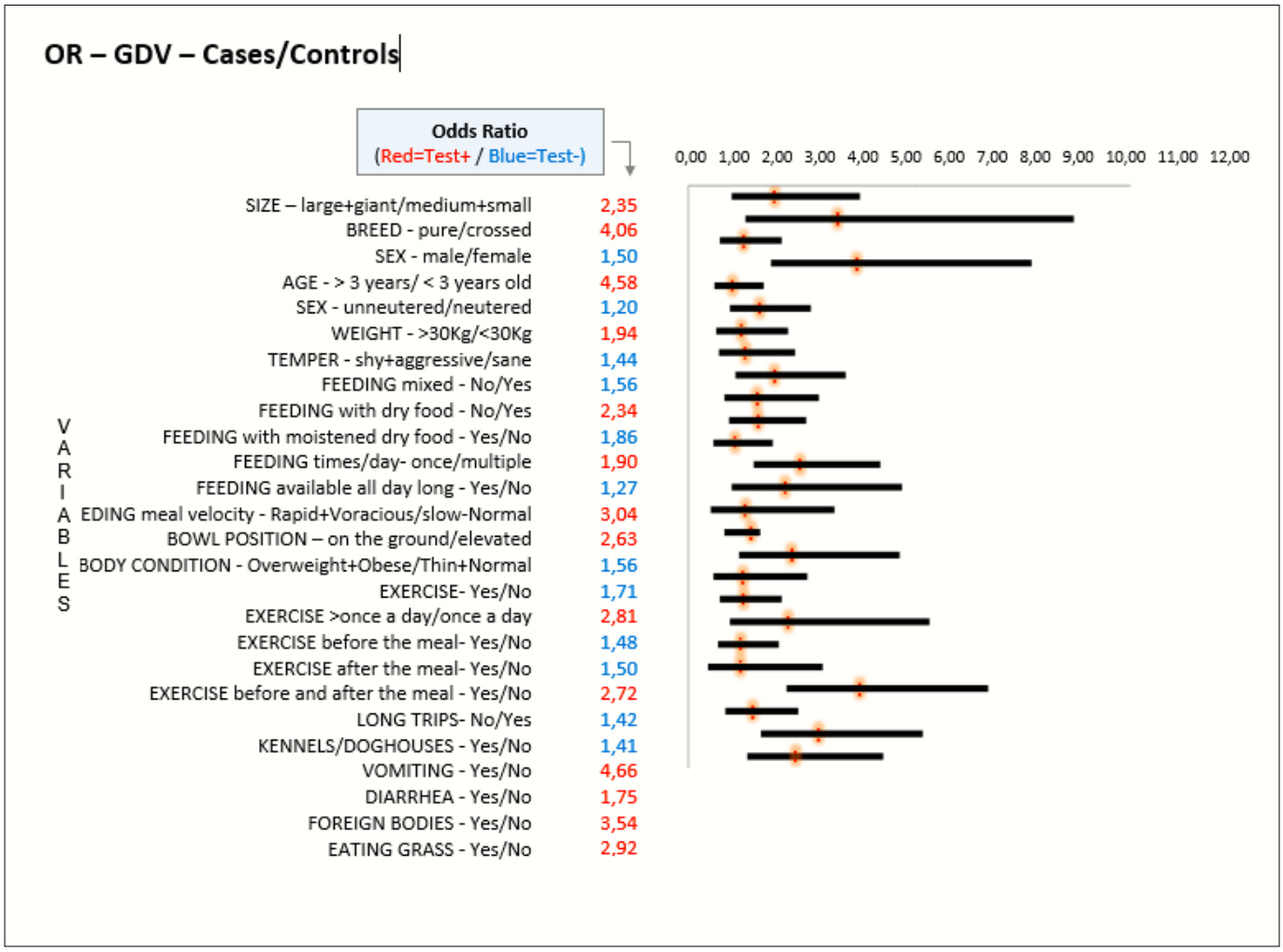
201	No	beagle	F	10	yes	14	timid	dry	2	no	fast	soil	2.5	living outside	1	1	3 h before	occasionally	no	occa-sionally	never	sometimes	some times
202	No	german shepherd	F	7	yes	32	balanced	homemade	1	no	fast	soil	2.5	walk	2	2	2 h later	never	no	never	never	no	some times
203	No	hound	M	6	no	17	timid	dry	1	no	normal	soil	2.5	living outside	2	1	1 h before, 2 h later	never	no	occa-sionally	occa-sionally	sometimes	no
204	No	dalmatian	F	9	no	20	exuberant	dry	3	no	slow	soil	2.5	living outside	2	1	2 h before, 2 h later	never	no	never	never	no	no
205	No	dalmatian	M	9	no	29	exuberant	dry	3	no	slow	soil	2.5	living outside	2	1	2 h before, 2 h later	never	no	never	never	no	no
206	No	husky	F	1	no	20	balanced	dry	1	yes	slow	soil	2.5	living outside	1	0.5	2 h before	never	no	never	never	sometimes	no
207	No	husky	M	1	no	27	balanced	dry	1	yes	voracious	rised	2.5	living outside	1	0.5	2 h before	never	no	never	never	no	no
208	No	husky	F	2	no	21	balanced	dry	1	yes	normal	rised	2.5	living outside	1	0.5	2 h before	never	yes	never	never	no	no
209	No	husky	M	2	no	27	balanced	dry	1	yes	normal	rised	2.5	living outside	1	0.5	2 h before	never	yes	never	never	no	no
210	No	german shepherd	M	6	no	40	balanced	dry	1	yes	normal	rised	2.5	living outside	1	0.5	2 h before	never	yes	never	never	no	no
211	No	border collie	M	4	no	25	balanced	dry	1	yes	normal	rised	2.5	living outside	1	0.5	2 h before	occasionally	no	never	never	no	no
212	No	spinone cross	M	2	no	35	balanced	dry	1	yes	voracious	rised	2.5	living outside	1	0.5	2 h before	never	no	never	never	no	no
213	No	german shepherd	F	10	no	30	balanced	dry	1	yes	normal	rised	2.5	living outside	1	0.5	2 h before	never	no	never	never	yes	no
214	No	pittbull	F	1	no	25	balanced	dry	1	yes	normal	rised	2.5	living outside	1	0.5	2 h before	never	no	never	never	no	no
215	No	boxer	F	9	no	30	balanced	dry	2	no	fast	soil	2.5	living outside	4	0.5	1 h later	occasionally	no	never	occa-sionally	sometimes	some times
216	No	labrador cross	M	8	yes	30	exuberant	homemade	2	no	normal	soil	2.5	living outside				never	no	never	never	sometimes	no
217	No	afghan greyhound	M	12	yes	30	balanced	dry	2	no	normal	soil	2.5	walk	2	0.5		never	no	never	never	no	no

218	No	afghan greyhound	F	2	yes	15	timid	home-made	2	no	normal	rised	1.5	living outside				never	no	never	never	no	no
219	No	afghan greyhound	M	10	yes	30	exuberant	home-made	2	no	normal	rised	2.5	living outside				never	no	never	never	no	no
220	No	afghan greyhound	M	9	yes	30	balanced	wet	2	no	fast	rised	2.5	living outside	2	0.5		never	no	never	never	no	no
221	No	malinois cross	M	1	yes	24	balanced	dry	2	no	normal	rised	2.5	living outside				never	no	never	never	no	sometimes	no
222	No	labrador cross	M	5	yes	30	balanced	dry	2	no	normal	rised	2.5	living outside				never	no	never	never	no	sometimes	no
223	No	australian shep-herd	M	2	no	35	balanced	home-made	2	yes	fast	soil	2.5	living outside			2 h later	never	no	never	never	no	no	no
224	No	labrador retriver	M	1	no	30	balanced	dry	3	no	slow	rised	2.5	walk	4	2	1 h later	never	no	never	never	no	sometimes	no
225	No	german shepherd	F	3	yes	42	timid	dry	1	no	fast	soil	2.5	nothing				never	no	never	never	no	no	no
226	No	weimaraner	F	4	no	30	timid	dry	2	no	vora-cious	soil	2.5	living outside				never	no	never	never	no	sometimes	no
227	No	german shepherd	M	4	no	40	balanced	dry	2	no	normal	soil	2.5	living outside				never	no	occa-sional ly	never	no	sometimes	no
228	No	german shepherd	F	10	no	35	timid	home-made	2	no	fast	soil	2.5	walk	1	2	3 h before	never	no	occa-sional ly	occa-sional ly	yes	no
229	No	boxer	M	10	yes	35	balanced	dry	2	no	normal	soil	2.5	walk	1	1	3 h later	never	no	occa-sional ly	occa-sional ly	sometimes	no
230	No	boxer	F	5	yes	30	balanced	home-made	2	no	normal	rised	2.5	walk	1	2	2 h later	never	no	never	never	no	no

Table 2. Dogs, feeding and physical activity caracteristics. The relationship between different carecteristics and statistic values: OR, OR MIN, OR MAX, ES and P Value

Variabile	GDV 115/230	CONTROL 115/230	TOT CASES 230	TOT CONTROLS 115/230	OR	OR MIN	OR MAX	ES	Pvalue
SIZE – large+giant breed, n	100	85	115	115	2,35	1,19	4,66	0,35	0,0200
BREED - pure breed, n	109	94	115	115	4,06	1,57	10,48	0,48	0,0041
SEX - male	76	65	115	115	1,50	0,88	2,56	0,27	0,1758
AGE - > 3 years of age	103	75	115	115	4,58	2,25	9,32	0,36	0,00002
SEX - intact	73	68	115	115	1,20	0,71	2,04	0,27	0,5881
WEIGHT - >30 kg	79	61	115	115	1,94	1,13	3,33	0,27	0,0216
TEMPER – shy oraggressive nature	27	27	82	106	1,44	0,76	2,71	0,32	0,3382
FEEDING only dry or wet food	93	84	115	115	1,56	0,84	2,90	0,31	0,2103
FEEDING with dry food	41	22	115	115	2,34	1,28	4,27	0,30	0,0078
FEEDING moistened dry food	31	19	115	115	1,86	0,98	3,54	0,32	0,0374
FEEDING once daily	62	44	114	114	1,90	1,12	3,21	0,26	0,0240
FEEDING available all day long	32	27	112	113	1,27	0,70	2,31	0,30	0,5183
FEEDING Rap-id+Voraciuous eating	69	38	115	115	3,04	1,77	5,21	0,27	0,0731
BOWL POSITION – on the ground	105	92	115	115	2,63	1,19	5,80	0,40	0,0240
BODY CONDITION – over-weight or obese	12	8	115	115	1,56	0,61	3,97	0,47	0,4827
EXERCISE-	81	67	115	115	1,71	0,99	1,96	0,27	0,0735
EXERCISE >once daily	49	38	66	75	2,81	1,37	5,73	0,36	0,0069
EXERCISE before the meal	26	34	43	67	1,48	0,68	3,23	0,27	0,4222
EXERCISE after the meal	76	65	115	115	1,50	0,88	2,56	0,27	0,1758
EXERCISE before and after the meal	16	12	43	67	2,72	1,13	6,54	0,44	0,0411
NOT USED TO LONG TRIPS	81	72	115	115	1,42	0,82	2,47	0,28	0,2637
USED TO KENNELS/ DOGHOUSES	11	8	115	115	1,41	0,55	3,66	0,48	0,6319
VOMITING	75	33	115	115	4,66	2,67	8,13	0,28	0,0001
DIARRHEA	51	36	115	115	1,75	1,02	3,00	0,27	0,0570
EATING FOREIGN BODIES	54	23	115	115	3,54	1,97	6,36	0,29	0,0277
EATING GRASS	93	68	115	115	2,92	1,61	5,30	0,30	0,0006

Table 3. The relationship between OR, for the different evaluated variables, in GDV cases and control cases



The majority of GDV dogs (76.6%) had a balanced temperament, whereas 23.4% were classified as being shy, aggressive or having an exuberant character.

When considering diet as a variable, 19% of GDV dogs (22/115) consumed a combination of commercial and homemade diet, while the remainder 81% (93/115) were either fed only a commercial diet or a homemade only diet. On the other hand, in the control dog group 26.9% (31/115) of dogs received a combination of commercial and homemade diet. (OR = 1,56, CL 95% = 0,84 – 2,90 and P = 0,2).A total of 230 animals consumed dry food, 64.3% (74/115) GDV dogs and 80.8% (93/115) of control dogs, respectively, and 73. 1 % cases (84/115) and 83.5% controls (96/115)) were fed dry food. Form these data results a positive statistic association between the dry food diet and the developpement of GDV (OR=2,34 CL 95%=1,28-4,77 and P=0,007). Overall, 62/115 (53.91%) GDV dogs were only fed once a day versus 44/115 (38.26%) control dogs. For this epidemiological variable too results a positive statistic association (OR = 1,90 CL 95% = 1, 12 – 3,21 and P = 0,02).

Out of a total of 230 animals, 13,9 % (32 / 230) GDV dogs and 11.7% (27 / 230) controls dogs had access to food throughout the day ad libitum; 69, 5 % (80 / 115) DGV dogs and 74,7 % (86 / 115) had not access to food throughout the day and ad libitum. Statistic analysis of these data did not show a valid and true association between our results and the development of GDV (OR 0 = 1,27 CL 95% = 0, 70 - 2,31 P = 0,5).

The analysis of meal intake rates showed that 40% of GDV dogs (46 / 115) and 66% of control dogs (38 /115) consumed their meal slowly, while 60% of affected cases (69/115) and 34% of controls (38/115) eat the meal quickly or voraciously. This trend would be a positive risk factor for development of GDV. However even if OR = 3,04 and CL 95% = 1,77 – 5,21 the result is not supported by a P Value that defines the statistically valid association (P = 0,07)

About the position of the bowel, the 91,4 % (105/115) of GDV dogs was fed with the bowl on the ground, whereas only the 8, 6 % (10/115). Between controls 80% (92/115) consume the meal with bowl on the ground and 20% (23/115) with raised bowl. Final data (OR= 2,63 95%CL = 1,19 – 5,80 and P = 0,02) define de statistically valid association.

Cases and controls were compared according to two groups of BSC: obese or overweight subjects (group 1) and thin or weight-form subjects (group 2). 10% of cases (12 / 115) were assigned in group 1, while the remaining 90% (103 / 115) was assigend to group 2. In the control sample the 6,9% (115/8) was overweight-obese and 93% (107/115) was thin or weight-form. The result is OR = 3.97, but CL 95% = 0.61-3.97 and P = 0.4 for which there is no statistically valid association.

Noumerous are the data obtained regarding the study as a possible risk factor for GDV. Out of 115 GDV dogs, 70.5% (81/115) performed physical activity during daytime (they are considered dogs that live in the garden and/or are taken on a walk by the owner), versus 50.5% (34/115) of control dogs considered sedentary animals, living in an apartment or at home without having access to the outside or animals that are not regularly walked by the owner. In this case, even if OR = 1.71, CL 95% = 0.99-1.96 and negative Chi square test (P = 0.07), the association is statistically significant.

Among the dogs performing physical activity, 74.2% (49/66)GDV dogs and 50.6% (38/75) control dogs performed physical activity more than once daily. For this variable, OR is calculated equal to 2.81, CL 95% = 1.37-5.73 and P = 0.006 for which the statistical test is valid and there is an evident association between this variable and the GDV.

About physical activity compared to meal timing, we report that 60% of GDV dogs (69/115) did physical activity before the meal and the 40% (46/115) did not before and that 58% (67/115) of control group did activity before meals compared to the 28,6% (33/115) that did not. Our statistical analysis with OR = 1,48 CL 95% = 0,68 – 3,23 and P = 0,04% show that our results are not statistically valid. Regarding potential stress factors, 29.5% of GDV dogs (34/115) and 37.3% (43/115) of control dogs were used to join the owner on long journeys and trips by car. In total, 9.57% of GDV (11/115) dogs and 6.96% of control dogs (8/115) were used to staying in pensions or kennels. With values of

OR=1,41, CL 95%=0,55-3,66 e P=0,6 not event this statistical analysis is significant for developping of GDV. In 65.2% of GDV dogs (72/115) there was a history of frequent vomiting, while only 28.6% of control dogs (33/115) had regular episodes of vomiting (OR= 2,63 95%CL = 1,19 – 5,80 and P = 0,02). Episodes of diarrhea were reported in 44.3% (51/115) of GDV dogs and 31.3% of control dogs (36/115) , respectively (OR=1,75, CL 95%=1,02-3 e P=0,057). Ingestion of foreign was present in 38.2% of GDV dogs (44/115) and in 20% of control dogs (23/115). Finally, 80.8% of GDV dogs (93/115) and 59.1% of control dogs (68/115) were reported to ingest grass or foreign bodies (OR=3,54, CL 95%=1,97-6,36 e P=0,02). Due to these 3 last results listed above as predisposing factors (vomiting, dhiarrea and foreign bodies) and consideting the results we can conclude that all three have a statistical positive significance.

In table1 and 2 statistical analyses of risk factors are summarized. Several predisposing risk factors were identified. There was a significant difference between large/giant dogs and medium/small dogs, with large and giant dogs having 2.35 odds to develop a GDV (OR = 2.35, 95% CL = 1.19-4.66 and P = 0.02).

Purebred dogs are also statistically significantly more likely to develop GDV, with an OR of 4.06. Dogs older than three years of age and dogs over 30 kg are also at increased risk, with OR of 4.58 and 1.94, respectively. Regarding food, a positive statistical association was found between dogs receiving dry food and the development of GDV (OR = 2.34). Dogs that only receive one meal a day, and dogs that consume the meal from a bowl on the floor are at increased risk (OR= 1.90 and 2.63, respectively). There was a trend of fast eating being a risk factors, however this revealed to not be statistically significant. Dogs performing daily activity, dogs that have physical activity several times daily, and dogs that perform physical activity around the meal are at increased risk of developing GDV (OR = 1.71, 2.81, and 2.72, respectively). A strong association was found between dogs having regular episodes of vomiting and GDV and also between dogs having regularly diarrhea and the development of GDV (OR = 4.66 and OR = 1.75, respectively). Ingestion of foreign bodies and ingestion of grass were likewise risk factors for the development of GDV (OR = 3.54 and OR = 2.92, respectively).

Discussion

This case-control study revealed several predisposing risk factors for the development of GDV in this population of dogs which are similar to risk factors previously described. The results support the data from existing literature that there is a significant difference between large/giant breed dogs and medium-small dogs[7, 12, 23] and that the subjects in the first group are more likely to develop GDV (OR = 2.35, 95% CI 1.19 - 4.66 and P = 0.02).

In this study there was little difference between the occurrence of GDV in large or giant breeds. This correlates with other studies which have previously found no significant difference between the incidence of GDV between large and giant breeds. In this study German Shepherd (51dogs/115), Great Dane (14 dogs/115) and Dobermann (8 dogs/115) were the most represented breeds. Other breeds exhibiting disease include: Akita Inu, Bobtail, Boxer, Bernese Mountain Dog, Cane Corso, Chow Chow, Dalmatian, Dogue de Bordeaux, Drahthaar, Greyhound, Leonberger, Neapolitan Mastiff, Shepherd of Brie, Shepherd of Maremma, Rhodesian Ridgeback, Rottweiler, Samoyed, Giant Schnauzer, Bavarian Hound, Italian Hound, Setter Gordon, Irish Setter and Newfoundland.

Purebred dogs are reported to present a significant risk factor for GDV [10,12,23,25]. Compatible with existing literature[21,23], this research also demonstrates purebred dogs have an increased likelihood of developing GDV. A case-control study done by Glickman et al. in 1997 [(17)] calculated that among a group of 1114 cases, 1089 dogs were purebred dogs (13% German shepherd, 12% Hay, 6% Standard Poodle, 4% Doberman, 63% other breeds) and that only 25 the dogs were mixed breed [17].There is variation in individual studies between the breed most predisposed to GDV and this has been thought to depend on the breed most widespread within a particular region.

Weight is also reported to represent a significant risk factor[10, 17]. Dogs weighing 30 kg or more have 1.94 times more likely to others of developing GDV and large mixed breed dogs are more at risk than small breeds[24].

Schellenberg et al. found female dogs present a higher risk for GDV than male dogs [26]. Pipan et al. in a published case control study of 2012 found that the OR of intact females showed them to be more predisposed to the development of GDV [23]. This finding was not supported in this study; male dogs appeared more predisposed to GDV, although males and females showed no significant difference (OR = 1.50, 95% CL 0.88-2.57 and P = 0.17). The sex of a dog has not yet been identified as a significant risk factor for GDV [14, 18, 24, 24] and previous studies have not found a significant difference between intact and neutered dogs[17]. This study found neither sex nor status of dogs were risk factors for the development of GDV.

Although GDV syndrome can affect young dogs, the risk increases significantly with increasing age[10,15]. The presented data supports that previously described in the literature, that an increase in age, corresponds with an increase in the risk of developing the disease[5, 16.] Dogs older than three years have a 4.58 fold higher risk of developing GDV with the median age for GDV at 7.8 years. It has been suggested that there is an association between an increase in age and stretching of the ligaments that support the stomach which would facilitate gastric torsion when the stomach is weighed down by food[6].

The occurrence of stress to the dog in the 8 hour time period before the gastric torsion-dilatation episode thus supports the theory that the dog's temperament poses a risk factor for disease[17]. In a comparison between large and giant breeds, large dogs with an aggressive temperament were associated with increased risk compared to dogs of a docile character. When dogs are amongst other people or animals the risk of disease is lower [10]. Despite the appearance that shy and aggressive, or exuberant dogs, seemed to be more predisposed to GDV development when comparing them to those with a balanced temperament, the finding was not statistically significant. However, the classification as to whether the dogs were aggressive or fearful was reliant on the owner's assessment. Since this is subjective, a more objective method for evaluating the dog temperament would have been useful and may have produced different results. In addition to the questionnaire, it would have been useful to widen the choice of selection criteria when determining character and add other items to better define the true temperament of the subject. Finally, by increasing the sample number, it is not excluded that the association between the dog's character and the risk of illness could give positive results. The role diet plays in developing GDV has not yet been determined. For several years it has been suggested that there is an association between the consumption of commercial dry food and acute gastric dilation[8, 23, 26]. It has not been defined whether this risk is associated with; the tendency of dry biscuits to expand into the stomach, the amount of food given per meal, whether there is some other characteristic of this type of food that influences the emptying of the stomach, or a combination of all of the above [20].However, others propose that the administration of dry versus wet commercial food does not increase the risk of GDV[17]. This study found that dogs that were fed a diet based on commercial dry food were more likely to development of GDV in contrast to dogs that did not eat dry diets. Moreover, it has been noted that some owners moisten dry food before giving it to their dog, thinking of making the foods more palatable or softening them, thus facilitating chewing. This action was not associated with a lower risk of developing GDV in the population. Our results are in agreement with another author who states that the consumption of dry food not previously humidified before administration is a protective factor against the disease[17]. However, moistening dry food increases the risk of GDV in large breeds but not in giant breeds [10]. Regarding other dietary habits, subjects who do not consume a mixed diet, in both commercial (dry food and / or canned wet food) and home-made (food leftovers, snacks or prizes like biscuits, bread, fruit , or food specially cooked for the dog as meat, soup, rice) are more predisposed to GDV (OR = 1.56, 95% CL = 0.84 to 2.90). Although in this study this association is not statistically valid (P = 0.2), according to some authors consuming only one type of diet represents a risk factor for GDV[14]. According to most of the literature data, statistically evident risk factors result in the administration of dry commercial food and the administration of wet dry food[12, 25, 27].

One study found that having food available throughout the day increased the incidence of 13% in large sizes and 55% in giant breeds[10]. This was not

found in this population. This study demonstrates a correlation between diet and risk of GDV. Although the combination of wet and dry food appears to protect dogs from developing GDV, this variable should be further investigated because it can be an important predisposing factor easy amendable by owners. It may be useful not only to increase the sample size, but also to record in detail the foods administered to each dog, in order to make more specific evaluations.

When environmental factors are considered, the administration of food in a bowl raised from the ground significantly increases the risk of developing GDV[23]. Eating from a raised bowl increases the risk of gastric torsion in large and giant dogs; 20.4% of large breed and 51.9% of giant breeds GDVs could be attributed to the use of raised bowl[10] . In contrast the results of this study show that more dogs developed GDVs that had been feed from a bowl on the ground compared to dogs fed with the raised bowl. However since almost all dogs were fed with the bowl on the ground, the association between the variable and the increase in risk is subject to confounding and therefore feeding from a bowl placed on the ground may not represent a real risk factor.

The study data agrees with the finding reported in most of the literature that dogs fed only once a day are more predisposed to develop the disease compared to dogs that consume more meals in a day[12, 25, 27]. Dogs that eat quickly or voraciously had a tendency to have a greater risk of developing GDV compared to dogs that eat the meal normally or slowly, however this finding was not statistically significant.

Regarding vomiting, Elwood et Al.[14] reported that, in particular Irish Setter, it has been seen that individuals affected by GDV do not report more frequent episodes of vomiting in anamnesis compared to control animals of the same sex and age. The autors concludes that, due to these data there is no significant association between vomiting and increased risk of GDV. Other authors, consider vomiting an indirect predisposing factor for the development of GDV due to the fact that it can cause aerophagia (bridal – caywood)In our study dogs that report vomiting episodes (daily, weekly or monthly) are more prone to develop GDV than dogs that do not wxhibit vomiting. In fact, there is a very significant statistical association (OR = 4,66 – CL 95%=2,67 – 8,13 and P = 0,0001). In any case, this variable should be further investigated especially as regards the causes of vomiting, the frequence of these episodes and the possible correlation with the meals. According to some authors, an increased risk of developing GDV is maily attributed to dogs that have had gastrointestinal problem in their clinical previous history [12, 23]. In our we did not investigated about multiple gastrointestinal problems but we studied only the relationship between previous episodes of diarrhea and GDV. From our data, dogs that report diarrhea episodes (daily, weekly or monthly) would be more predisposed to developing the disease (OR = 1.75, CL 95% = 1.02-3 and P = 0.05), even if the association is not statistically significant. The P Value, however, is at the limit to be considered statistically valid, so the study of this variable should be deepened. By increasing the sample, it is not excluded that the association between the disease and this variable could be positive. In our research we considered also the factor foreign body. Owners were asked if their dogs were used to ingest accidentally or spontaneously things other than food (grass or foreign body). It has been seen that dogs that tend to ingest grass were more predisposed to develop GDV than dogs that do not have this feeding behaviour. The calculated values (OR = 2.92, CL95% = 1.61-5.30 and P = 0.0006) testify that the ingestion of grass represents a risk factor for the GDVAbout foreign bodies a recent paper shows that there is a correlation between foreign body and development of GDV [(24)]. Our data from this research confirmed this positive association and showed a significant statistical relationship between the ingestion of foreign bodies and an increase in the risk of GDV (OR = 3.54, CL 95% = 1.97-6.36 and P = 0.02). According to the owners, the most ingested foreign bodies are: stones, cat litter, pieces of wood, pieces of plastic and linen (underwear, socks). Our data agree well with a recent study that states that in large and giant breed dogs, the ingestion of foreign bodies increases the risk of developing GDV by 5 times[24]. The theories of why the ingestion of foreign bodies could increase the risk of GDV are different[24]. Gastric foreign bodies can cause acute or chronic mechanical obstruction, partial or total. Obstructed outflow delays

gastric emptying and can cause gastric distension. Furthermore, the presence of CE can cause gastritis. Therefore, given the serious damage that the ingestion of foreign bodies can cause, owners of dogs of predisposed breeds should restrict access to foreign material as much as possible to minimize the risk of GDV[24].

Despite the complexity of the risk factors, it is possible to reduce the incidence of GDV in high-risk breeds by observing some precautions[25]. It is not recommended to feed the dog only once a day[25]. They should be fed with small amounts of food per meal and have more meals per day (at least 2)[18]. It would also be useful to reduce the speed of recruitment[14, 25], as slowing the speed of intake has a preventative effect[7].

Feeding with dry commercial food alone may not be a well suited choice for dogs at risk [20] adding home food to the commercial diet may be useful for preventing the syndrome[14]. It is advisable to avoid administering only a commercial crunchy diet to those at risk[14].

There are still doubts about the role of physical activity; according to some authors, the intense physical activity should be reduced in the two hours after the meal [14]. According to others, moderate daily physical activity and moderate post-prandial exercise appears to be beneficial for the reduction of risk [20].

Owners of dogs of the breeds more predisposed to the disease should also be advised to restrict access to foreign material as much as possible, as the presence of a FB at the gastric level increases the possibility of developing GDV.

Regarding other aspects, it would certainly be useful for purebred clubs to work closely with researchers and veterinary surgeons to better identify specific morphometric and genetic factors that predispose certain dogs to the development of GDV [14].

This Study Contains Several Limitations

In a case-control study, the case group and the control group are selected on the basis of the outcome (ie, having the disease of interest compared to not having the disease) and comparing the two groups with respect to their previous exposure frequencies to possible risk factors. Recruitment of subjects is specifically chosen by groups of subjects with or without the disease of interest[26].

Conversely there are also advantages of this type of study. It is inexpensive, useful and effective for investigating a infrequently occurring disease. The clinician was also able to access a lot data from a single subject. Interviews with one owner granted information on signalling, eating habits and lifestyle.

Nonetheless, the case-control study is very sensitive to BIAS (or distortion). This term means the difference between the estimate obtained from the sample and the true characteristic of the population. To avoid a distortion in the identification and quantification of risk factors, it would be useful to match the cases with controls that are as similar as possible (for example the same age, sex and breed) using a procedure called "matching"[26]. However, in this study this type of procedure was not used and the controls were chosen on the basis of other criteria, as explained below. Furthermore it is the opinion of the authors that increasing the sample size might change final results.

Conclusion

In this study several risk factors have been identified for GDV development. These include; large and giant dogs, purebred dogs, dogs over 3 years old, a weight>30 kg, a diet which consists of commercial dry food, the ingestion of foreign bodies and grass, a history of episodes of diarrhoea and/or vomiting, exercise more than once a day and both before and after the meal, the consumption of a single daily meal and the speed of food intake.

On the contrary, neither sex nor the status of the subject (integer/neutered), temperament, BCS and the habit of long journeys or to stay in pensions or kennels are to be considered risk factors.

This study concludes that the risk of GDV in certain breeds and in certain conditions remains high. Since GDV continues to be an extremely current disease it is important that risk factors are understood. Although consideration should be given to both the complexity of the risk factors and the etiopathogenesis of GDV, the author suggests it is not possible to prevent this syndrome by acting solely on the risk factors. The only

safe method to prevent the disease is preventive gastropexy [27-32].

Competing Interests

The authors declare that they have no competing interests.

Availability of Data and Materials

All data generated or analysed during this study are included in this article.

Consent for Publication

Not applicable

Ethics Approval and Consent to Participate:

Not applicable

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Abbreviations

GDV - Gastric Dilatation Volvulus

SIRS - Systemic Inflammatory Response Syndrome

MODS - Multiple Organ Dysfunction Syndrome
DIC - Disseminated Intravascular oagulation

BCS - Body condition score

FB - Foreign Body

OR – Odds Ratio

ES – Effect Size

OR MIN – Odds Radio Minimal

OR MAX – Odds Ratio Maxima

TOT – Total

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