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Behavior and health issues in Bengal cats as perceived by their owners: A descriptive study.

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Abstract

The Bengal cat is a recently established hybrid cat breed that was created by crossbreeding the domestic shorthair cat (*Felis silvestris catus*) and the wild Asian leopard cat (*Prionailurus bengalensis*). In spite of its popularity, research on behavior and health issues in this breed remains limited. A questionnaire was sent to Bengal cat owners in Flanders and Wallonia (Belgium) and the Netherlands to document the suitability of the breed as a pet from the point of view of the owners by exploring the presence of behavioral and health issues that may provoke the cat's relinquishment. It included questions about their decision to own a Bengal, the cat demographics and living environment, potential undesirable behaviors and health issues. The owners of 60.5% (n=155) of cats chose this breed due to a combination of looks and character. For most cats (99.2% n=254), the respondents looked for information about the breed before acquiring a cat. Breed-typical health conditions, as described by International Cat Care, were reported in 9.9 % (n=24) of cats, with being overweight as the most common one. The most frequent behaviors were climbing (89.5%, n=229), vocalizing (88.7%, n=227), playing with water (79.7%, n=204) and hunting (78.9%, n=202) These were, however, rarely considered problematic by the owners. The most frequent behaviors often classified as problematic by the owners were destructive behaviors (33.2%, n=85), followed by pica (16.4%, n=42), aggression toward animals (16%, n=41) and urination outside the litter tray (13.3%, n=34). There were no significant differences between cats from early and later generations nor between cats with and without outdoor access. The fact that most owners looked for information about the breed before acquiring the cat and that the most frequently displayed behaviors were not considered problematic by their owners could translate into a lower incidence of relinquishments. Nevertheless, some of those behaviors may still be indicative of welfare issues, independently of the owner perception. Further and more in depth research is needed to understand the potential issues of keeping Bengal cats as pets.

Keywords: cat welfare; Bengal cat; hybrid breed; cat behavior

Introduction

The Bengal cat is an interspecies hybrid of an Asian leopard cat (*Prionailurus bengalensis*) and an American or European shorthair cat (*Felis silvestris catus*) or an Egyptian Mau ("Bengal Genetics," 2017.; Cameron-Beaumont et al., 2002; Vigne et al., 2016). Asian leopard cats are believed to be one of the least tameable of all the wild felids, as they do not usually display any social behavior towards their keepers, unlike other felids in captivity (Bradshaw et al., 2012a; Cameron-Beaumont et al., 2002). Consequently, whether domestication traits as those found in domestic cats are also present in Bengal cats, is not clear. The amount of wild felid genes expressed in this breed is difficult to predict, although it is believed to be small (Bradshaw et al., 2012a). The males of the first hybrid generations are sterile and, as a consequence, the fertile hybrid females are crossed with male hybrids from subsequent generations or with male domestic cats (Gershony et al., 2014). The different generations of Bengal cats are identified with an F (for *filial*) plus the number of the generation. As such, a Bengal cat originating from a domestic cat and an Asian leopard cat would be F1, and a F2 would be the result from crossing a F1 and a domestic cat. It is believed that cats from earlier generations are likely to maintain behavior repertoires closer to those of the Asian leopard cat (Belyaev, 1979; DEWHA, 2008; Vervaecke et al., 2016). However, even if most Bengals from later generations have been selected to have a gentle temperament (Cutts, 2008), due to the presumed genetic linkage between the strongly preferred and selected typical wild color patterns and some wild behavior traits (Belyaev, 1979; Kukekova et al., 2011), the small percentage of the leopard cat genes that can be linked to wild behavior are likely to be present in all Bengals.

The Bengal cat as a companion animal.

Bengal cats are believed to have some particularities that may affect their relationship with an unprepared owner, such as a more active and/or fearful personality (Salonen et al., 2019). These cats are also reported to display more vocalizations directed to the owner, be more playful (Braastad et al., 2016), show significantly more predatory behavior (Wilhelmy et al., 2016), like to interact with water, often show aggressive behaviors towards members of the family, tend to mark territory and not always use the litter box (Turner and Bateson, 2000). In addition, some health problems have also been particularly associated with the Bengal breed, such as flat chested kitten syndrome, progressive retinal atrophy, hip dysplasia and hypertrophic cardiomyopathy (International Cat Care, 2017; Vapalahti et al., 2016).

Some of the behaviors and health issues mentioned before may be indicative of welfare problems but there is little research on the welfare of this particular breed, most being limited to the study of heritable health conditions (Bensfield et al., 2011; Bourguet et al., 2017; Ofri et al., 2015).

In addition, little information is known about the environment that Bengal cats are living in when housed as a pet. Living conditions of an animal constitute an important aspect of which types and frequency of behaviors it shows. One of the main environmental factors that influence cats' wellbeing is whether they have access to outdoors. Outdoor access is believed to be beneficial to cats' welfare but it also entails some risks such as fights, diseases, accidents and unwanted pregnancies. Contrarily, cats that are kept indoors may suffer from lack of stimulation and stress and frustration due to the impossibility of displaying some natural behaviors (International Cat Care, 2019.; Yeates and Yates, 2017). Other factors include the presence of other animals, specially cats, in the same household, the availability of toys and environmental enrichment. There is no much information available about whether the particularities of the Bengal breed may exacerbate the effect of those factors and contribute to the apparition of potentially undesired behaviors.

An indirect welfare issue may come from the perception of the owners and a mismatch between the Bengal behavior and their expectations when acquiring a Bengal cat. The presence of behavioral problems is considered an important reason why people relinquish pets (Casey et al., 2009; Patronek et al., 1996), but also the owners' expectations and knowledge of the normal behavior of cats may influence whether a behavior is perceived as problematic (Scarlett et al., 1999; Stella and Croney, 2016). Pet owners' satisfaction has been reported to be highly related to the chances of relinquishment (Marder and Duxbury, 2008; Shore, 2005; Stella and Croney, 2016).

With the increase in popularity of Bengal cats, the number of cats that have been abandoned in shelters or sanctuaries has increased considerably. For example, in the US, rescue centers like *"Big Cat Rescue"* and *"Wildcat Sanctuary"* have denounced the high amount of requests to take in Bengal cats due to undesirable behaviors (Big Cat Rescue, 2019., Wild Cat Sanctuary,2012).

In this study, we investigate the suitability of Bengal cats as pets based on the behaviors they show and whether their owners find these disturbing. This and the match with the expectations the owners had about Bengal cats provides an indication of how likely owners might be to relinquish their cats, which is considered a potential welfare problem. We map the environment a Bengal cat is typically kept in and whether there is an association with any problematic behavior. We also examine how frequent and which health issues occur. Finally, for behavior, we investigate if (1) cats from early (F1-F4) versus later (F5 and beyond) generations and (2) cats with and without outdoor access differ.

Materials and methods

An online questionnaire in Dutch and French was made available to owners of Bengal cats in Flanders and Wallonia (Belgium) and in The Netherlands, using the online survey platform

www.surveymonkey.com. The questionnaire consisted of 28 multiple choice and open-ended questions (See annex for an English translation of the questionnaire). Bengal cat owners were invited to complete the survey multiple times if they had more than one Bengal cat in their household. Consequently, the number of responses in the results section reflects the number of Bengal cats, not the number of Bengal cat owners.

Cat demographics and owner expectations

This part of the questionnaire included questions about the country where the cat resides, the age, generation, sex and reproductive status. It also inquired about the origin of the cat, the reasons behind the choice of the Bengal breed, whether respondents did some research before deciding to acquire the breed and the sources of information used.

Cat living environment

For this section, the respondents answered questions about the type of living environment, outdoor access, whether the cats have caused problems in the neighborhood (for example by provoking complaints from the neighbors due to urine marking, destruction of property or aggressivity toward the neighbors or their pets), how long the cat is left alone during the day and the cats' reaction if left alone for long periods of time and the presence of other animals and potential conflicts with those animals.

Behavior, problematic behavior and behavior problems

This part included questions about the level of activity and playfulness of the cat. In addition, a list of potentially undesirable behaviors was presented (Table 4). The respondent could indicate if the cats displayed those behaviors and if they were indeed problematic to them or another member of the household (hereafter referred to as 'the owners') or not. This approach

is based on Porters et al. (2014) and Moons et al. (2018). The behaviors included in the questionnaire were selected from behaviors that have been commonly associated with Bengal cats in the literature. The list was completed with the addition of some problems (such as fear of people, noises and objects) that may be presented by cats, independently of their breed, and that are sometimes associated with welfare issues (Bradshaw et al, 1997) .

Finally, the respondents were asked whether their cats had been diagnosed with a behavioral problem or if they suspected that their cat had one despite not having been diagnosed.

Health problems

Health data were acquired using the list by International Cat Care of health issues associated with the Bengal breed (International Cat Care, 2017). The health issues were fertility problems, overweight, hip dysplasia, patella luxation, hypertrophic cardiomyopathy, blindness, progressive retinal atrophy, distal neuropathy, and flat chest kitten syndrome. Respondents could also indicate if another health condition had been diagnosed.

Data collection and analysis

Bengal cat owners (including catteries) were identified and recruited using online search engines and social media. The potential respondents were contacted online, either by private or group messages containing the link to the online survey.

The questionnaire was available during a two-month period at the beginning of 2017. As an exclusion criterion, respondents who did not answer the first eight questions were removed from the analysis. These questions included, among others, the generation, gender and neuter status of the Bengal cat, as well as reasons for acquiring this particular breed. Responses regarding Asian leopard cats were also excluded, since they were not the focus of this study.

An exploratory descriptive analysis was performed using Microsoft Excel 2016 and IBM SPSS statistics 25. Response frequencies (in percentage) for each question were examined, with the total number of responses (N) representing the number of cats for which the question was answered. These percentages are presented in the results section together with the subtotal (n) of responses corresponding to that answer option.

The potential existence of differences in behavior between cats from earlier (F1-F4) and later generations (F5 and beyond) was investigated to test whether later generations are better adapted to and suited for life as a companion animal. Differences were also explored between cats with and without outdoor access. In both cases, potential differences between the behaviors displayed by the two groups were explored using a Chi-Squared test of goodness-of-fit with a Bonferroni-adjusted alpha level of 0.003 (0.05/14).

Results

Cat Demographics and owner expectations

From the 307 responses received, 256 reached the criterion and were included in the analysis. Tables 1 and 2 show the information collected in this part of the questionnaire.

Category	Sub-Category	n	%
Region	The Netherlands	177	69.1
	Wallonia	22	8.6
	Flanders	57	22.3
Type of owners	Cat breeders	55	21.5
	Private owners	201	78.5
Method of obtaining the cat	Bought from a Bengal cat breeder	225	87.9
	Adopted	16	6.2
	Other	15	5.9
Reasons to choose a Bengal	The looks of the Bengal appeal me	22	8.6
	The character of the Bengals appeals me	56	21.9
	The combination between looks and character appeals me	155	60.5
	The choice of breed was not important for me	3	1.2
	Someone recommended them to me	4	1.6
	Other	16	6.2
Sources of information pre-acquisition (Multiple answer)	Internet	81	31.6
	Breeders	19	7.4
	Internet and Breeders	131	51.2
	Other combinations (shows, books, breeder associations, etc.)	23	9.0
	Did not look for information pre-acquisition	2	0.8

Table 1: Information about the acquisition of Bengal cats, expressed as the number and percentage per answer option of cats for which the survey was completed (N=256).

Category	1st Subcategory	n	%	2nd Subcategory	n	%
Reproductive Status	Female Intact	40	15.6			
	Female Neutered	80	31.3			
	Male Intact	20	7.8			
	Male neutered	116	45.3			
Pedigree	Yes	226	88.3			
	No	30	11.7			
	F1-F4	39	15.2	The Netherlands	21	11.9
				Flanders	15	26.4
				Wallonia	3	13.6
	F5 or later	108	42.2	The Netherlands	69	39.0
				Flanders	21	36.8
				Wallonia	18	81.8
	Unknown	109	42.6	The Netherlands	87	49.1
				Flanders	21	36.8
				Wallonia	1	4.6
Age (years)	Mean= 3.5, median=3, SD=2.9, min 0.3 - max.19					

Table 2: Demographic information about the Bengal cats and expressed as number and percentage of cats ascribed to each of the subcategories of possible answers (N=256).

Cat living environment

A summary of the information obtained about the cat living environment can be found in table 3.

Category	1st Subcategory	n	%	2nd Subcategory	n	%
Room access N=252	All the rooms in the house	195	77.4			
	Restricted to one or few rooms	57	22.6			
Outdoor access N=256	Indoors only	150	58.6	Female Intact	24	16.0
				Female Neutered	41	27.3
				Male Intact	14	9.3
				Male neutered	71	47.4
	Outdoors only on leash	42	16.4	Female Intact	10	23.8
				Female Neutered	9	21.4
				Male Intact	4	9.5
				Male neutered	19	45.3
	Free outdoor access	64	25.0	Female Intact	6	9.4
				Female Neutered	30	46.9
				Male Intact	2	3.1
				Male neutered	26	40.6
Problems in the neighborhood N=64 *(Includes only cats with free outdoor access)*	Never causes any problems	32	50.0			
	Rarely causes problems	8	12.5			
	Often causes problems	0	0.0			
	Unknown/ Non applicable	24	37.5			
Toy availability N=249	Yes and the cat is interested	218	87.6			
	Yes but the cat is not interested	30	12.0			
	No	1	0.4			
Average daily time of interaction owner-cat (minutes)	Mean= 97, median=60, SD=93, min 1.5-max 700, N=239					

Table 3: Information about the living environment of Bengal cats, expressed as number and percentage of cats ascribed to each of the subcategories of possible answers.

Behavior, problematic behavior and behavior problems

Regarding the activity level of the Bengal cat, 249 responses were collected. For 34.1 % (n=85) of cats, the respondent described their cat as being frequently very active and playful. For 5.6 % (n=14) this was inactive and spending most of the time resting. For the remaining cats, the respondents described their animals as being balanced between active and inactive (60.3%, n=150). The percentage of respondents describing their cats as active was slightly lower among the 136 owners that only had Bengal cats (32.3%, n=44) than among the 120 owners that had both Bengals and non-Bengals (34.2%, n=41). The perception of their cat being particularly active was similar between the 55 cat breeders (34.5%, n=19) and the 201 normal cat owners (32.8%, n=66)

Almost half of the cats were left alone for a prolonged period of time (6-8 hours) during weekdays (48.4%, n=124). According to the respondents, 11.3% (n=14) of these cats frequently displayed disruptive behavior when they were alone, such as trying to escape from the house and breaking things.

When asked if they would describe their cats as "cats that enjoy close contact (likes to lie on their lap, likes to be picked up and stroked) 62.5 % (n=160) of all respondents answered positively.

Table 4 shows the percentage of cats that showed each of the proposed behaviors. The percentage of cats that showed at least one behavior considered problematic by the owner was smaller (44.9%, n=115) than the cats that did not show any behavior considered problematic (55.1%, n=141). Only 5.1 % (n=13) of the respondents declared that they suspected a behavior problem and 2.3 % (n=6) said that their cat had actually been diagnosed with a behavior problem. The diagnosed problems described in this section were aggression toward other cats (n=2) and toward humans (n=1), excessive self-grooming (n=1), excessive

vocalization (n=1) and inappropriate elimination (n=1). 92.6% (n=237) of the respondents believed that their cats did not have a behavior problem.

Behavior	Cats that show this behavior		Cats whose owners find this behavior problematic		Cats whose owners do not find this behavior problematic	
	n	%	n	%	n	%
Climbing	229	89.5	3	1.3	226	98.7
Vocalization	227	88.7	19	8.4	208	91.6
Hunting behavior	202	78.9	2	1.0	200	99.0
Playing with water	204	79.7	5	2.4	199	97.6
Excessively licking same spot	13	5.1	4	30.8	9	69.2
Destructive behavior	85	33.2	42	49.4	43	50.6
Fear response to noises	83	32.4	4	4.8	79	95.2
Fear response to people	43	16.8	6	14.0	37	86.0
Fear response to some situations	72	28.1	6	8.3	66	91.7
Fear response to objects	46	18	1	2.2	45	97.8
Aggression towards animals	41	16.0	24	58.5	17	41.5
Pica	42	16.4	28	66.7	14	33.3
Urine spraying	37	14.5	26	70.3	11	29.7
Urination outside the litter tray	34	13.3	27	79.4	7	20.6
Aggression towards people	5	2.0	4	80.0	1	20.0

Table 4: Bengal cats showing possibly problematic behaviors according to their owners and the percentages of cats whose owners find the behavior problematic or not problematic.

The percentage of Bengal cats that displayed at least one behavior considered to be problematic by their owners was slightly higher in generation F1-F4 (41.0%, n=16) than in generations F5 or later (39.8%, n=43) but the difference was not significant (x^2 (1, n=155)=0.17, p = 0.895). Regarding the display of each particular behavior, no significant differences were found between the two groups (Table 5). Aggression towards people was only described in cats from F1 to F4 but the percentage was low. The cats whose generation was unknown by the respondent were not included in this analysis.

Regarding the living environment of the cats, the percentage of cats with outdoors access (free or on a leash) that showed at least one undesirable behavior was higher (46.2%) than the percentage of cats that always remain indoors (44.0%) but the difference was not significant (x^2 (1, n=256)=0.124, p = 0.724). For all behaviors examined, there were no significant differences between the two groups (Table 6). Since the number of cats diagnosed with behavioral problems was small, it was not possible to assess the potential effect of the environment on the appearance of these problems.

Behavior	Early generation cats (F1-F4) that show this behavior		Later generation cats (F5 or further) that show this behavior		X^2	P
	n	(%)	n	(%)		
Climbing	35	89.7	100	92.6	n/a*	n/a*
Vocalization	33	84.6	96	88.9	0.487	0.569
Hunting behavior	32	82.0	87	80.5	0.042	0.838
Playing with water	32	82.0	89	82.4	0.002	0.962
Excessively licking same spot	2	5.1	9	8.3	0.425	0.514
Destructive behavior	10	25.6	26	24.1	0.038	0.845
Fear response to noises	16	41.0	35	32.4	0.939	0.433
Fear response to people	8	20.5	18	16.7	0.291	0.627
Fear response to some situations	10	25.6	32	29.6	0.223	0.685
Feat response to objects	6	15.4	17	15.7	0.003	0.958
Aggression towards animals	8	20.5	14	13.0	1.283	0.297
Pica	4	10.3	16	14.8	0.507	0.593
Urine spraying	5	12.8	21	19.4	0.864	0.465
Urination outside the litter tray	5	12.8	17	15.7	0.192	0.797
Aggression towards people	2	5.1	0	0.0	n/a*	n/a*

Table 5: Behaviors shown by earlier and later generations of Bengal cats in Belgium and the Netherlands according to their owners (*one or more cells with an expected count lower than 5). Cats whose generation was unknown were excluded of this analysis. Bonferroni-corrected alpha-level: 0.003.

Behavior	Cats without outdoor access that show this behavior		Cats with outdoor access that show this behavior		X^2	P
	n	(%)	n	(%)		
Climbing	134	89.3	95	89.6	0.006	0.941
Vocalisation	130	86.7	97	91.5	1.450	0.229
Hunting behavior	115	76.7	87	82.1	1.092	0.296
Playing with water	118	78.7	86	81.1	1.29	0.359
Excessively licking same spot	12	8.0	1	0.9	6.416	0.011
Destructive behavior	56	37.3	29	27.4	0.008	0.928
Fear response to noises	51	34.0	31	29.2	0.645	0.422
Fear response to people	21	14.0	22	20.8	2.028	0.154
Feat response to objects	29	19.3	17	16.0	0.458	0.499
Feat response to situations	43	28.7	29	27.4	0.053	0.819
Aggression towards animals	19	12.7	22	20.8	2.786	0.095
Pica	27	18.0	15	14.2	0.671	0.413
Urine spraying	25	16.7	12	11.3	1.436	0.231
Urination outside the litter tray	21	14.0	13	12.3	0.162	0.893
Aggression towards people	1	0.7	4	3.8	n/a*	n/a*

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254 **Table 6**: Behaviors shown by Bengal cats with and without outdoor access in Belgium and the Netherlands
255 according to their owners (*one or more cells with an expected count lower than 5). Bonferroni-corrected alpha-
256 level: 0.003.

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Most Bengal cats that lived or were frequently in contact with other animals (84%, n=215) did not have conflicts with those particular individuals. 9.2% (n=23) displayed aggressive behaviors toward familiar animals and 6.0% (n=15) displayed fear behaviors. A description of the different types of interaction between the cats and the other animals can be found in table 7.

Category	n	%	Sub-Category	n	%
In contact with other Bengals	46	18.0	Aggressivity	3	6.5%
			Fear	2	4.4%
			Aggresivity and Fear	0	0.0%
			No Conflicts	41	89.1%
In contact with non-Bengal cats	45	17.6	Aggressivity	4	8.9%
			Fear	2	4.4%
			Aggresivity and Fear	2	4.4%
			No Conflicts	37	82.3%
In contact with Bengals and non-Bengals	25	9.8	Aggressivity	4	16.0%
			Fear	2	8.0%
			Aggresivity and Fear	2	8.0%
			No Conflicts	17	68.0%
In contact with dogs	12*	4.6	Aggressivity	0	0.0%
			Fear	0	0.0%
			Aggresivity and Fear	0	0.0%
			No Conflicts	11*	100.0%
In contact with dogs and cats	73	28.5	Aggressivity	12	16.5%
			Fear	5	6.8%
			Aggresivity and Fear	0	0.0%
			No Conflicts	56	76.7%
Living with other species only (rabbits, reptiles)	5	2.0	Aggressivity	0	0.0%
			Fear	1	20.0%
			Aggresivity and Fear	0	0.0%
			No Conflicts	4	80.0%
Only regular contact with strange cats	17	6.6	Aggressivity	6	35.3%
			Fear	0	0.0%
			Aggresivity and Fear	1	5.9%
			No Conflicts	10	58.8%
No contact with other animals	33	12.9	n/a	n/a	n/a

Table 7: Information about other species that the cat is in contact with and whether there are conflicts with those animals. *The extra information regarding one of the cats that was in contact with dogs was not provided.

Health problems

When asked about health issues, the respondents (N=249) reported for 78.3 % (n=195) of Bengals that they did not show any health problems (Table 8). In contrast, 9.6% (n=24) of the cats had a health condition that is considered typical for the breed, while 12.1% (n=30) were reported to suffer from other conditions, with gastrointestinal and autoimmune-related conditions being the most frequent. Only two cats had more than one of the Bengal-related conditions. The first one was overweight and had fertility problems and the second one had blindness and progressive retinal atrophy, although in this last case (a 3 year old female) both conditions were likely to be related.

Health problem	**Bengal cats that have this condition**	
	n	**%**
Overweight	12	4.9
Flat chested kitten syndrome	3	1.2
Patella luxation	2	0.8
Hypertrophic cardiomyopathy	2	0.8
Hip dysplasia	2	0.8
Blindness during the first year	1	0.4
Progressive retinal atrophy	1	0.4
Fertility problems	1	0.4
Distal neuropathy	0	0
Other	30	12.0

Table 8: Health problems associated with the Bengal breed and number and percentage of Bengal cats that experience these conditions in Flanders, Wallonia and the Netherlands according to their owners.

Discussion

The purpose of this research was to investigate the suitability of the Bengal cat as a pet from the point of view of the owners to indirectly assess the likelihood of relinquishment. This assessment was based on factors that are known to influence the chances of relinquishment,

294 such as behavior, owner expectations and health issues (Patronek et al., 1996; Salman et al.,
295 2010; Stella and Croney, 2016).
296 A number of limitations can be identified in this study. First, as with most online
297 questionnaires, the number of questions must be minimized to ensure high participation,
298 thereby limiting the amount of detail that can be collected. We chose to adopt the approach
299 used by Porters et al. (2014) and Moons et al. (2018), where a description of potentially
300 disturbing behaviors is given, along with the question of whether they occurred and if they
301 were disturbing to the respondent or his/her family members. The point of view of the owner
302 is likely to have an impact in the welfare of the cat, since owner perception and satisfaction
303 with their companion animals is an important factor influencing the chances of animal
304 relinquishment (Shore, 2005). Second, in hindsight, some questions may have been
305 interpreted differently than we intended. For instance, the question regarding the amount of
306 time that the respondents actively spend with their cat (Question N. 21). The fact that some
307 owners indicated 12 hours, suggests that they interpreted this question as being with the cat,
308 rather than spending time interacting with the cat. Also asking whether the cat had been
309 diagnosed with a behavioral problem but not specifying who should have made the diagnosis,
310 makes the interpretation of the positive answers ambiguous. Third, some of the participants in
311 the study were cat owners while others were also Bengal cat breeders. This could influence
312 the results of the questionnaire, either because the population of cats may be different between
313 breeders and non-breeders (i.e. due to differences in the numbers of neutered versus intact
314 cats or differences in the living environment (Ström Holst and Frössling, 2009)), or because
315 breeders have a different perception of the cats compared to non-breeders. A final
316 encountered issue was the under-representation of early generation Bengals, especially from
317 the Wallonia region in Belgium, but the otherwise high participation suggests that the study

provides a good insight on the living situation of the Bengal cats from the Netherlands, Flanders and Wallonia

Cat demographics

Remarkably, information was collected for only 22 Bengals from the Walloon region and the number of F1-F4 Bengals was low in comparison with the other regions. A possible explanation for this is the mandatory registration of all Bengal cats in Wallonia, risking prosecution and the more complicated registration of the early generation Bengals in this region. There may be a fear of seizure of the animal in case of non-compliance ("Bien-être animal - Bengal," Wallonie Service Public.). Although the anonymity of the questionnaire responses was emphasized in the invitation, the participation in Wallonia remained low, making it difficult to establish a meaningful comparison between regions.

Cat living environment

More than half of the Bengal cats did not have outdoor access. This finding agrees with Brander and Warren (2016) who observed that, although Bengal cats have a preference to be outdoors, they are often kept indoors. In this study, the high percentage of indoor cats could have been partially explained by the high percentage of intact cats, as it has been suggested that intact cats are often kept indoors to avoid undesirable pregnancies (Scherk, 2016). However, the difference between the number of neutered and intact cats that were kept indoors was small. An indoor-only life is a factor that has been described to contribute to the occurrence of some behavioral problems such as inappropriate elimination or pica (Amat et al., 2009; Porters et al., 2014) but also to decrease the occurrence of others, for example, intra-cat aggresivity (Levine et al., 2005). In our study, there were no significant differences in the behavior of cats with and without outdoor access. Nevertheless, it has been reported

that indoor cats are more likely to be relinquished (Stella and Croney, 2016) and not having outdoor access could potentially be a particularly important welfare issue for Bengals cats, even if not perceived by the owner. Indoor cats in general need extra stimulation to avoid having their welfare compromised (International Cat Care, 2019) and Bengals are also often described as active cats that need extra stimulation and that tend to display predatory behaviors more often than other breeds (Wilhelmy et al., 2016). Proper enrichment and toys designed to elicit hunting behaviors should be recommended to owners of Bengal cats, especially those without outdoor access (Brander and Waran, 2016). In this study, most cats had toys available, although not all of them were interested in them.

Most of the Bengal cats lived or had contact with other animals of the same or a different species and one in four displayed aggressive behaviors, fear behaviors or both. In addition, one in four Bengal cats that lived with both Bengals and non-Bengals displayed either aggressive or fearful behaviors towards the other cats. This is not uncommon in multi-cat households (Bradshaw et al., 2012b) but the percentage is higher than previously reported (Levine et al., 2005). However, it is difficult to associate this with the breed since aggresivity can depend on several factors. For instance, Levine et al, (2005a) described that the chances of aggression between cats in the same household was associated with outdoor access, outdoor access being associated with a higher prevalence of intra-cat aggresivity. In this study, Bengal cats with outdoor access presented slightly more intra-cat aggresivity than the indoors-only cats, but the difference was not significant. Nevertheless, despite a high percentage of cats in this study not having outdoor access, the percentage of aggression was still high and could be an indicative of other factors influencing this percentage. For example, it has been suggested that intact females (Finkler and Terkel, 2010) and intact males (Beaver, 2004; Overall et al., 2005) tend to display more aggressive behaviors toward other cats. The high number of non-neutered cats in our population could therefore explain the frequency of

aggression, but a potential higher predisposition of Bengals to display aggression towards other cats cannot be dismissed based on our results.

Conflicts with strange cats were also frequently described in the questionnaire. Several authors (Hart et al., n.d., 2013; Wassink-van der Schot et al., 2016) described the behavior as typical of the Bengal breed but again, aggressive behavior can have different possible causes and it is not necessarily a breed-related trait (Levine et al., 2005; Overall et al., 2005)

Half of the cats spent long periods of time alone, and approximately one in ten of those cats displayed behaviors in the absence of the owners that could indicate the presence of a separation-related problem. This percentage is similar to those previously reported (de Souza Machado et al., 2020) and does not seem to indicate a more severe problem affecting Bengal cats. Nevertheless, a much more in-depth assessment would be necessary to identify a separation-related problem.

Behavior, problematic behavior and behavior problems

1. *Behaviors typical of the Bengal breed*

Almost all Bengals in this survey displayed behaviors described as typical for the breed, such as frequently vocalizing, playing with water and behaviors that, despite being common to most breeds, are considered particularly important for Bengals, for example climbing and hunting (Braastad et al., 2016; Salonen et al., 2019). Out of all these behaviors, vocalization was most frequently problematic to the owners. This fact has also been previously mentioned in other studies such as Wassink-van der Schot et al. (2016) and Braastad et al. (2016).

2. *Behaviors frequently considered problematic*

The percentage of behaviors considered problematic by the owners in this study was in line with what is reported in the literature. For example, in the study by Strickler and Shull (2014), 61% of the participant cat owners reported at least one from a list of six potentially

392 undesirable behaviors although they did not indicate whether they did consider them
393 undesirable.
394 In our study, the behaviors most frequently defined by respondents as problematic or
395 inconvenient were inappropriate elimination, spraying and aggression towards people. These
396 findings are similar to the ones described in Porters et al. (2014) and Moons et al. (2018) who
397 also found that cat owners are particularly displeased with those behaviors. However, the
398 number of Bengal cats from our study that displayed these behaviors was low compared with
399 other studies. For instance, the two most frequent problematic behaviors reported by Strickler
400 and Shull (2014) were also aggression to the owners (36%) and inappropriate elimination
401 (24%), but the occurrence was considerably higher than in our study (2% and 13.3%
402 respectively). Interspecific aggresivity has also been described to be more common in other
403 studies' populations such as Cannas et al. (2018) (14.9%) and in Berteselli et al. (2008a)
404 (53%). The percentage of cats presenting inappropriate elimination was also higher in those
405 studys, with a 48% reported by Berteselli et al. (2008b) and a 51.2% by Cannas et al.(2018)
406 Other potentially problematic behaviors, such as destructive behaviors, pica and fear and
407 aggression towards other animals, were more frequently displayed but less often perceived as
408 problematic by the respondents. These are behaviors that have also been associated with the
409 Bengal breed (Salonen et al., 2019).
410 Pica was the most frequent behavior of those considered problematic by the respondents, with
411 a prevalence higher than some studies (Bamberger and Houpt, 2006) but lower than others
412 (Bradshaw et al., 1997; Demontigny-Bédard et al., 2016). In the case of Bradshaw et al.'s
413 study, the population consisted mainly of cats belonging to Asiatic breeds, which are believed
414 to be especially predisposed to this type of behavior. In addition to being associated with
415 some breeds, pica has also being linked with other factors such as early weaning, (Bradshaw
416 et al., 1997), stress (Amat et al., 2016) indoor confinement (Schubnel and Arpaillange, 2008)

417 and frustrated hunting behaviors (Neville, 1996). These two last factors are probably related
418 and they are present in the population of this study. Since hunting seems to be an important
419 behavior for Bengal cats, this factor together with the high number of indoor-only cats could
420 influence the percentage of pica. In this study, pica was indeed more often displayed by
421 indoor only cats but the difference was not significant. However, in a more recent study by
422 Demontigny-Bédard et al (2016), having outdoor access was significantly associated with the
423 presence of pica. Since the causes of this behavior are not clear, it is difficult to draw any
424 conclusions.
425 Destructive behavior was another of the more frequent behaviors considered problematic by
426 half of the owners. This behavior has been frequently associated with the Bengal breed,
427 particularly when they do not receive enough attention or do not have enough enrichment
428 available (Brander and Waran, 2016). In this population, most cats had permanent access to
429 toys but the daily amount of interaction with the owners was very variable. In addition, since
430 most of the cats were living indoors, it is likely that they were less stimulated and therefore
431 more prone to display destructive behaviors.
432 It should be noted that these behaviors, despite of not being considered problematic by many
433 owners, can still be indicative of behavior and/or welfare problems. However, an extensive
434 assessment of each individual case would be necessary to understand the causes behind them.
435 Lastly, analysis of the data did not show significant differences in the behaviors displayed by
436 cats from F1-F4 and cats from F5 or later. This conflicts with the extended belief that earlier
437 generations tend to exacerbate some behaviors such as urine spraying or aggresivity. (
438 Belyaev, 1979) and would suggest that the fact that many owners (specially in Flanders and
439 the Netherlands) were unaware of which generation their cat belongs to would not have an
440 impact in their expectations and the cats' chances of relinquishment.
441 *3. Behavioral problems*

Behavioral problems are considered one of the main reasons for relinquishment (Stella and Croney, 2016). Only 7 Bengals from this survey had been diagnosed with behavioral problems, although no information was collected about who had performed the examination and diagnosis, and one in ten of the respondents suspected a behavioral problem. The presence of behavioral problems was low compared with other epidemiological studies, particularly considering that most of the cats did not have outdoor access. For example, in their study, Finka et al (2019) reported that 20% of the respondents from a total of 3165 cat owners indicated that their cats presented a behavioral problem. However, almost a half of the cats displayed at least one behavior that was considered problematic by the owners, a percentage more in line to those reported previously (Heidenberger, 1997). That could indicate that most behaviors, despite of being frequently considered annoying by the owners, were not given enough importance or were not enough severe to be considered a behavior problem.

Health problems

Most of the cats in the study did not present any health issues according to the respondents. International Cat Care suggested multiple diseases as being more common in the Bengal breed (International cat care, 2017). From those diseases, the most frequently described problem was overweight, which could be linked with the fact that a high percentage of these cats lived indoors, one of the risk factors for overweight in cats in general (Kaufman et al., 2013; Rowe et al., 2015). Nevertheless, the percentage of overweight cats in this study is notably lower than prevalence of cat overweight in the developed world as reported in different studies, which varies from 11.5% to 63% (Wall et al., 2019)

Decreased fertility, which according to Lyons (2015) can persist up to the 29th generation of the breed, was not described. However, many of the Bengals in this study had been neutered and it is not known whether they could have produced litters before the surgery.

Regarding the progressive retinal atrophy, the prevalence in this study is consistent with previous reports (Ofri et al., 2015). A DNA-test exists for this condition but its use is not mandatory for Bengal breeders in Belgium and The Netherlands. Phenotypical screening by an ophthalmologist is recommended but there is no legal obligation to do this (Belgian Cat Club, 1999). Nevertheless, some breeders could be using this screening to select cats for reproduction, thereby decreasing the chances of progressive retinal atrophy presentation.

The fact that the population was relatively young could also explain the lower presence of some of these diseases. Some of them, could be present subclinically and therefore not yet observed by the owner (Bourguet et al., 2018). However, this is not always the case since some of the conditions such as polyneuropathy (Bensfield et al., 2011) , the flat chested kitten syndrome or the progressive retinal degeneration (Ofri et al., 2015) usually present an early onset.

Owner expectations

Very few respondents, according to the results of this survey, have become owners of a Bengal cat without searching information about the breed in advance. Pre-acquisition information was mainly obtained through both the internet and breeders' advice. Internet was the most frequent source of information, which is similar to what has been described for owners of other purebred cats (Plitman et al., 2019). Bengals are often described in specialized websites as active, playful, social and vocal cats. The fact that Bengal owners tend to do some research before acquiring their cats - most of the times using the internet – may indicate that those were personality traits that they considered desirable in their future cats or

at least were not opposed to. However, it is important to consider that internet was often the only source of information and it cannot always be considered as reliable (Oxley et al., 2017). Consequently, the description of the Bengal cat character may be different between respondents.

Interestingly, veterinarians were never mentioned as a source of information by any of the respondents. That could indicate that vets are not seen as a source of medical and behavioral information when people select a pet and they should make a greater effort to profile themselves in this role. For example, in the UK, the British Veterinary Association (BVA) has recently encouraged veterinarians to offer pre-purchase consultations to advise people that are considering buying animals from brachycephalic breeds to avoid acquiring animals with potentially compromised welfare (Atkin, 2018). Similarly, veterinarians could help manage expectations of future cat owners by offering information about potential breed-related issues and breed particularities.

Regarding the reasons why the respondents opted for a Bengal cat and not a different breed, both character and appearance were ultimately the most important factors. Character was the most important single factor, with a percentage higher than appearance alone. This contrasts with the findings in Plitman et al.(2019) where the three groups of cat owners (brachycephalic with pedigree, non-brachycephalic with pedigree and cats without pedigree) gave more importance to their cats' appearance that to their behavior. It had also been previously described that owners choose their cats usually based on their appearance (Onodera et al., 2014).Despite of this, Neidhart and Boyd (2002) found that personality was the first reason linked with post-adoption owner satisfaction (Delgado et al., 2012).

Owners expectations and knowledge of the species typical behavior (Scarlett et al., 1999; Stella and Croney, 2016) is also considered a factor that influence the probabilities of relinquishment. In this study, most respondents searched for information about the

515 characteristics of the Bengal breed before acquiring a cat and seemed to value the character of
516 the breed in addition to its physical appearance. This could explain that most owners did not
517 find behaviors considered typical of the breed problematic and the most frequent behaviors
518 that were considered problematic were behaviors also common in other breeds. This fact may
519 have positive repercussion on how well the owner's expectations match reality and therefore
520 how satisfied they are with their purchase. A high level of owner satisfaction should lead to a
521 lower number of relinquished cats.(Casey et al., 2009).
522

Conclusions

The results of this questionnaire did not reveal any strong indications of severe breed-related behavioral or health problems in the Bengal cats from the perspective of the owners and therefore does not seem to indicate a probability of relinquishment higher than other breeds'. Most of the respondents searched for information before purchasing the cats and decided to acquire them not only for their appearance but also because of their character. This could explain why most of the owners were not disturbed by the behaviors typical of the breed such as vocalization, climbing, playing with water, with the sole exception of aggression towards humans. Some behaviors that may be indicative of a welfare issue and have been previously associated with Bengals such as destruction and pica were also present but they were not perceived as a problem by the owners. As described in the literature, urinating outside the litter box and spraying were the behaviors that made owners most unhappy but these behaviors were less frequent than in other studies regarding non-Bengal populations. There were no differences in behavior between early and later generations of Bengal cats and between cats with and without outdoor access. None of the health issues most associated with the breed were common. The study did not show issues that affect the suitability of Bengals, specifically, as pets from the owners' point of view, although the respondents indicated that several undesired behaviors were present in this population and the cats that presented those behaviors could still be at risk of relinquishment due to the owner's dissatisfaction. In addition, since some behaviors not considered problematic by the owners could be signaling welfare issues, further and more in-depth research is recommended to be able to draw conclusions about the suitability of Bengals as a pet from the cat's own point of view.

Conflict of interest statement

The authors have no conflict of interest to declare.

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Ethical considerations

This research did not involve the use of live animals nor did it involve the acquisition of identifiable private information about human subjects.

Authorship statement

The idea for the paper was conceived by H. Vervaecke and C.P.H. Moons

The experiments were performed by J. Rosseau

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