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PREPUBERTAL GONADECTOMY IN CATS:

Long-term effects on behaviour

by

Annelies VALCKE

Promoters: Prof. dr. Christel Moons
Prof. dr. Hilde de Rooster

Research Report
as part of the Master's Dissertation

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PREFACE

Welfare of cats is something I consider extremely important but still not fully integrated in our society. By being part of the present research project, I hope that I contributed to a brighter future for our furry friends. Of course, I was not able to do so all by myself. I want to thank several people who helped me deliver this fascinating research.

First of all, I would like to thank my promotors Christel Moons and Hilde de Rooster. They were available day and night to answer all of my questions and always gave me very extensive feedback about the draft versions of my research. Secondly, I want to thank my statistician, Katrien Verschueren. She did not only give me the essential results of the research, but was also prepared to explain me every uncertainty I had about the statistical part of the project. Thirdly, I would like to thank Nathalie Porters. Her interesting research was fundamental for this project. Of course I want to express my appreciation to all the cooperative cat-owners who were willing to help me with this research. I also want to thank my roommate and her boyfriend for their help with my Excel-struggles. Lastly, I thank my parents, sister and boyfriend for their never-ending support during my life as a veterinarian student.

I wish you a pleasant and interesting reading experience.

Annelies Valcke

Ghent, April 12 2017

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SUMMARY

The goal of this study was to assess if there is a difference in long-term (potentially) undesirable behaviours between prepubertally gonadectomised (PPG) and traditional age gonadectomised (TAG) cats and to evaluate the evolution of these behaviours over five to seven years.

Owners of cats that enrolled in a previous research of Porters (2014) were contacted again in this study. The cats had been divided in randomly assigned groups (1/3 TAG and 2/3 PPG) before, and owners were contacted to seek renewed participation in this study. In total, 549 owners were contacted. An online survey, asking about potentially undesirable and undesirable behaviours of their cat, was filled in by 187 owners. The answers were analysed using the statistical program SAS version 9.4 C (SAS Institute Inc., USA).

The conclusion of the research was that there is no detectable difference in total number of (potentially) undesirable behaviour between PPG and TAG cats, and that the evolution of those behaviours over five to seven years of time is the same between the two groups.

Key words: Behaviour, cats, health, prepubertal gonadectomy, traditional-age gonadectomy

INTRODUCTION

In 2014, Belgians owned 1,497,000 dogs and 2,194,000 cats, which makes cats the most popular pets (FGOV Statistieken, 2016). Despite their popularity, large numbers of cats are relinquished to shelters every year. In 2015, 22,311 animals (cats, dogs and other species) were admitted to Flemish shelters. Of this number, 12,091 were cats, and 9% of these cats (n = 1,088) had to be euthanized (Office of Flemish minister of Mobility, Public Works, Flemish Council, Tourism and Animal Welfare, personal communication). Issues in the humane lifestyle such as moving, landlords not allowing a pet, or financial problems are the main reason for relinquishing cats to shelters, followed by behavioural issues (Salman et al., 1998). The most common behavioural issues were house-soiling, problems with other pets, destructive behaviour, aggression towards humans or animals, and being hyperactive.

Despite the fact that owners relinquishing their animal is the main reason for the high number of cats in shelters, a significant proportion of the shelter population is due to stray cats (Casey et al., 2009). Because cats are very fertile animals, the amount of stray cats will continue to increase if the community does not intervene appropriately. Indeed, on average stray queens have 1.5 litters per year, with four kittens per litter (Levy et al., 2004). On top of this, cats can start reproducing from the age of four months (Schäfer-Somi et al., 2014). A group of six stray cats can therefore result in a group of 30 stray cats, just in one year (Neijenhuis and van Niekerk, 2015). Stray cats can cause several problems: they can cause infected bites, both to humans and other cats, they can spread diseases like FeLV, FIV and parasites such as fleas, the noise they make at night is considered annoying, they destroy garbage bags and spread fecal contamination, both of which can cause odour nuisance (Robertson, 2008). It is important for the welfare of both humans and animals that the stray cat population is controlled.

Different techniques are described to attempt reduction of the number of stray cats, but none of them is 100% effective. Stray cats can be hunted or poisoned. Although this technique is not considered very humane, it is still being used in several European countries (Tasker, 2008). Another possibility is catching and euthanizing of stray cats. All of the above techniques lead to the so-called ‘vacuum effect’ (Gunther and Terkel, 2002). By removing cats, the area will be taken by a similar number of new cats. Migration will only be enhanced without permanently reducing the number of stray cats. It is therefore only a short-term solution. Another technique described is the introduction of diseases, such as FIV and FeLV, in the stray cat population. This technique is not only very unethical, it was shown that there is a fast resistance development against the diseases introduced (Van Aerde, 1983). The trap-neuter-release (TNR) technique is a method, by which cats are caught, neutered and released back where they came from. The castrated cats cannot reproduce any longer but still defend the area against immigration of new cats. However, this immigration cannot be completely avoided and, therefore, continuous castration and sterilization of stray cats is necessary (Peeters, 2007). The TNR technique is the only technique used in Belgium to control the stray cat population (Tasker, 2008).
An important note to make is that castration of stray cats without raising awareness in the human population about neutering pet cats is worthless. Indeed, according to a study performed in Rome,

there was a reduction in the amount of stray cats with 16-32% after introducing the TNR technique. However, an immigration of 21% of new cats made the hard work worthless. These new cats were cats mostly cats that were abandoned by their owners (Natoli et al., 2006). It was shown that 68% of the litters of pet cats are unplanned (New et al., 2004). These unplanned kittens often end up in shelters or on the streets, resulting again in increasing numbers of stray and shelter cats. Currently most privately owned cats are being gonadectomised starting from the age of six months, although there is not any scientific evidence that this is the optimal age for gonadectomy (Root, 2007). Because cats can enter puberty already at four months of age (Schäfer-Somi et al., 2014), it is possible they have litters before they are being gonadectomised.

LITERATURE STUDY

1. Gonadectomising cats

Gonadectomy is defined as the surgical removal of ovaries or testes, by ovari(ohyster)ectomy or castration respectively. A distinction is made between traditional aged gonadectomy (TAG) and prepubertal gonadectomy (PPG). TAG is gonadectomy starting from the age of six months, whereas PPG is gonadectomy performed at an earlier age, although the exact range varies between 6-14 weeks of age (Root, 2002; Joyce and Yates, 2011), 8-16 weeks of age (Kustritz, 1999) or 8-12 weeks of age (Porters, 2014). In this study, PPG is defined as gonadectomy performed at 8-12 weeks of age.

The 1987 European Convention for the Protection of Pet Animals promoted gonadectomising cats and dogs, to reduce the unplanned breeding of both stray animals and pets. Nevertheless, not all European member states follow this advice (European Convention for the Protection of Pet Animals, 1987). In Norway, routine surgical sterilization of animals is forbidden by law. Although in Sweden, Denmark, Finland and Germany, the removal of organs just for convenience to humans is discouraged, surgical castration is not completely prohibited (Murray et al., 2015). In contrast, it has been obligatory in Belgium since September 1st 2014 to gonadectomise all cats that are traded, including cats in shelters. Only cats that are being traded to foreign countries or cats bought by a registered breeder do not have to be neutered (FOD Volksgezondheid, 2012). The obligation in Belgium to gonadectomise all cats before they are traded, has as a consequence that kittens are being gonadectomised too before adoption. Some breeders offer kittens for adoption starting from the age of eight weeks. If they have to be neutered before this age, gonadectomy will have to be prepubertal.

Although performed already, opinions on the subject greatly differ. Only 28% of the veterinarians in the United Kingdom perform prepubertal gonadectomy (Joyce and Yates, 2011) but the numbers in Australia and New-Zealand are higher: 65% of the vets perform early-age gonadectomy (Farnworth et al., 2012). In Belgium a survey was performed showing that 54% of the veterinarians in Flanders and 19% in Wallonia perform early-age gonadectomy (Moons C.P.H., Polis I., Diederich C., de Rooster H., unpublished data, 2015-2016). This difference might be explained by less training in early-age neutering, received by the veterinarian students in the UK and Wallonia (Spain et al., 2002). These major differences in performing (prepubertal) gonadectomy between countries suggest mixed sentiments and opinions by professional organizations, authorities and most likely also veterinarians about gonadectomy in general, and early-age gonadectomy specifically.

2. Effects of prepubertal gonadectomy

Several studies have already been performed about the effects of prepubertal gonadectomy. They investigated both health issues and behavioural problems.

2.1. Behaviour

The occurrence of sexually dimorphic behaviour, i.e. a behaviour pattern displayed by either mainly males or females, is common in cats. Examples are mounting, urine spraying and fighting in male cats (Hart and Eckstein, 1997) and nesting or other maternal behaviour in females (Root, 2005). As mentioned before, some of these behaviours are risk factors for relinquishment in shelters because owners perceive them as undesirable (Salman et al., 1998). It was shown that intact cats express more of these possibly undesirable behaviours like aggression, less affection, urine spraying or mounting (Stubbs et al., 1996). Although gonadectomy does not guarantee that the sexually dimorphic behaviour will disappear, it is considered to be the most effective way to decrease its expression (Stubbs et al., 1996).

To prevent sexually dimorphic behaviour from developing, kittens can be neutered before the onset of puberty (Horwitz, 2008). Since cats enter puberty starting from the age of four months (Schäfer-Somi et al., 2014), they should be gonadectomised before that age. However, the period in which prepubertal gonadectomy is performed, overlaps with the socialization period of the kittens. The socialization period is a very sensitive period that starts between two to three weeks and ends between seven and ten weeks of age (McCune, 1995; Bradshaw et al., 1999; Casey and Bradshaw, 2008). During this period kittens learn to develop social relationships with other cats and with other species (Casey & Bradshaw 2008). They do so by learning from their mother (Bradshaw et al., 1999) and their father (McCune, 1995). During this period, cats also start learning how to deal with different environmental stimuli, which is called ‘environmental learning’ (Gambino et al., 2015). The nervous system is very sensitive to different kinds of stimuli during this period, so stimuli with a great impact on the kitten can have consequences on the later life of the cat. The transportation to the veterinarian, the recovery from anaesthesia and the possible pain and fear associated with these events, can be stressful for a kitten. Therefore, a lot of veterinarians still have their concerns about the impact of early-age gonadectomy on the behaviour of the cats later in life (Joyce and Yates, 2011).

Only a few studies found behavioural differences between kittens neutered at an early-age versus at a traditional age, whereas others did not. For example, the retrospective study of Spain et al. (2004), which looked at behavioural differences between 1,660 PPG and TAG cats, found an increased frequency of hiding in early-age gonadectomised male kittens. Also, both male and female early-age gonadectomised kittens showed a decrease in hyperactivity and an increase in shyness. Since these behaviours are not usually considered undesirable by owners, the risk for relinquishment is fairly low (Salman et al., 1998). Other studies did not find differences in behaviour between PPG and TAG cats. In one experimental study with 31 cats, behavioural parameters (aggression and affection) were assessed at 12 months of age. There were no significant differences between the PPG cats and the TAG cats (Stubbs et al., 1996). Another study investigated long-term behaviour of cats. They were

followed for about three years after gonadectomy and again, no differences in behaviour were observed between the prepubertal gonadectomised cats and the cats gonadectomised at traditional age (Howe et al., 2000.). More recent studies (Wright and Amoss, 2004; Porters et al., 2014) investigated the association between prepubertal gonadectomy and possibly undesirable behaviours (inappropriate urination or defecation, play-related or non-play-related aggression towards people or animals, fearful behaviour, non-social behaviour towards humans or animals, hunting, destructive behaviour, disobedience, excessive vocalization and attention seeking, excessive or inadequate coat care, hyperactivity, stealing food and showing sexual behaviour), in which prepubertal kittens were kittens neutered before the age of 12-13 weeks. No differences between the prepubertal gonadectomised group and the group gonadectomised at traditional age were found for the behaviours of interest.

2.2. Health

2.2.1. Obesity

Gonadectomy is the most commonly reported risk factor to develop overweight or obesity in cats (Fettman et al., 1997; Nguyen et al., 2004). A cat is obese when it has 15% or more excess over the ideal body weight, whereas being overweight means excess body weight under 15%. With a prevalence between 19-40%, being overweight or obese were the most common nutritional disorders in adult cats in several countries (Sloth, 1992; Scarlett et al., 1994; Donoghue and Scarlett, 1998; Robertson, 1999). Although the effects of gonadectomy on the occurrence of obesity are investigated intensively, only few studies compared the age of gonadectomy itself as a risk factor. Also, the results were contradictory. A study performed by Spain et al. (2004) with a median follow-up time of 3.9 years, showed that early-age neutering did not increase the risk of obesity, compared to traditional-age neutering. Unfortunately, these results were based on owners' estimation of their cat's body condition score (BCS), which is known to be suspect (Howe et al., 2000). On the other hand, more recent studies showed that prepubertal gonadectomised female kittens might be at higher risk for developing obesity (Alexander et al., 2011; Porters, 2014). Unfortunately, these studies ended after one to two years of follow-up, so actual long-term effects could not be obtained.

2.2.2. Delay in growth-plate closure

It has been shown that gonadectomy prior to growth-plate closure delays this closure in cats (May et al., 1991; Root et al., 1997). This results in lengthening of the associated bones and makes growth plates more vulnerable to fracture (Root et al., 1997). One study showed that prepubertal gonadectomy might be a risk factor for physeal fractures, however, these results should be interpreted with caution, since all of the cats with fractures were also overweight (McNicholas et al., 2002). On the other hand, in another study with a median follow-up time of 3.9 years comparing 1,660 cats, no significant correlation was found between age of gonadectomy and physeal fractures (Spain et al., 2004).

2.2.3. Feline lower urinary tract disease

In early-neutered cats, the external genitalia remain the size of their infantile appearance (Joyce and Yates, 2011). If prepubertal gonadectomy can cause an underdevelopment of the genitals, and therefore of the urethral diameter, it is easy to see why many veterinarians still have concerns about the higher incidence of FLUTD (feline lower urinary tract disease, a syndrome consisting of hematuria, dysuria or pollakiuria, and possible urethral obstruction (Root, 2007)) in prepubertal gonadectomised cats (Spain et al., 2002). However, there is no scientific evidence for these concerns. Studies showed prepubertal gonadectomy does not lead to a decrease in urethral diameter (Herron, 1972) or increase in FLUTD, compared to cats that were gonadectomised at a traditional age (Root, 2007; Spain et al., 2004). One study even found decrease in occurrence of FLUTD in early-neutered cats (Howe et al., 2000).

2.2.4. Mammary gland neoplasia

Sexually intact cats have seven times the risk to develop mammary gland neoplasms compared to spayed cats (Root, 2007). On top of this, about 90% of the mammary gland neoplasms are malignant in cats (Hayes et al., 1981). With an incidence of 2.5%, it is the third most common tumour in female cats. Mammary gland neoplasia usually has a late onset: on average, cats are older than ten years (Lekcharoensuk et al., 2001). Although the exact mechanism is not known yet, it was shown that oestrogen and progesterone have stimulatory effects on mammary gland tissue (Root, 2007). By gonadectomising cats, these hormonal stimulatory effects can be avoided. The age at which cats are spayed does have an effect on the occurrence of mammary gland neoplasia. In a study performed with 708 cats, it was shown that cats that were spayed before the age of one year had an 86% reduction in risk compared to intact cats. Cats spayed before the age of six months had a 91% reduction in risk (Overley et al., 2005). However, the prepubertally gonadectomised cats in this study could have been under hormonal influence already, since puberty in cats can start from the age of four months (Schäfer-Somi et al., 2014). If the PPG cats all would have been younger than four months, even higher reduction in risk for mammary gland neoplasia might have been seen.

AIM OF THE PRESENT STUDY

The current study investigates whether there is a difference in total number of (potentially) undesirable behaviours in PPG and TAG cats, between five to seven years after adoption. Furthermore it is investigated whether, when taking results from previous surveys into account, the evolution of those behaviours over time is different between the two groups.

MATERIALS AND METHODS

1. Animals

The animals included in this study had been enrolled in a previous research project that lasted from 2010 until 2014 (Porters, 2014). Briefly, shelter cats were recruited from shelters in Flanders between April 2010 and August 2012. In total, 800 cats were randomly assigned to two different groups with unequal sample size. The first group consisted of prepubertal gonadectomised cats (between 8-12 weeks of age) and contained two thirds of the cats. The remaining cats were allocated to the second group and were gonadectomised at the traditional age (between 6-8 months of age). All cats were adopted by owners who were aware they participated in a clinical study, and were willing to fill in surveys and to visit the faculty for health check-ups for two years. At the end of that study, owners were asked if they would agree to participate in a follow-up study. The 549 owners that responded positively to this last question were contacted for the purpose of the current investigation.

2. Survey

All 549 owners were contacted by e-mail in September 2016 and were invited to fill out an online questionnaire (see Appendix I), which was available for five weeks. If needed a reminder was sent. The questionnaire was based on a previously designed survey (Porters, 2014) but questions irrelevant for the current study were deleted. Owners were asked to complete 23 questions. Owners with more than one cat that had been included in the project were asked to complete the survey for each cat separately.

Owners were given the option to indicate if their cat was still living with them and, if not, why not. Several owners replied via e-mail that their cat had disappeared or died. This information was added to the database.

The questions in the survey inquired after the cat's behaviour. Behaviours included were: inappropriate urination or defecation, play-related or non-play-related aggression towards people or animals, fearful behaviour, non-social behaviour towards humans or animals, hunting, destructive behaviour, disobedience, excessive vocalization and attention seeking, excessive or inadequate coat care, hyperactivity, stealing food and showing sexual behaviour. All of these were defined as 'potentially undesirable behaviours' in the original study by Porters (2014). If owners indicated that one or more of these behaviours were present, they were asked for how long the behaviour had been present (longer than 30 days or less than 30 days). If the behaviour was not present at the moment of completing the survey, owners had to indicate if it had been present in the past two years. If the behaviour was currently present or had been at some point during the past two years, they were asked if the behaviour bothered them (defined as an 'undesirable behaviour').

The survey also included information about the environment of the cats. Because these results were not relevant for the present study, they were not presented.

3. Statistical analysis

Data were exported from the online survey to Microsoft Excel 2010. Answers were transformed to a binary code: when owners responded that the behaviour was not present, this was transformed into '0'; when owners responded that the behaviour was present, this was transformed into '1'. Descriptive statistics were calculated to give a representation of the sample population.

The goal of the inferential statistical analysis was twofold. The main goal was to compare the total number of potentially undesirable behaviours and undesirable behaviours between PPG and TAG cats five to seven years after adoption (= follow-up time point). In addition, the evolution of potentially undesirable and undesirable behaviours in PPG and TAG cats was evaluated. To reach both goals, two statistical analyses were performed using SAS version 9.4 C (SAS Institute Inc., USA). Significance was set at 0.05.

To compare the total number of potentially undesirable behaviours and undesirable behaviours in PPG and TAG cats five to seven years after adoption, a t-test was run on the data. Parameters included were: the time of castration (PPG or TAG), total number of potentially undesirable behaviours and total number of undesirable behaviours. Variance was checked using Levene's test. If the variance was equal, the Pooled-method was used. If the variance was unequal, the Satterthwaite-method was used.

For the evaluation of the evolution over time of total number of potentially undesirable and undesirable behaviours in PPG and TAG cats, a longitudinal analysis was used (regression model for repeated measures). Firstly, data were transformed to the log-scale to make them normally distributed. For interpretation of results, the outcomes were back-transformed to the original scale. The responses of the owners were regressed on group (PPG or TAG cats), time (different time points being 2, 6, 12, 18 and 24 months after adoption (data used from the previous study) and five to seven years (= 60 to 84 months) after adoption (data from current study)) and the interaction between group and time. Because the responses at different time points for a specific kitten are correlated, this correlation has been taken into account in the chosen model. Gender and interaction between time and group are also added to model. By means of backward model selection only significant effects were retained.

RESULTS

1. Descriptive statistics

In total, 43% of the owners (N = 187) who had been invited to fill out the survey responded to our request, either by email or by filling out the survey. Of this number, 72% were PPG cats (n = 135), with 61 male and 74 female cats. The other 28% were TAG cats (n = 52), with 25 male and 27 female cats.

In PPG cats and TAG cats combined, the average total number of potentially undesirable behaviours per cat was 3.86 (± 2.25) and average of the total number of undesirable behaviours per cat was 0.92 (± 1.61) with a minimum value for both of 0. Maximum value for total number of potentially undesirable behaviours shown by one cat was 12, maximum value for total number of undesirable behaviours shown by one cat was 9.

The prevalences of the ten most commonly reported potentially undesirable behaviours and the ten most commonly reported undesirable behaviours in both PPG and TAG cats are shown in table 1a and 1b respectively.

Table 1a: Prevalence of the ten most commonly reported potentially undesirable behaviours in PPG and TAG cats together (N = 187).

Potentially undesirable behaviours	**% of cats showing this behaviour**
Hunting	67.9%
Fearful behaviour	58.3%
Destructive behaviour	40.6%
Attention seeking behaviour	28.3%
Stealing food	24.6%
Excessive vocalization	16.6%
Non-social behaviour towards humans	16.0%
Non-play-related aggression towards animals	15.5%
Non-social behaviour towards animals	12.3%
Non-play related aggression toward humans	11.7%

Table 1b: Prevalence of the ten most commonly reported undesirable behaviours in PPG and TAG cats together (N = 187).

Undesirable behaviours	% of cats showing this behaviour
Destructive behaviour	19.8%
Stealing food	10.7%
Fearful behaviour	7.5%
Non-play-related aggression towards animals	5.3%
Play-related aggression	4.3%
Non-play-related aggression towards humans	4.3%
Hunting	4.3%
Attention seeking	4.3%
Disobedience	4.3%
Inappropriate urination or defecation	3.7%

2. Comparison of total number of potentially undesirable behaviours and undesirable behaviours in PPG and TAG cats, five to seven years after adoption

To compare the total number of potentially undesirable behaviours and total number of undesirable behaviours between PPG and TAG cats, a t-test was run on the data. For potentially undesirable behaviours, a mean value of 3.24 (± 2.52) behaviours was noticed in the PPG group and a mean value of 3.62 (± 2.37) behaviours was noticed in the TAG group (Table 2). As p (= 0.36) > 0.05 (Table 3), no significant difference between the PPG and the TAG cats could be found in total number of potentially undesirable behaviours.

Table 2: Mean values of potentially undesirable behaviours in PPG and TAG cats.

Group	N	Mean	Std Dev
PPG	135	3.24	2.52
TAG	52	3.62	2.37

Table 3: Variance between PPG and TAG cats for potentially undesirable behaviours was equal, therefore the Pooled-method had to be used. A p-value of 0.36 was observed, which is larger than 0.05, so the null-hypothesis could be rejected.

Method	Variances	p-value
Pooled	Equal	0.36
Satterthwaite	Unequal	0.35

The same method was used for the total number of undesirable behaviours. The mean value of undesirable behaviours in PPG cats was 0.79 (± 1.49) and in TAG cats 0.81 (± 1.66). The p-value (=

0.95) was > 0.05, so there was no statistically significant difference in total number of undesirable behaviours between PPG and TAG cats (Table 5).

Table 4: Mean value of undesirable behaviours in PPG and TAG cats.

Group	N	Mean	Std Dev
PPG	135	0.79	1.49
TAG	52	0.81	1.66

Table 5: Variance between PPG and TAG cats for undesirable behaviours was equal, therefore the Pooled-method had to be used. A p-value of 0.95 was observed, which is larger than 0.05, so the null-hypothesis could be rejected.

Method	Variances	p-value
Pooled	Equal	0.95
Satterthwaite	Unequal	0.95

3. Evolution of total number of potentially undesirable and undesirable behaviours in PPG and TAG cats

To evaluate the evolution of the total number of potentially undesirable and undesirable behaviours in PPG and TAG cats over time (two months after adoption until five to seven years (= 60 to 84 months) after adoption), the data from all of previous time points, collected by Porters (2014), were taken into account. The variables were 'Months after adoption' (months after adoption at which the surveys were completed), and 'Group' (PPG or TAG cat). Data were back-calculated to the original scale.

In table 6 the difference in total number of potentially undesirable behaviours between TAG and PPG cats can be seen. For example, at time point '12', the median number representing the total number of potentially undesirable behaviours for TAG cats was (1-0.98)x100% (= 2%) less in TAG cats than in PPG cats. By looking at the p-value (= 1.00), the conclusion was that this difference is not statistically significant, since p > 0.05. The median number representing the total number of potentially undesirable can thus be calculated for each time point. The p-values at every time point tell us that none of the differences in total number of potentially undesirable behaviours between the PPG-group and the TAG-group were significantly different.

The same reasoning goes for total number of undesirable behaviours For example, at time point '2' (two months after adoption), the median number representing the total number of undesirable behaviours for TAG cats was (1-0.99)x100% (= 1%) less than for PPG cats. By looking at the p-value (= 1.00), the conclusion was that this difference is not statistically significant, since p > 0.05. Again, the adjusted p-values at every time point were > 0.05, so there was no significant difference in total number of undesirable behaviours between PPG and TAG cats.

Because the present model also takes into account the correlation between animals at different time points, the p-values in table 6 represent no significant difference of total number of (potentially) undesirable behaviours at different time points as well. This means there is no significant evolution over time in these behaviours.

Table 6: Differences in total numbers of potentially undesirable behaviours and undesirable behaviours between PPG and TAG cats at different time points (months after adoption), with their respective p-values.

Months after adoption	Group	Group	Difference in number of potentially undesirable behaviours	Adjusted p-value (potentially undesirable behaviours)	Difference in number of undesirable behaviours	Adjusted p-value (undesirable behaviours)
2	TAG	PPG	1.03	0.99	0.99	1.00
6	TAG	PPG	0.99	1.00	0.98	1.00
12	TAG	PPG	0.98	1.00	0.95	0.99
18	TAG	PPG	0.99	1.00	0.99	1.00
24	TAG	PPG	0.99	1.00	0.96	1.00
60-84	TAG	PPG	1.07	0.97	0.99	1.00

DISCUSSION

The aim of this study was to assess the long-term behaviour in cats that were prepubertally gonadectomised (PPG) and to compare it to that of cats who had been gonadectomised at a traditional age (TAG). The present study showed no statistical difference in the total number of potentially undesirable or undesirable behaviours between PPG and TAG cats. Two elements of the behaviour of these cats were investigated. Firstly the difference in behaviour at five to seven years after adoption was assessed. Based on our results, there is no difference between the PPG and the TAG cats. Secondly, the evolution of behaviour over time in PPG and TAG cats was investigated. There was no significant evolution in the total number of behaviours, nor was there a significant difference between PPG and TAG cats in the behaviours over time.

Several studies have been performed about the difference in behaviour between PPG and TAG cats already. Most of them did not reveal any difference in behaviour between these two groups (Stubbs et al. 1996; Howe et al., 2000; Wright and Amoss, 2004). Although the conclusion of these studies was substantially similar, they often had different types of shortcomings. Some did not examine the long-term behaviour of the cats and observations stopped at 12 months of age (Stubbs et al. 1996; Wright and Amoss, 2004). Behaviour of cats can develop until they are three years old, when they become socially mature, which suggests a prolonged evaluation of the evolution of their behaviour might be useful. Others defined prepubertal gonadectomy as gonadectomy before the age of 24 weeks (Howe et al., 2000; Spain et al., 2004), while cats can already be in puberty at that time (Schäfer-Somi et al., 2014). The present study tried to overcome the previously described pitfalls. Firstly, the follow-up time was five to seven years after adoption. Secondly, the prepubertal cats were defined as cats that had been neutered before the age of 12 weeks, so long enough before the age they can go into puberty (Schäfer-Somi et al., 2014).

The present study is partially a retrospective study, since owners were asked, if a (potentially) undesirable behaviour was not present at the time of the survey, to indicate if it had been present in the last two years. Therefore, a recall bias might be present for those past two years. We cannot exclude the fact that owners remember things incorrectly or that they do not remember relevant details about past behaviour of their cat. To avoid this bias, a long-term (i.e. five to seven years) prospective study should be performed with cats that are correctly defined as being prepubertally gonadectomised (i.e. before the age of 12 weeks), taking into account that this requires considerable resources.

The conclusion of the present study is in agreement with the conclusion of most previous studies, namely, there is no difference in behaviour between PPG and TAG cats. However, one previous study did note a difference between PPG and TAG cats (Spain et al., 2004). All cats showed increased shyness and decreased hyperactivity, and early-age gonadectomised male cats showed increased hiding. Since these behaviours may appear after stressful events, for example adoption,

and later can resolve (Houpt, 1998), it was not clear if these behaviours were consequences of early-age gonadectomy or simply because the cats were adopted at a young age.
Although a large proportion of the cats (PPG + TAG) in our study showed the potentially undesirable behaviour 'hunting', this behaviour was usually not perceived as undesirable. The behaviour mostly reported as undesirable was 'destructive behaviour'. This shows that it might be interesting in the future to evaluate every behaviour separately for PPG and TAG cats, and evaluate if there exists a difference in occurrence between those two groups. Indeed, the present study evaluated the total number of (potentially) undesirable behaviours, but since some behaviours can be perceived as more undesirable than others, the total number of behaviours does not give a perfect idea about how much the cat is at risk for relinquishment. Of course, the total number of (potentially) undesirable behaviours can give some idea about this risk. The cat that showed most undesirable behaviours in this study (nine) is obviously at high risk for relinquishment, and it is advised that owners seek professional help for this cat.

Cats are not only relinquished because of behavioural problems. Other research has shown that up to 68% of the kittens being born are unexpected litters (New et al., 2004) and therefore might end up in shelters or on the streets. In the USA, adopters have to sign a contract that they will neuter their cat after adoption out of the shelter. Unfortunately, only less than 60% of these owners actually do neuter their animal (Root, 2007). Therefore, a better approach would be if shelters routinely neutered their cats before adoption. This applies to adult animals, but also to kittens. Since kittens can be adopted from the age of eight weeks old, prepubertal gonadectomy is unavoidable. Another significant proportion of the animals that enter the shelters are stray cats, both kittens and adult cats (Casey et al., 2009). Trying to lower the number of stray cats is therefore also an important step in reducing the amount of cats in shelters and cats being euthanized. Different techniques exist in an attempt to lower the number of stray cats. Hunting, poisoning, catch and euthanize or introduction of diseases are described and some of these techniques are still used in several European countries. The only technique used in Belgium is the trap-neuter-release (TNR) technique (Tasker, 2008). Since also kittens are being gonadectomised with this technique, again, prepubertal gonadectomy is unavoidable. As mentioned before, the previous measures are worthless if awareness about overpopulation of cats is not being raised in the human society (Natoli et al., 2006). In an attempt to do so, the Flemish government developed a plan for multiple years. According to this plan, firstly shelters were obliged to neuter all of the cats older than six months, before or after they were being adopted. Secondly, these shelters had to neuter all of the cats that were older than six months before leaving the shelter. In the third phase, also cats younger than six months had to be neutered. In phase four, cats sold by breeders had to be neutered. The fifth phase prohibited all publicity about selling cats. Although the last phase, which should have started in 2016, is not yet completely in operation, the goal is to have every cat born after 1/1/2011 neutered, identified and registered. The only exception for not neutering cats applies to cats bought by official breeders or cats being traded to a foreign country (FOD Volksgezondheid, 2011). Since kittens are often being sold before the age at

which traditional-age gonadectomy is performed (six months), once again, prepubertal gonadectomy is necessary in these kittens.

All of the previous proves that trying to reduce the number of stray cats and cats in shelters, is most efficient if it goes hand in hand with prepubertal gonadectomy. It is therefore of great importance that existing concerns about this subject are being challenged, and that governments, individuals and veterinarians become familiar with this technique. By proving in this study there is no reason for concern about long-term behavioural problems in prepubertal gonadectomised cats, the authors hope to contribute to this goal.

CONCLUSION

The present study provides statistically reliable conclusions about the total number of potentially undesirable and undesirable behaviours in prepubertal gonadectomised (PPG) and traditional-age gonadectomised (TAG) cats and the evolution of these behaviours over five to seven years after adoption. Since there was no statistically significant difference in the total number of potentially undesirable and undesirable behaviours and the behaviours did not evolve much over time, these results should be used by governments, veterinarians and individuals in an attempt to lower the number of pet cats ending up as stray cats and cats being relinquished to shelters.

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APPENDIX

Appendix 1

Name of the cat: ……..
Date:…….
Name of the organization where you adopted the cat: ……

Project Sterycat – Survey

Please mark the '◦' or the '▫'of the correct answers and answer the questions in full.

1) Is the cat still living at your home?
   Please select one of the values.
   - ◦ Yes
   - ◦ No

2) Why is the cat no longer in your family?
   - ◦ Not applicable
   - ◦ Briefly describe the reason:
     ……
     ……..
     ……
     ……..

3) According to you, does the cat still have problems of adaptation after adoption from the animal shelter?
   Please select one of the values.
   - ◦ No
   - ◦ Yes
     Specify:
     ……
     ……

4) Have you taken any action to remedy the problems of adaptation?
   Please select one of the values.
   - ◦ Not applicable

- Yes; briefly specify
  ……
  ….
- No

5) Have you consulted a veterinarian over the past 2 years because your cat was ill?
   - No
   - Yes
     mark all applicable reasons:
     - □ vomiting
     - □ diarrhea
     - □ constipation
     - □ sneezing and / or coughing
     - □ not eating, lack of appetite
     - □ not / painful urinating
     - □ excessive drinking and urinating
     - □ oversensitive reaction to vaccination
     - □ other; briefly specify:
       ……

6) Have any specific changes occurred in your family or in the day-to-day routine over the past 30 days?
   - Yes – which changes? *Mark all that is applicable:*
     - □ Change in working hours
       Did you observe a subsequent effect on your cat's behaviour?
       - Yes; briefly specify:
         ……
         …
       - No
       - I do not know
     - □ Changes in family composition / pets
       Did you observe a subsequent effect on your cat's behaviour?
       - Yes; briefly specify:
         ……
         …
       - No
       - I do not know
     - □ Move
       Did you observe a subsequent effect on your cat's behaviour?

- Yes; briefly specify:
  ……
  …
- No
- I do not know

□ Renovations
Did you observe a subsequent effect on your cat's behaviour?

- Yes; briefly specify:
  ……
  …
- No
- I do not know

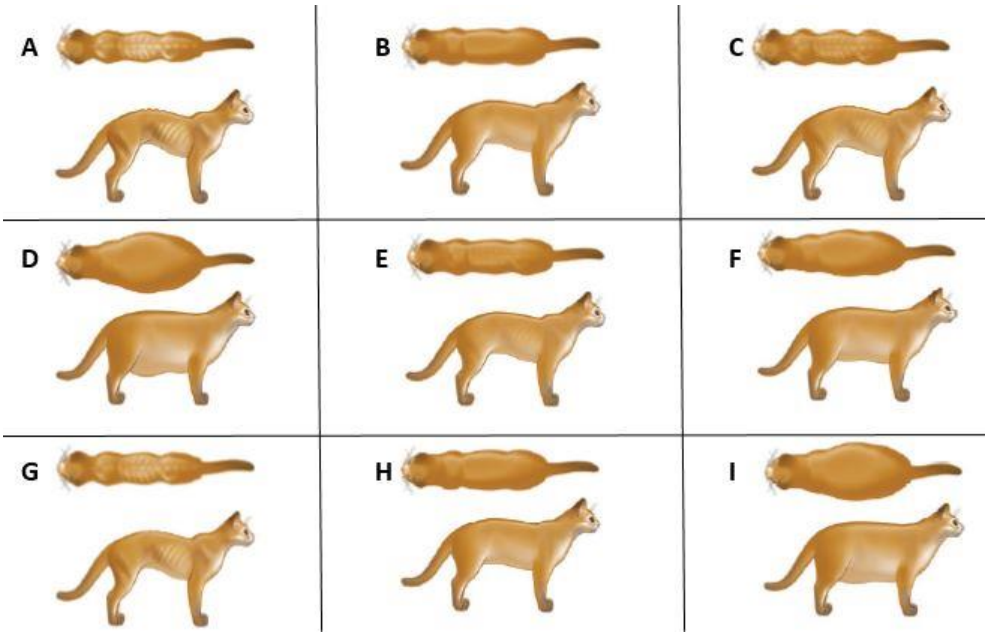
□ New pets
Did you observe a subsequent effect on your cat's behaviour?

- Yes; briefly specify:
  ……
  …
- No
- I do not know

□ Other; briefly specify:
……
….

- No

7) Mark which of the below pictures best corresponds to the shape of your own cat:
Please choose one of the values.



- Picture A
- Picture B
- Picture C
- Picture D
- Picture E
- Picture F
- Picture G
- Picture H
- Picture I

8) For each of the below behaviour descriptions, indicate whether or not it is currently existing with your cat. If you answer 'Yes' you are asked when this behaviour started. If you indicate 'No', the question follows whether this behaviour did occur at some point in the past two years. If this behaviour is currently existing, or when this behaviour occurred at some point in the past two years, you are asked whether this behaviour is or was annoying for you and / or members of your family. *Please mind: this is about frequently observed behaviour*.

Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*
Behaviour:	**Currently existing or not?** *Please select one value only.*	**If you answered 'Yes' in Column 2, when did this behaviour start?** *Please select one value only.*	**If you answered 'No' in Column 2, was this behaviour existing at some point in the past 2 years?** *Please select one value only.*	**If this behaviour is currently existing or was existing at some point over the past 2 years: is / was this annoying for you and / or the members of your family?** *Please select one value only.*
Quickly inclined to avoid certain noises,	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No

situations and people				
Demands a lot of attention	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Washing extremely frequently	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Is rather disobedient	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Mews a lot	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Is destructive and damages objects when the cat is home alone	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Hides when you or someone of your family walks into the room where the cat is	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Is rather quiet and little active	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Regularly munches, bites or scratches	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No

clothing that I am wearing				
Often gives people a painful bite while playing	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Is often restless and hyperactive	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Washes very rarely if ever	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Urinates indoors, not in the cat box	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Is rather seclusive	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Likes to play with other pets in the house	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Regularly munches, bites or scratches clothing that is lying on the floor	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No

Is quickly biting when being petted (not at play)	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Is often chased by other pets in the house and clearly dislikes this	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Hides when a strange pet walks into the room where the cat is	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Hunts for and catches prey (like birds, fish, insects, mice,…)	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Hisses and / or scratches people	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Uses furniture or other unsuited objects as a scratching post	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Is destructive and damages objects when I myself or someone of	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No

the family is at home				
Leaves droppings indoors, not in the cat box	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Munches or bites plants	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Exhibits sexual behaviour (e.g. riding people, animals, blankets, other objects,…)	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Steals food from the table	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Hides when a visitor walks into the room where the cat is	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Constantly licks its own coat at the same spot	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No

Frequently hisses and / or scratches other animals	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Hunts for, but does not catch prey (like birds, fish, insects, mice,…)	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Avoids rooms or indoor spaces where it is often busy	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Is nervous and quickly startled	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No
Likes to be petted	○ Yes ○ No	○ Less than 30 days ago ○ More than 30 days ago	○ Yes ○ No	○ Yes ○ No

Nearly there! These final questions relate to the living conditions of the cat.

9) Do you have a partner, child(ren) or homemate?
   - No
   - Yes: *please fill out the below table*

Sex	**Age**	**Relation** *<u>Please chose between:</u>* *child – partner – homemate– other (please specify)*

10) Do you have other pets (than the cat(s) involved in this project)
   - No
   - Yes: *please fill out the below table*

Name	**Animal species**	**Breed**	**Sex**	**Age**

11) You work / take lessons
   - Not applicable
   - According to a fixed schedule
     - only during the week (Mondays to Fridays)

- during the week and also during the weekend
- With irregular periods (early and late shifts, on call,…)
  - only during the week (Mondays to Fridays)
  - during the week and also during the weekend
- other:
  briefly
  specify:……..

12) You are living in a
- house
  - with garden and / or terrace and /or inner court
  - without garden and / or terrace and /or inner court
- apartment or apartment studio
  - with garden and / or terrace and /or inner court
  - without garden and / or terrace and /or inner court
- other
  briefly specify: ……..

13) Can the cat walk around indoors or outdoors when SOMEONE is at home?
Mark all relevant items
- □ indoors: where is the cat staying?
  - in a cat bench
  - in one or two rooms (e.g. kitchen, office, …)
  - access to one floor
  - access to the whole housetoegang tot hele huis
- □ outdoors :
  - the cat stays in the garden, inner court or on the terrace
  - the cat walks beyond our garden, inner court or terrace

14) Can the cat walk around indoors or outdoors when NOBODY is at home?
- □ indoors: where is the cat staying?
  - in a cat bench
  - in one or two rooms (e.g. kitchen, office, …)
  - access to one floor
  - access to the whole housetoegang tot hele huis
- □ outdoors :
  - the cat stays in the garden, inner court or on the terrace
  - the cat walks beyond our garden, inner court or terrace

15) Indoors, does your cat have at its disposal:
- □ basket
  - ○ 1
  - ○ several: ……. *(please specify number)*
- □ scratch-post
  - ○ 1
  - ○ several: ……. *(please specify number)*
- □ toys (miscellaneous)
  - ○ 1
  - ○ several: ……. *(please specify number)*
- □ open cat box
  - ○ 1
  - ○ several: ……. *(please specify number)*
- □ closed cat box
  - ○ 1
  - ○ several: ……. *(please specify number)*
- □ food bowl
  - ○ 1
  - ○ several: ……. *(please specify number)*
- □ waterbowl
  - ○ 1
  - □ several: ……. *(please specify number)*
- □ none of the above

16) Which of the below objects are separated from each other by less than half a meter?
- □ Water bowl(s) versus food bowl(s)
- □ Water bowl(s) versus each other
- □ Food bowl(s) versus each other
- □ Each object is separated from another by more than half a meter

17) On a day on which you do not have to work / attend lessons: how minutes (per day) do you / family member(s) spend on your cat? Number: …….minutes
(time spent on attending to the cat, paying attention and playing

18) On a day on which you have to work / attend lessons: how minutes (per day) do you / family member(s) spend on your cat? Number: …….minutes

(time spent on attending to the cat, paying attention and playing

19) What do you feed the cat? When requested, please also provide the brand.
- □ dry food (kibble,...)
  brand:…….
- □ wet food (canned,...)
  brand:…….
- □ kitchen leftovers
- □ deep-frozen food (BARF, ready-to-eat,…)
  brand:……..
- □ homemade meals (specifically prepared for the cat)
- □ other:
  briefly specify: ……

20) What food is available to the cat 24/24?
- □ dry food (kibble,...)
- □ wet food (canned,...)
- □ kitchen spillovers
- □ deep-frozen food (BARF, ready-to-eat,…)
- □ homemade meals (specifically prepared for the cat)
- □ other:
  briefly specify: ……...
- □ none (all food is provided in portions)

21) Can the cat eat food that is not intended for him / her?
- ○ Yes
- ○ No
- ○ I don't know

22) The cat can drink from *(mark all applicable items)*
- □ waterbowl
- □ electrical cat fountain
- □ aquarium

- □ pond
- □ puddles
- □ fountain or artificial well in the garden
- □ other:
  briefly specify

23) Finally, if you want to mention particular events, remarks or suggestions, you can write these down in the below frame.

THANK YOU VERY MUCH FOR YOUR TIME AND EFFORT!

DUTCH TWO-PAGE SUMMARY

As required by the procedures relating to the Master's Dissertation, a two-page Dutch summary of the dissertation is presented below.

Elk jaar worden in België nog steeds grote aantallen asielkatten geëuthanaseerd wegens overpopulatie (Kabinet Vlaams minister van Mobiliteit, Openbare Werken, Vlaamse Rand, Toerisme en Dierenwelzijn, persoonlijke communicatie). De belangrijkste redenen waarom katten in asielen terecht komen zijn problemen in de levensstijl van de eigenaars (verhuis, huisbaas die geen huisdieren toelaat of financiële problemen), gevolgd door gedragsproblemen bij de kat zelf (onzindelijkheid, problemen met andere huisdieren, vernielzuchtig gedrag, agressie en hyperactiviteit) (Salman et al., 1998). Een andere belangrijke reden waarom asielen kampen met overpopulatie van katten, is het grote aantal straatkatten dat hierin terecht komt (Casey et al., 2009). Er zijn verschillende manieren beschreven om het aantal straatkatten te verminderen, maar de enige techniek die momenteel in België gebruikt wordt, is de TNR (vangen-castreren-vrijlaten) techniek (Tasker, 2008). Hoewel dit een succesvolle techniek kan zijn, is het belangrijk dat er aan sensibilisering onder de bevolking wordt uitgevoerd over de castratie van huiskatten. Het is immers bewezen dat 68% van de nestjes van huiskatten ongepland zijn (New et al., 2004). Deze kittens komen vaak in asielen of op straat terecht, wat opnieuw leidt tot een verhoging van het aantal asiel- en straatkatten. Momenteel worden de meeste huiskatten traditioneel gesteriliseerd en gecastreerd vanaf een leeftijd van zes maanden, hoewel er geen enkel wetenschappelijk bewijs bestaat dat dit de optimale leeftijd is (Root, 2007). Aangezien katten al vanaf vier maanden leeftijd in puberteit kunnen komen (Schäfer-Somi et al., 2014), is het mogelijk dat zij al kittens hebben voordat ze gesteriliseerd of gecastreerd zijn.

Gonadectomie wordt gedefinieerd als het chirurgisch verwijderen van ovaria of testes (respectievelijk ovari(ohyster)ectomie of castratie). Er wordt een onderscheid gemaakt tussen vroegcastratie (VC) (tussen acht en twaalf weken leeftijd) (Porters, 2014), en laatcastratie (LC) (vanaf zes maanden leeftijd) (Joyce and Yates, 2011). Hoewel er al verschillende studies zijn uitgevoerd, bestaan er nog steeds grote meningsverschillen over het al dan niet uitvoeren van vroegcastratie, wegens bezorgdheden over het effect van vroegcastratie op het gedrag en de gezondheid van katten, zowel bij dierenartsen als niet-dierenartsen (Joyce and Yates, 2011; Farnworth et al., 2012; Moons C.P.H., Polis I., Diederich C., de Rooster H., niet-gepubliceerde data, 2015-2016).

Het doel van voorliggende studie bestond erin na te gaan of er een verschil is in het voorkomen van (potentieel) ongewenste gedragingen op lange termijn tussen katten die vroegcastratie (VC) ondergingen en katten die laatcastratie (LC) ondergingen. Ook werd de evolutie van deze gedragingen over een tijdsperiode van vijf tot zeven jaar geëvalueerd.

Eigenaars van katten die aan een vorig onderzoek in verband met vroegcastratie bij katten deelnamen (Porters, 2014), werden opnieuw gecontacteerd. Er werd gevraagd of ze een online enquête, bestaande uit 23 vragen, wilden invullen in verband met (potentieel) ongewenste gedragingen van hun kat(ten). In totaal werden 549 eigenaars gecontacteerd, waarvan er 187 de enquête invulden. Data

werden geëxporteerd naar Microsoft Excel 2010 en geanalyseerd gebruik makende van SAS versie 9.4 C (SAS Institute Inc., USA).

De populatie bestond voor 72% uit VC katten (n = 135), waarvan 61 mannelijke en 74 vrouwelijke katten. De andere 28% waren LC katten (n = 52), waarvan 25 mannelijk en 27 vrouwelijk. Om het totaal aantal (potentieel) ongewenste gedragingen te vergelijken tussen VC en LC katten, werd een t-test gebruikt. Er werd een gemiddelde van 3,24 (± 2.52) totaal aantal potentieel ongewenste gedragingen en een gemiddelde van 0.79 (± 1.49) totaal aantal ongewenste gedragingen vastgesteld in de VC groep. Een gemiddelde van 3.62 (± 2.37) totaal aantal potentieel ongewenste gedragingen en een gemiddelde van 0.81 (± 1.66) totaal aantal ongewenste gedragingen werd in de LC vastgesteld. Deze verschillen waren niet statistisch significant. Om de evolutie van de gedragingen in VC en LC katten over een tijdsperiode van vijf tot zeven jaar te bepalen, werd een longitudinaal model gebruikt. Opnieuw waren er geen statistisch significante verschillen, noch overheen de tijd, noch tussen de VC en LC groepen.

Het is aangeraden dat huidige resultaten gebruikt worden in een poging het aantal straatkatten en asielkatten te verminderen. Hiervoor kunnen asielen katten routinematig steriliseren en castreren alvorens ze geadopteerd worden (dus ook de kittens), straatkatten kunnen gesteriliseerd en gecastreerd worden (opnieuw ook de kittens) en eigenaars worden sinds 2016 verplicht katten die ze verkopen of weggeven te steriliseren en casteren (zo kunnen ook kittens gesteriliseerd en gecastreerd weggegeven of verkocht worden) (FOD Volksgezondheid, 2011). De resultaten uit deze studie tonen aan dat er geen enkele reden is tot het niet uitvoeren van vroegcastratie bij katten in verband met gedragsproblemen op lange-termijn.