Declawing has no effect on biting behavior but does affect adoption outcomes for domestic cats in an animal shelter.

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Abstract

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Opponents of declawing contend that it causes behavioral problems, whereas others, including the American Veterinary Medical Association, state that because destructive scratching is a risk factor for relinquishment and euthanasia, declawing is a reasonable alternative. If declawing causes behavior problems, the declawing of cats would put them at higher risk of surrender and euthanasia. If declawing does not cause behavior problems but it is assumed to, declawed cats could be at higher risk for lack of adoption and euthanasia at shelters.

We compared the estimate of the percentage of declawed cats in the general population to that found in the shelter population. We also examined the possible relationships between declawing and biting behavior, length of stay in a shelter, and euthanasia. Finally, we compared the number

of actual biting cats in the shelter to estimates of cats surrendered to shelters at large for the stated reason of biting. In *post hoc* exploratory analyses, in addition to declaw status, we included other variables that could contribute to predicting the likelihood of a cat biting, of being euthanized or of staying longer in a shelter. Biting behavior was operationalized as contact between a cat's teeth and a human such that the human's skin was broken.

We found that declawed cats were significantly underrepresented in the shelter as compared to estimates in the population at large. We found no significant correlation between declawing and biting behavior, or between declawing and euthanasia. We found a significant increase in the length of time that declawed cats spend at the shelter before being adopted. We also found that biting behavior was rarer in the shelter cats than would be expected based on owner reports for reasons of surrender on average to a shelter. Exploratory analyses of variables contributing to the risks of biting, lack of adoption, and euthanasia revealed a number of alternative explanatory factors.

Keywords: *Felis catus*, onychectomy, euthanasia, adoption, biting

Introduction

The declawing (onychectomy) of the domestic pet cat (*Felis catus)* is a controversial topic. Declawing is an elective procedure performed to prevent destructive or injurious scratching behaviors and consists of the amputation of all or part of a cat's third phalanges (AVMA, 2009). Scratching is a normal behavior for the cat, serving many purposes including territory marking; depriving an animal of its ability to express the full range of normal behaviors can be considered to be detrimental to its welfare (Wechsler, 2007). Therefore, declawing is banned in a number of countries, as well as in some municipalities in the United States ("The Paw Project," n.d.). However, the procedure remains legal throughout most of the United States and is performed routinely, with an estimated 24.4% of the 74 million owned cats in the United States being declawed (ASPCA, 2015; Patronek, 2001).

Opponents of declawing state that it causes a variety of physical, psychological and behavioral problems such as muscle weakening, arthritis and chronic pain; stress and depression; and litterbox avoidance and biting, respectively (Gaynor, 2005; "The Paw Project," n.d.; Tobias, 1994). Veterinary staff and shelter workers believe that declawed cats have markedly different demeanors than non-declawed cats, perhaps as a result of chronic pain or frustration, and are more likely to be aggressive and more likely to have inappropriate elimination (Atwood-Harvey, 2005; Patronek, 2001). Those opposed to rendering the procedure illegal, including the American Veterinary Medical Association (AVMA), contend that because destructive scratching is a risk factor for relinquishment and euthanasia, declawing remains a reasonable intervention, albeit only after all other behavioral modification efforts have been exhausted (Atwood-Harvey, 2005; AVMA, 2015; Landsberg, 1991b).

There are 1.4 million feline euthanasias in shelters every year, half of which are a result of behavioral problems (ASPCA, 2015; Salman et al., 2000). The top three behavioral reasons for relinquishment of a cat to a shelter are inappropriate elimination (37-43%), aggression (10-18%), and inappropriate scratching (12%) (Patronek, Glickman, Beck, McCabe, & Ecker, 1996; Salman et al., 1998, 2000). If declawing, which addresses reason number three, actually causes an increase in the top two reasons, as is asserted by opponents, then the declawing of cats would put them at higher risk of surrender and euthanasia. If declawing does not cause behavior problems but those who work with cats as well as the general public continue to assume that it does, declawed cats could be at higher risk for lack of adoption at shelters (leading to euthanasia in shelters that cannot hold animals indefinitely).

The objective of this research was to examine the possible connection between declawing and biting behavior using a descriptive approach with a large sample. We compared the estimate of the percentage of declawed cats in the general population to that found in the shelter population. We also examined the possible relationships between declawing and biting behavior, length of stay in a shelter, and euthanasia. Finally, we compared the number of actual biting cats in the shelter to estimates of cats surrendered to shelters at large for the stated reason of biting. After five pre-planned statistical tests, we expanded our analyses to include descriptive exploratory model fitting using a multivariate approach. In addition to declaw status, we included a number of other variables that might contribute to predicting the likelihood of a cat biting, of being euthanized or of staying longer in a shelter. There is some evidence that stray cats tolerate the shelter environment better than owner-surrender cats, which could affect their

outcomes, so we included intake type (e.g. stray) as a variable (Dybdall, Strasser, & Katz, 2007). Because anecdotal evidence has contributed to a number of contentions made about certain colors or color-types of cats (e.g. orange or tortoiseshell), including aggression, we also included color variations as variables (Delgado, Munera, & Reevy, 2012; Fogle, 1992, pp. 169-170). Length of stay at the shelter was included as an independent variable when examining biting behavior and euthanasia risk to check for possible habituation or lack thereof. Age and sex were also examined.

Materials and Methods

Study Site

Data were gathered from computerized records at a large urban animal shelter located near Seattle, WA. This shelter defines itself as "no-kill" or "low-kill" and only euthanizes animals that have been deemed unadoptable either for medical or behavioral reasons. It is a private, non-profit shelter, though it is contracted with certain local municipalities to accept stray animals.

Subjects and housing

Records were examined for all cats that visited the animal shelter between March 2, 2011 and June 21, 2012. Cats deemed feral by shelter staff, cats under the age of 1 year, and cats retrieved by owners within 24 hours were not included in analysis. Feral cats were excluded for two reasons: they are by definition un-owned and therefore unlikely to have had the expensive surgical procedure of declawing, and this shelter euthanizes the majority of feral cats within 24 hours of arrival. Juvenile cats (under the age of 1 year) were excluded because this study was focused on the behavior of adult cats; cats are sexually mature by 1 year of age (Vella, Shelton, McGonagle, & Stanglein, 2000, p. 23). Cats that returned to their home in under 24 hours were

excluded because they were not at the shelter long enough for proper assessment of their behavior. Of the remaining 1018 adult cats, 58 cats had two visits during this time period—for this study, only the first visit was considered. Three cats died, one cat escaped, and one cat had previously had a tendonectomy (a procedure that renders the claws useless but does not remove them altogether)—all were removed from consideration, leaving a total of 1013 unique cats. The cats were typically housed individually in metal cages. During quarantine or while meeting potential adopters, the cats may have been housed in other small rooms, though still singly.

Design

Retrospective and correlational statistical analyses of computerized records kept for each cat were performed. Biting behavior was strictly defined as contact between a cat's teeth and a human such that the human's skin was broken. This definition served a two-fold purpose: first, it removed the ambiguity that sometimes occurs when people say an animal has bitten them—contact with the teeth without breaking the skin is better described as an inhibited warning signal. Second, this definition guarantees that any animal that bit during the time period examined would have a computerized record associated with the behavior, as biting requires a documented ten day quarantine period in Washington State, in order to monitor for rabies.

Variables were defined as follows: *Declawed*: cats were considered declawed if they had either the two front or all four paws onychectomized (N=92); *Bite*: contact with a human such that teeth broke the skin (N=22); *Outcome*: euthanized or not (Ns=euthanized, 117; adopted, 836; transferred to another facility, 60). *Length of stay*: number of days spent in the shelter. The distribution of *Length of stay* was not normal

(qualitatively observed by q-q plot and quantitatively by measures of skewness and kurtosis); it was log-transformed and the q-q plot, skewness and kurtosis of the log-transformed data were within conservative acceptable levels.

Statistical Tests

Four *a priori* analyses and one *post hoc* analysis were performed. The family-wise error rate was Bonferroni-corrected and maintained at $p<.05$. χ^2 tests were done by hand; other statistics were done in R (R Core Team, 2014) or Systat 10 (Wilkinson, Blank, & Gruber, 1996). A Pearson's chi-squared (χ^2) goodness-of-fit test was used to compare the number of declawed cats in the shelter versus the estimate of the number of cats declawed in the general population. Logistic regression was used to examine the relationship between declaw status and biting behavior. An independent-samples t-test was used to examine the relationship between declaw status and the log-transformed length of time spent in the shelter. Logistic regression was used to examine the relationship between declaw status and the likelihood of euthanasia. A Pearson's χ^2 goodness-of-fit test (*post hoc*) was used to compare the number of biting cats in the shelter versus an estimate of number of cats surrendered to shelters for biting.

Model Fitting

In order to investigate whether declaw status might become relevant in the presence of other variables as well as to see if other independent variables might better explain the various dependent variables (biting behavior, length of stay and outcome), exploratory model fitting was performed. All available variables were considered in exhaustive screening using iterative generalized linear modeling with Akaike Information Criterion (AIC) comparison of all possible models to explain the three outcomes. See Figure 1.

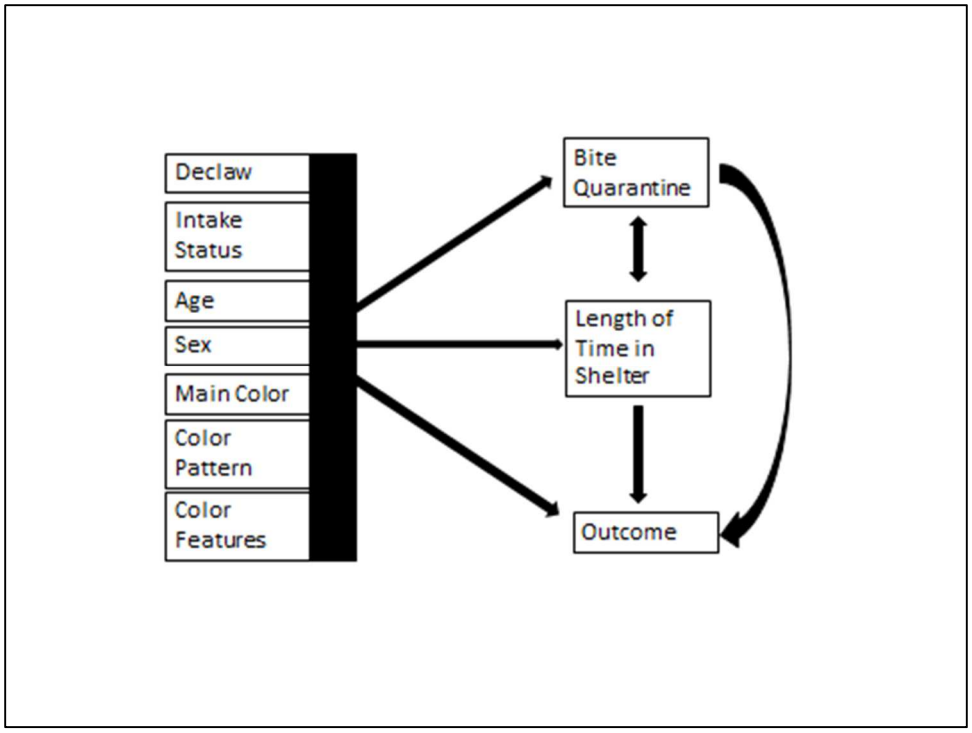

Figure 1. All possible independent variables tested for relationships with biting behavior, length of time in shelter, and risk of euthanasia.

Exhaustive screening was performed using the R package "Glmulti" (Calcagno, 2013; Calcagno & de Mazancourt, 2010). The variable *Length of Stay* was not independent from the variable of *Bite*, due to the mandatory 10 day quarantine, therefore 10 days were removed from the length of stay for all biting cats and this *Adjusted Length of Stay* variable was used in all models. Furthermore, *Adjusted Length of Stay* remained non-normal and was therefore log-transformed when serving as a dependent variable. A Kaplan-Meier survival analysis was applied to the relationship between *Adjusted Length of Stay* and bite risk. Additional variables considered in creating these best-fit descriptive models were defined as follows: *Age*: age in years; *Sex*: male/female; *Intake Status*: owner-surrender, stray, transferred in from another facility, seized by animal control officers; *Color*: main color (orange, black, white, brown); *Color pattern*: tabby, pied,

solid, calico/tortoiseshell, torbie; *Color features*: atypical (either dilute and/or pointed), typical (neither dilute nor pointed). Pointed cats are those with a genetically-based form of temperature-sensitive albinism and dilute cats have a pair of the recessive *dense pigment* alleles (Vella et al., 2000, pp. 140-141). The various color variables were included because the genetic underpinnings of color are well-understood and objectively observable, as well as being commonly (anecdotally) linked to various behavior issues (Delgado et al., 2012); **Breed*: excluded as a variable. Breed identification is highly subjective, unreliable and often arbitrarily based on hair length or color. The vast majority of the cats were classified as Domestic Short-, Medium, or Long-hairs. Other possible breeds were assigned based on colors (e.g. Russian Blue: grey), patterns (e.g. Maine Coon: tabby) or features (e.g. Siamese: points) and therefore the color variables should be adequate in addressing any possible breed-related differences.

Results

Number of declawed cats in the shelter v. estimate of number of declawed cats in the general population

There were significantly fewer declawed cats in the shelter than would be expected based on the population at large: $\chi^2(2, N = 1013) = 128.84$, $w=.36$, $p<0.001$. The 92 declawed cats in this study represented 9.1% of the sampled shelter cats versus approximately 24.4% in general population (Patronek, 2001).

The relationship between declaw status and biting behavior, length of stay in the shelter, and risk of euthanasia

Declawed cats were not more likely to bite than non-declawed cats. Logistic regression showed no effect of declaw status on the likelihood of biting ($p=0.456$). Declawed cats stayed 55% longer at the shelter. An independent t-test on the log-transformed data showed a

significant difference in the log length of stay at the shelter for declawed cats (M=3.28, SD=1.08) and non-declawed cats (M=2.85, SD=1.14), t(1011)= -3.539, 95% CI (-0.68, -0.20), p <0.001. Declawed cats were not more likely to be euthanized. Logistic regression showed no effect of declaw status on the likelihood of euthanasia (p=0.579).

Post-hoc analysis of number of biting cats in this shelter compared with an estimate of the number of cats surrendered to shelters at large for biting

In the literature, owners have reported biting as the sole reason for relinquishment 9.2% of the time (Salman et al., 2000). Biting behavior in this sampled population was significantly less than expected, at 2%. $\chi^2(2, N = 1013) = 59.9$, w=.24, p<0.001.

Model Fitting

Best-fit descriptive model for likelihood of biting

After testing 250 models, the logistic program "Glmulti" converged and returned color features, adjusted length of stay, age, and intake status as the best-fitting independent variables to explain the risk of biting in this population. However, it also returned a warning indicating a lack of fit. Stepwise removal of independent variables revealed an issue with main color and intake status. Investigation of the relationship between those two variables showed that there was one combination of main color and intake status that never existed in this sample, namely: white and seized by animal control. Given that main color was not returned as significant in the original model and intake status was, the decision was made to remove white cats (N=22) from the model and reevaluate. After testing another 250 models, the logistic "Glmulti" without white cats returned the same variables: color features, adjusted length of stay, age, and intake status as the best-fitting independent variables to explain the risk of biting in this

population. In both models, only color features and adjusted length of stay were significant explanatory variables for the risk of biting. The only noticeable difference in odds ratios for the significant variables was in color features: OR = 0.31 in the first model and OR = 0.33 in the second model. For this population of cats, the best-fitting logistic regression model indicated that cats with typical color features (not dilute, not pointed, N=764) were at decreased risk for biting (OR 0.33); cats who stayed longer at the shelter were at increased risk of biting (OR 1.02). Declaw status remained non-significant. To investigate whether the length of stay effect on biting was real or simply a result of random probability (cats that exist longer have a higher random chance of biting), we ran a Kaplan-Meier survival analysis. The bite hazard function was not significantly different from the overall survival function, indicating that the length of stay effect found by GLM was indeed attributable to random probability, Mantel $\chi^2(1, N = 1013) = 1.571$, p=0.210.

Best-fit descriptive model for likelihood of euthanasia

After testing 500 models, logistic "Glmulti" converged and returned color features, intake status, biting status, age, and adjusted length of stay, as the best-fitting independent variables to explain the risk of euthanasia in this population. The GLM of the returned variables showed color features to be non-significant; intake status, biting status, age, and adjusted length of stay were the best explanatory variables for the risk of euthanasia.

For this population of cats, the best-fitting logistic regression model indicated that, relative to cats surrendered by their owner, cats seized by animal control were at increased risk of euthanasia (OR 4.93), as were cats coming to the shelter as strays (OR 3.06). Cats transferred in from another facility were, relative to cats surrendered by their owners, at a decreased risk of euthanasia (OR 0.29), as were cats that stayed longer at the shelter (OR 0.97). Cats that bite at

the shelter were at a greatly increased risk of euthanasia (OR 45.83). Older cats experienced an increased risk of euthanasia (OR 1.43); Table 1. Declaw status remained non-significant.

Euthanasia Risk

Independent Variable	Log odds	Odds Ratio
Bite Quarantine-yes	3.82	45.83
Intake-seized	1.59	4.93
Intake-stray	1.12	3.06
Age (years)	0.36	1.43
Adj. Length of Stay (days)	-0.03	0.97
Intake-transfer in	-1.25	0.29
Color features-typical	ns	ns

Table 1. The log odds and odds ratios for euthanasia risk based on intake status, biting behavior, age, and length of stay. Relative to cats surrendered by their owners, stray cats and cats seized by animal control were at increased risk of euthanasia, as were cats that bit and older cats. Cats transferred in from elsewhere, relative to those surrendered by their owners, and cats that stayed longer at the shelter were at decreased risk of euthanasia.

Best fit descriptive model for variables relating to adjusted length of stay in the shelter

The distributions of adjusted length of stay and age were not normal (qualitatively observed by q-q plot and quantitatively by measures of skewness and kurtosis); they were log-transformed and the q-q plot, skewness and kurtosis of the log-transformed data were within conservative acceptable levels. While it is not required to log transform non-normal independent variables, it was done in this case for ease of comparison with the log-transformed dependent variable.

After testing 250 models, “Glmulti” including the log-transformed data converged and returned color features, intake status, sex, declaw status, biting behavior, and age as

the best-fitting independent variables to explain the length of time that a cat stays in the shelter.

For this population of cats, the best-fitting regression model indicated that, relative to cats surrendered by their owner, cats coming to the shelter as strays spent 17% less time at the shelter and cats transferred in from another facility spent 48% less time in the shelter. Cats with typical color features spent 31% longer at the shelter than those with atypical features (dilute or points). Male cats spent 20% less time in the shelter than female cats. Declawed cats spent 36% longer in the shelter than non-declawed cats. Cats that bit spent 227% longer than those that do not bite. For every log-year increase in age (~2.72 years), cats spent 15% more time in the shelter; Table 2.

Adjusted Length of stay, (log-transformed)

Independent Variable	B	SE	Change in log days (e^B)	% Change in length of stay
Bite Quarantine-yes	1.18	0.24	3.27	227%
Declawed	0.31	0.12	1.36	36%
Color features-typical	0.27	0.08	1.31	31%
Age (log years)	0.14	0.05	1.15	15%
Intake-transfer in	-0.65	0.10	0.52	-48%
Sex-male	-0.23	0.07	0.80	-20%
Intake-stray	-0.18	0.08	0.83	-17%
Intake-seized	ns	ns	ns	ns

Table 2: The linear increase in log-days based on color features, intake status, sex, declaw status, biting behavior, and log-age. Cats with typical color features, declawed cats, older cats and cats that bit spent significantly longer in the shelter. Cats that arrived as strays or transferred in from another facility (as opposed to being surrendered by the owner) spent significantly less time in the shelter, as did male cats.

Discussion

There was no association between declawing and biting behavior in these 1013 shelter cats. This study supports the findings of previous studies that have investigated the possible relationship between declawing and problem behaviors and have found no correlation between declawing and biting (Bennett, Houpt, & Erb, 1988; Landsberg, 1991a; Morgan & Houpt, 1989; Patronek, 2001; Yeon, Flanders, Scarlett, Ayers, & Houpt, 2001).

There was a relationship between declaw status and how long a cat stayed at the shelter, with declawed cats staying on average 36%, or approximately 12 days, longer than non-declawed cats. This could be because declawed cats were showing problem behaviors in the shelter that were not captured by the metric of uninhibited biting behavior. However, there was no association between declaw status and euthanasia. If declawed cats were showing undesirable behaviors causing them to be less likely to be adopted and stay longer at the shelter, it is reasonable to expect an increase in euthanasia as a result. Given that declawed cats were not more likely to be euthanized but did wait longer to be adopted, the possibility exists that declawed cats are being discriminated against by the general public and/or the shelter staff, based on beliefs about their behavior. Shelter staff, in general, believe that declawed cats have behavior problems (Patronek, 2001). Based on these beliefs, it is not unreasonable to consider that they might direct potential adopters away from declawed cats.

Declawed cats were underrepresented in this shelter population. This could be the result of a protective effect offered by declawing, as has been hinted by trends in past studies (Patronek et al., 1996). Declawed cats are by definition incapable of destructive scratching and may not anger the owner as often as intact cats, leading to a better relationship (Landsberg, 1991a). Also, declawing is an expensive procedure and it may be the case that declawed cats already have desirable temperaments and behaviors other than destructive scratching, such that the owner is

willing to invest more money in the cat, and is therefore less likely to surrender the cat to a shelter (Bennett et al., 1988). Overall, owners tend to be pleased with the results of declawing (Landsberg, 1991a; Yeon et al., 2001). It is also possible that the underrepresentation of declawed cats in this shelter is a reflection of changes in the rate of declawing: the most recent estimate of the number of declawed cats in the US (24.4%) is 14 years old (Patronek, 2001). However, one recent study looked at the prevalence of declawing in cats near Raleigh, NC and found that almost 21% of cats were declawed (Lockhart, Motsinger-Reif, Simpson, & Posner, 2014). Clearly declawing is still prevalent, though more information is necessary to make accurate estimates. Regardless of whether declawing is mildly protective or not, declawed cats do end up in the shelter. 9.1% of the cats in this shelter were declawed; that translates into approximately 6.8 million cats in the United States that, if they end up in a shelter, may be at risk for being overlooked for adoption based on beliefs about their behavior.

Our final analysis was a *post hoc* comparison of actual biting cats in the shelter, as compared to estimates of biting as a reason for relinquishment in shelters at large. Approximately 400,000 cat bites occur each year in the US and account for 3%-15% of all animal bites (Kravetz & Federman, 2002). If each of the bites was perpetrated by a unique cat, the result would be 400,000 cats out of approximately 74 million owned cats, or a 0.005% rate of biting cats. It stands to reason that cats being relinquished to a shelter might have higher incidences of behavior problems, including biting; biting is cited as a reason for relinquishment 17.2% of the time and as the sole reason 9.2% of the time (Salman et al., 2000). We found that only 2% of the cats in this shelter bit during their tenure, a significantly smaller number than that claimed by surrendering owners. There are many possible explanations for this finding. It is possible that biting is more rare in the shelter than in the home; rather than getting more

aggressive when in the stressful shelter environment, it is likely that cats practice a "conservation-withdrawal" strategy in response to the stress of the shelter, and offer fewer of their typical behaviors, including biting (Carlstead, Brown, & Strawn, 1993). It is also possible that owners are using a more general definition of biting behavior, failing to differentiate between bites that break the skin (uninhibited) and bites that do not (inhibited), different behaviors that can lead to different conclusions about motivation and temperament. It is also possible that cats, by virtue of random probability associated with the amount of time spent in the home versus in the shelter, have more chances to bite at home. Overall, uninhibited biting behavior in cats is rare.

After failing to find support for the claim that declawing is related to an increase in biting behavior or euthanasia, we explored our data set in an effort to define those variables that *were* correlated with biting behavior and euthanasia. We also wondered what other variables might have contributed to a longer stay at the shelter, in conjunction with being declawed. The resulting findings were descriptive in nature, based on data-mining procedures that must be validated in the future on a new subset of shelter cats in order to have predictive value.

With regards to risk of biting, we found that cats with typical color features were at a decreased risk for biting relative to pointed cats and dilute cats. It is possible that there is a genetic component to this decreased risk; however, more research would need to be done to determine such a relationship.

The risk of euthanasia was influenced by intake type, biting status, age, and length of stay at the shelter. Relative to cats surrendered by their owner, cats seized by animal control were at increased risk of euthanasia, as were cats coming to the shelter as strays, whereas cats transferred in from another facility were at a decreased risk of euthanasia.

Significant differences in stress level and illness has been found between stray cats and those surrendered by their owner: stray cats were found to have higher levels of disease at presentation to that shelter and were more likely to be euthanized for that reason, while owner-surrendered cats showed higher stress levels and became ill more quickly than stray cats once in the shelter (Dybdall et al., 2007). It is possible that the increased risk of euthanasia for the stray and animal-control-seized cats in our sample reflects a similar higher incidence of disease when they arrived, though it is not possible to know for sure because the computerized records did not include that information. It is also possible that stray cats, because they are actually less stressed at the shelter, show a broader range of behaviors while at the shelter, which could include undesirable behaviors (other than biting). Cats transferred in from another facility might be a decreased risk of euthanasia relative to owner-surrender cats because they have already survived the separation from their owner, the initial stress of a shelter and the commonly concomitant illnesses, before arriving at this facility, possibly reflecting habituation. Habituation could also explain the decreased risk of euthanasia associated with a longer stay at the shelter.

Cats who bit during their tenure were at a much higher risk of euthanasia, likely because biting is a behavior that might cause them to be deemed unadoptable by the shelter. Older cats also were more likely to be euthanized. This could be because older cats are more likely to have medical problems that make them less adoptable. It is not possible to be certain as to why these cats were euthanized, as specific reasons for euthanasia were not often available in the records at this shelter.

The factors that influenced the length of stay at the shelter for these cats were intake status, color features, sex, declaw status, biting behavior, and age. Relative to cats surrendered by their owners, both stray cats and cats transferred in from other facilities spent significantly less

time at the shelter. Given that stray and transferred cats might be less stressed than owner-surrendered cats, it is possible that these cats were better able to demonstrate a broader range of behaviors. There is evidence that adoption is more likely when potential adopters can assess the personality of the cat (DiGangi, Crawford, & Levy, 2006; Neidhart & Boyd, 2002). The increased risk of euthanasia for stray cats likely also contributed to their shorter stay times.

Dilute and pointed cats spent significantly less time in the shelter than those cats with more common color features. Previous findings have indicated that pointed cats and grey cats (dilute form of the black cat) are more readily adopted than the more typical tabby cat, which could account for their shorter stay times (Lepper, Kass, & Hart, 2002). The appearance of a cat, including color, is often a main reason for choosing a cat, in conjunction with their personality; appearance-related beliefs about cat personality are likely to play a role in the decision to adopt a particular cat (Delgado et al., 2012; Podberscek, 1988). It is possible that beliefs associated with points or dilution influenced the outcomes of these cats. It is also possible that these cats are considered more desirable because they are less common.

Male cats spent significantly less time at the shelter than female cats. It is possible that this is a result of beliefs about the behavior and personality differences between the two sexes based on appearance as well. The gene for orange coloration is carried on the X chromosome. A male cat with the dominant form of the gene will be orange and with the recessive will be non-orange, whereas a female cat needs two dominant alleles to be orange, two recessive to be non-orange, and a dominant and recessive combination will create the tortoiseshell coloration. As a result, male cats are slightly more likely than

females to be orange and all tortoiseshell (and calico, which combines the dominant and recessive orange alleles with a white spotting gene) cats are female, barring rare genetic abnormalities (Vella et al., 2000, pp. 143-145). Calico and tortoiseshell cats are perceived as less friendly, more aloof and intolerant, stubborn, independent, and unpredictable—it is possible that these beliefs may be generalized to some extent to all female cats (Delgado et al., 2012). Orange cats, in contrast, are more likely to be described as friendly, less aloof, and more tolerant—again, it is possible that these beliefs could be generalized to all male cats (Delgado et al., 2012). It is also possible that male and female cats behave differently at the shelter, perhaps due to differing responses to stress, though this has not been investigated.

Older cats stayed longer at the shelter, likely because they are less likely to be adopted (Lepper et al., 2002). Cats that bit spent significantly longer at the shelter as well, perhaps because they were not considered by the staff to be the best adoption candidates. Declawed cats also spent a significantly longer time at the shelter, again, possibly due to perceived lack of adoptability based on beliefs regarding undesirable behaviors associated with declawing.

Conclusions

Declawing is not statistically associated with biting behavior, nor is it associated with any problem behavior cited as a reason for relinquishment. Given the prevalence of this surgery and the controversy surrounding it, more research should be undertaken to explore what, if any, long-term negative outcomes may arise as a result of declawing. Until or unless such research exists, an effort should be made to educate shelter staff, veterinary staff, and the general public, so as to avoid discrimination against declawed cats that find themselves in an animal shelter. Misinformation about sex and color attributions should be similarly addressed.

With regards to the exploratory analyses, the risks of biting, lack of adoption, and euthanasia could potentially be mitigated by interventions designed to decrease stress in the shelter environment, such as minimizing loud noises and intrinsically unpleasant conditions, consistency with human caretakers, consistency with diet, and hiding and perching areas (Carlstead et al., 1993; Stella, Lord, & Buffington, 2011; Vinke, Godijn, & van der Leij, 2014).

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