

Should cats be allowed outdoors? A research survey on animal welfare risks for free-ranging cats in Brazil

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Abstract

A need exists for research that contributes to estimating the risk factors associated with the management of outdoor cats (*Felis silvestris catus*) and addresses the lack of such surveys in Brazil and other Latin American countries. With this in mind we aimed to: i) identify the causal factors affecting the practice of owners allowing their cats to roam freely and; ii) evaluate potential welfare risks associated with the allowance of outdoor access, based on cat owners' reports. An online questionnaire consisting of 25 questions was answered by 8,485 Brazilian cat owners and logistic regression models used to obtain odds ratios. A number of the factors significantly related to owners allowing their cats to have outdoor access were unneutered cats, the manner in which the cat was acquired, residence in rural areas, the number of cats owned, the presence of other pets in the house, younger owner age, owner declaration of not being responsible for the cat, owner perception about the role of the cat in the house, owner knowledge about cats' potential for transmitting diseases, a lack of knowledge about zoonoses, and a lack of knowledge regarding toxoplasmosis. The practice of allowing outdoor access was associated with significantly higher odds of owners reporting several welfare issues, such as frequent flea contamination, sporotrichosis, going missing, poisoning, mistreatment, and accidents. We conclude that the practice of allowing outdoor access, as reported by 37.1% of our respondents, may result in risks to feline welfare. Increasing public awareness through campaigns that highlight the risks associated with outdoor access would improve feline management practices and welfare.

Keywords: animal welfare, cat owners, *Felis silvestris catus*, management, online questionnaire, risk factors

Introduction

In recent years people's preference for having domestic cats as pets (*Felis silvestris catus*) has increased, generating the need for a greater understanding of how these animals are kept and treated (Sandøe *et al* 2017, 2018). Regarding the management of cats, there is a lot of disagreement as to which strategy is the most appropriate (Wald *et al* 2013; Yeates & Yates 2017). Some argue that these animals need to free-roam, ie that they be allowed to go where they please, without restrictions artificially imposed on their dwelling areas, and be able to exhibit natural behaviours, such as predation (Jongman 2007; Sandøe *et al* 2018; Crowley *et al* 2019). Free-roaming, or free-ranging, owned cats are free-circulating cats that have a residence but spend most of their time outdoors (Levy & Crawford 2004; Crowley *et al* 2019). While others contend that the most appropriate way to keep cats is exclusively confined (indoors), with the owner controlling their animals' feeding, reproduction, and movements, with limited access to external environments (Rochlitz 2003, 2004a,b; Jongman 2007; Sandøe *et al* 2017).

The management choice (indoor or outdoor) may be linked, for example, to cultural aspects, which would perhaps differ depending on the owners' country of origin (Delgado & Reevy 2018; Escobar-Aguirre *et al* 2019; Rochlitz & Yeates 2019). In the US, for example, the indoor management of cats is widely recommended, with it speculated that most cat owners keep their animals indoors (Hall *et al* 2016; Rochlitz & Yeates 2019). In the UK and Denmark, however, most owners allow their cats outdoor access (Siracusa & Provoost 2016; Sandøe *et al* 2018; Rochlitz & Yeates 2019). In Brazil, no information exists on the management style most commonly adopted by cat owners, which suggests a need for research that addresses the impacts of outdoor management and its implications for feline welfare. An investigation of the types of factors or environmental characteristics (for example, the type of residence) that affect the practice of allowing cats to roam freely is also relevant. In terms of feline welfare, both management practices (indoor or outdoor) might encompass risks and benefits, generating a debate about which is more appropriate (Yeates & Yates 2017). For instance, indoor cats are generally more

likely to develop obesity as well as certain types of behavioural problems, such as separation-related problems, urination in inappropriate places, destructive behaviour and aggression (Rochlitz 2005; Stella & Croney 2016; Sandøe *et al* 2017; Yeates & Yates 2017; Finka *et al* 2019; Machado *et al* 2020a,b). On the other hand, outdoor cats might be exposed to contagious diseases, car accidents and other hazards, such as mistreatment and poisoning (Shamir *et al* 2002; Rochlitz 2004a,b; Lockwood 2005; Natoli *et al* 2005; Yeates & Yates 2017; Chalkowski *et al* 2019). However, little comparative research has been applied to the indoor/outdoor dilemma, comparing the risks and benefits of each option (Siracusa & Provoost 2016; Sandøe *et al* 2017; Yeates & Yates 2017; Chalkowski *et al* 2019; Tan *et al* 2020), or the different types of risks associated with outdoor management.

Considering the need for research that contributes to estimating risk factors associated with the outdoor management of owned cats, and the lack of such surveys in Brazil and other Latin American countries, we aimed to: i) identify the causal factors that affect the practice of owners allowing their cats to roam freely and; ii) evaluate potential welfare risks associated with the allowance of outdoor access, based on cat owners' reports.

Materials and methods

Ethical statement

As the questionnaire was carried out online and the survey did not collect any personally identifiable data on subjects, it is exempt from the requirement of institutional review board or ethical committee review, according to the Brazilian Ethical Standards of Scientific Research Involving Human Subjects (Resolution n 510/2016 of the National Health Board). Ethical goals were attained by ensuring the non-identified respondents were fully informed about who conducted the research and the content and purpose of the study so that they could make an informed decision about whether they wished to participate. Confidentiality and anonymity were assured. Respondents were also informed that their participation did not imply any type of financial or other compensation and that they could withdraw from answering the questionnaire at any time.

Questionnaire structure and application

A questionnaire with 25 questions, written in Portuguese to be answered by Brazilian cat owners, was developed based on published papers about feline management (Buffington 2002; Rochlitz 2005; Sandøe *et al* 2018). The questionnaire was composed of multiple- and forced-choice questions, in addition to open-ended questions to gather respondents' information (Table 1; see supplementary material to papers published in *Animal Welfare*: <https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material>). Three sets of closed-questions were included: i) one question regarding whether or not cats were allowed outdoor access to define the predominant type of management that the owner declared to practice (indoor or outdoor); ii) 13 questions regarding feline neutering, manner in which the cat was acquired (appeared at the owner's house, adopted as a stray, adopted from a shelter, was a gift or was bought), in

addition to characteristics of the environment (type of residence, number of cats dwelling in the household, presence of other pets in the household) and owner's information (state of residence, sex, age, primary responsibility for the cat, perception about the role of the cat in the house, knowledge regarding the potential of cats to transmit diseases, knowledge about zoonoses, knowledge of toxoplasmosis); iii) eleven questions related to previous occurrences of welfare issues as reported by the owners (flea contamination, sporotrichosis, going missing, poisoning, mistreatment, feline immunodeficiency virus [FIV]/feline leukemia virus [FeLV], respiratory tract diseases, accidents, visits to the veterinarian, vaccination and deworming).

Through convenience sampling, survey respondents were recruited using the virtual snowball sampling method. The questionnaire link was sent via social networks (e-mail, Facebook, Instagram, and WhatsApp) using the free online survey tool 'Google forms' (Google). The respondents were allowed to participate only if they met the criteria of owning at least one cat. Data collection took place between 24 January and 23 March, 2019 and a total of 8,610 participants from all Brazilian states answered the questionnaire, with the highest concentration of responses from the south-east region of Brazil. Thereafter, cleaning of the dataset was performed, in which answers considered dubious based on the participant's age (must be above 18 years old) and the number of cats (zero cats or more than 55 cats were excluded). Thus, 8,485 responses were analysed.

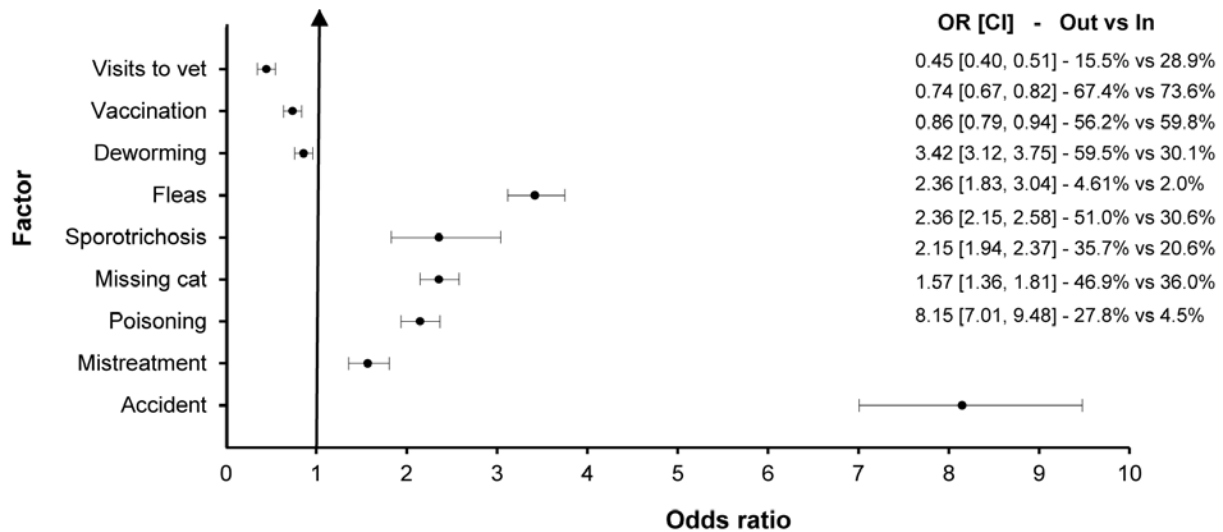
Data analysis

Descriptive data analyses were initially performed by obtaining the absolute and relative frequencies of responses. Then, logistic regression analyses were performed with a logit-link function for binomial response variables. Logistic regression models generate the probability associated with the occurrence of a given event, estimated through the odds ratio (OR) as a function of one or more independent variables (fixed effects). All analyses were performed using the Statistical Analysis System (SAS, version 9.2, SAS Institute Inc, Cary, NC, USA), and *P*-values were considered significant when $P < 0.05$.

First, we tested the effects of the manner in which cats were acquired as well as neutering status, in addition to environmental factors and owner information, on the probability of outdoor access allowance. Logistic models included the type of management as a binomial dependent variable (indoor vs outdoor), and each of the independent variables were analysed in separate models. The OR was calculated by exponentiating the regression coefficients (β). The OR refers to the amount the probability of outdoor access increases or decreases for each independent variable category in comparison to the reference class, with OR = 1. Odds ratios with 95% confidence intervals (95% CI) and *P*-values were estimated for the independent variables (feline neutering and the way cats were acquired, environmental characteristics, and owner information).

The effects of outdoor access on the occurrence of several factors that are considered to be welfare issues for free-roaming cats were evaluated. The logistic models included the following dependent variables with a binomial distribution (occurrence vs non-occurrence): frequency of visits to a veterinarian, vaccina-

Figure 1



Odds ratios (OR) for welfare issues for outdoor compared to indoor cats (OR = 1, vertical black line), as reported by cat owners (n = 8,485). Confidence intervals (CI) are expressed by the horizontal bars. The percentages (%) of each welfare issue reported for outdoor (Out) vs indoor cats (In) are included.

tion, deworming, flea contamination, sporotrichosis, FIV/FeLV, respiratory tract diseases, going missing, mistreatment, poisoning, and accidents. Type of management (indoor vs outdoor) was included as an independent variable, with indoor management defined as the reference class (OR = 1), so that the OR of outdoor access could be obtained and discussed.

Results

Factors affecting the allowance of outdoor access

The most common management practice reported by the Brazilian owners surveyed in this study was to keep cats indoors (62.92%; 5,339/8,485). Among the owners surveyed, 37.08% (3,146/8,485) allowed their cats to have outdoor access. We evaluated whether feline neutering, the way the cat was acquired, and owner information and environmental characteristics affected the likelihood of outdoor access. The permission of outdoor access was significantly associated with the way the cat was acquired ($\chi^2 = 742.90$; $P = 0.001$) and neutering ($\chi^2 = 184.75$; $P = 0.001$); type of residence ($\chi^2 = 1,622.70$; $P = 0.001$); number of cats in the house ($\chi^2 = 81.32$; $P = 0.001$); and the presence of other pets in the house ($\chi^2 = 477.89$; $P = 0.001$) (Table 2; see supplementary material to papers published in *Animal Welfare*: <https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material>). Regarding owner information, sex ($\chi^2 = 4.81$; $P = 0.03$); age ($\chi^2 = 55.83$; $P = 0.001$); responsibility for the cat ($\chi^2 = 119.61$; $P = 0.001$); perception about the role of the cat in the house ($\chi^2 = 125.76$; $P = 0.001$); knowledge about cats' potential for transmitting diseases ($\chi^2 = 138.69$; $P = 0.001$); knowledge about zoonoses ($\chi^2 = 6.44$; $P = 0.01$); and knowledge about toxoplasmosis ($\chi^2 = 43.62$; $P = 0.001$) were related to the permission of outdoor access (Table 2; <https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material>).

The chances of owners declaring that they allowed their cats to have outdoor access were higher in cases of unneutered cats,

cats that appeared at the house as a stray and were adopted, residences in rural areas, houses with four to ten cats and houses with other pets, ie with animals of other species (Table 2). In addition, those who identified as male owners, were aged 18 to 35 years, respondents who did not declare themselves as responsible for their cats, owners who perceived their cat as a pet, those who had knowledge of cats as potential disease transmitters, but a lack of knowledge about zoonoses and lack of knowledge about toxoplasmosis were more prone to declare that they allowed their cats to have outdoor access (Table 2).

Feline welfare issues related to outdoor access

Logistic regression analyses were also performed to evaluate risk factors to the welfare of cats according to their type of management (indoor vs outdoor), with indoor management defined as the reference class (OR = 1). Thus, the variables that had a significant relationship with the declared type of management were: visits to the veterinary clinic ($\chi^2 = 203.95$; $P = 0.001$); vaccination ($\chi^2 = 36.82$; $P = 0.001$); deworming ($\chi^2 = 10.29$; $P = 0.001$); flea contamination ($\chi^2 = 709.21$; $P = 0.001$); sporotrichosis ($\chi^2 = 44.66$; $P = 0.001$); going missing ($\chi^2 = 346.48$; $P = 0.001$); poisoning ($\chi^2 = 230.56$; $P = 0.001$); mistreatment ($\chi^2 = 37.72$; $P = 0.001$) and accidents ($\chi^2 = 922.15$; $P = 0.001$) (Figure 1). No significant effect of management type was found for the previous report of FIV/FeLV and respiratory tract diseases ($P > 0.05$).

Thus, owners who allowed their cats to have outdoor access were more likely to report previous occurrences of frequent flea contamination, sporotrichosis, going missing, mistreatment, and accidents, as evidenced by a higher OR (Figure 1). Regarding indoor management, owners who stated that they kept their cats indoors were more likely to report frequent visits to the veterinarian, vaccination, and deworming, given the higher OR for indoor (Figure 1).

Discussion

In this study, we aimed to gather owners' reports and information to contribute to the debate regarding the most appropriate type of management for domestic cats (indoor vs outdoor), with a focus on the causal factors and risks related to the permission of outdoor access. Most of the owners surveyed did not allow their cats to have outdoor access, and about one-third reported allowing their cats to roam. We identified a few factors related to the chance of owners stating that they allowed their cats to have outdoor access, such as male owners, residences in rural areas, houses with four to ten cats, and houses with other pets. The outdoor permission increased the risks of frequent flea contamination, sporotrichosis, going missing, mistreatment, poisoning, and accidents. Thus, the practice of allowing cats to roam freely might result in risks for feline welfare, some of them highly lethal, such as carbamate poisoning and car accidents (Marlet & Maiorka 2010; Siracusa & Provoost 2016).

In general, various papers addressing risk factors related to free-roaming cats have focused on unowned, abandoned and feral cats (Sparkes *et al* 2013; Gunther *et al* 2015; Seo & Tanida 2018). A recent systematic review (Foreman-Worsley & Farnworth 2019) found that most studies with domestic cats were carried out in shelters, laboratories and on feral animals in places where cats had major ecological impacts, such as islands (Bruce *et al* 2019; Foreman-Worsley & Farnworth 2019; Zito *et al* 2019), with only 21 articles directly addressing cats in at-home, indoor scenarios (Foreman-Worsley & Farnworth 2019). The little empirical information available comparing the risks for feline welfare related to indoor vs outdoor access originates from Europe (Sandøe *et al* 2017), with scarce literature in Latin American countries (Escobar-Aguirre *et al* 2019). In addition, the method of management might vary across countries and regions. In a survey conducted in Denmark, with a representative sample, only 16.8% of owners reported that their cats had 'No outdoor access' (ie cats were kept exclusively indoors), while 38% had 'Outdoor access when owner lets the cat out', 25% had 'Outdoor access through cat flap', 8.8% were 'Outdoor that rarely or seldom comes inside', 7.8% had 'Access to a closed garden' and 3.6% of cats had 'Only outdoor access part of the time' (Sandøe *et al* 2017). In a survey conducted in Australia to assess cats' management practices reported by cat owners, half of them allowed their cats to roam freely outdoors (49%) (Howell *et al* 2016). While another study conducted in Chile found that approximately 66% of respondents reported allowing free access to the outdoors (Escobar-Aguirre *et al* 2019). Within our sample of Brazilian cat owners, the most common practice is to keep cats indoors since only 37.1% of owners reported outdoor management.

It was possible to observe a significant relationship between the allowance of outdoor access and the cats' neuter status. Although it was less frequent in the sample, the 'unneutered' cats had the highest frequency of outdoor access. This result could be explained, in part, by the cats' behaviour since unneutered cats are more motivated to roam in search of

sexual partners (Ferreira *et al* 2016; Cafazzo *et al* 2019). Although there is still a debate as to the implications of neutering for the welfare of domestic cats, research has indicated that it reduces fights between conspecifics and the likelihood of disease transmission; making it recommendable for cats with outdoor access (Cafazzo *et al* 2019; Ferreira *et al* 2020). Remaining intact may increase the number of unowned and feral cats in urban and peri-urban environments, leading to concerns related to public health, animal welfare, and ecological problems (Loss & Marra 2017; Bruce *et al* 2019; Escobar-Aguirre *et al* 2019).

Where cats were acquired was also related to the owners' report of permitting outdoor access. Cats that 'appeared at the owner's house' were six times more likely to have outdoor access than those that were purchased, which had the lowest frequency of outdoor access. We also observed a significant relationship between the allowance of outdoor access and the presence of other species of pets in the home, as also observed in other studies carried out in Germany (Kuhne *et al* 2019) and in Chile (Escobar-Aguirre *et al* 2019). In houses with a higher number of animals, maintenance in closed environments could be more challenging given the greater likelihood of agonistic interactions among them.

The type of residence also impacted owners' management practices, with a greater chance of owners reporting the allowance of outdoor access for farm-living cats, followed by houses in urban areas, and a reduced likelihood in apartments, as expected. In general, animals living in apartments are more confined, as apartments are generally situated at height and located in densely populated areas (Sandøe *et al* 2018). In contrast, owners living on farms and in houses face more difficulty in restricting cats' movements. It is evident that many Brazilian residences lack structural possibilities to limit the cats from roaming freely unless the animal remained confined to a room. Thus, most of the owners of outdoor cats may lack the opportunity to restrict the cats' movements. However, a portion of the owners who reported allowing outdoor access might do so because they see this practice as beneficial to the welfare of their cats (Machado *et al* 2020b). One limitation of the questionnaire was not including a question addressing these points in more detail.

With respect to owner characteristics, male respondents had a higher likelihood of allowing outdoor access than females. A study showed that female owners might pay more attention to their cats, showing greater attachment to the pet under their care than males (Martens *et al* 2016). In addition, female owners are also more likely to report satisfaction with their cats' behaviours, to rate highly on statements regarding their ability to care for them and be more likely to report more checks and/or treatment for parasites (Howell *et al* 2016). Kuhne and collaborators (2019) also observed more responsible practices in women. That is, they were more likely to neuter, identify, and register their cats more frequently than male respondents. These previous studies perhaps reveal that the sex of owners implies different styles of feline management practices, as we found. Regarding the age of owners, 18 to 35 year old respondents reported allowing greater outdoor access compared to elderly respon-

dents (60 to 91 years old). This may be related to the fact that people over 60 years of age might spend more time at home, given their retirement, leading them to expend more time and attention on their cats' care.

Nowadays, the perception of companion animals as members of the human family has become more common among pet owners (Downey & Ellis 2008; Howell *et al* 2016; Martens *et al* 2016; Pongrácz & Szapu 2018; Grigg & Kogan 2019; McConnell *et al* 2019). So, we hypothesised that owners, who viewed their cats as members of the human family, as well as those who were primarily responsible for the cat, would be more prone to adopt indoor management practices. Most of the participants (94.48%) answered that they loved their cats, which were part of the human family, and among them, 64.36% adopted indoor management practices. Among respondents that did not declare themselves as being primarily responsible for the cat, the chances of allowing outdoor access were higher, as previously hypothesised.

Since the type of management (indoor or outdoor) is related to the susceptibility of animals to certain diseases (Buffington 2002; Goldstein & Abrahamian 2015; Chalkowski *et al* 2019), we hypothesised that owners with basic knowledge of zoonoses and the mode of their transmission could restrict their cats from free-roaming. Contrary to our expectations, outdoor access permission was higher for people who reported knowing that cats can transmit disease. A plausible explanation would be that although the respondents claimed to know that cats can spread diseases, they do not understand how it occurs (Oliveira-Neto *et al* 2018). We also asked if respondents knew what the term 'zoonosis' meant, and only 11.04% reported not knowing its meaning. This percentage was higher than that reported in a study conducted in São Paulo county assessing public perception about diseases transmitted by cats, in which only 29% of respondents knew the word 'zoonosis' (Oliveira-Neto *et al* 2018). In this case, the results confirmed our hypothesis, since people who reported knowing the term 'zoonosis' were less likely to allow their cats to roam freely. Most of the respondents showed a correct response to the relationship between 'contamination through cat faeces' and 'toxoplasmosis', with only 8.79% responding erroneously. According to most of our results, owners lacking a basic understanding about zoonoses were more likely to report allowing their cats to have outdoor access. However, a causal relationship could not be established because several confounding factors could lead to this association, such as owners' level of education and socioeconomic conditions.

We thus investigated welfare issues and risks related to the type of management practices reported by the owners. Some of these issues were related to practices of preventive clinical care, such as visits to the veterinarian, vaccinations, and periodic deworming that have major implications for the welfare of cats (Tan *et al* 2020). We noted that cat owners who declared allowing outdoor access were less likely to report regular practices of preventive clinical care. This result suggests that owners reporting indoor management practices may have increased likelihood of preventive care. It is also likely influenced by closer contact with cats kept exclusively indoors with the owner since these cats often sit

on the owners' laps and sleep in their beds (Martens *et al* 2016; Chalkowski *et al* 2019). However, the relationship between indoor management practices and higher preventive clinical care may also be a product of some underlying socioeconomic aspect, or other cultural issues, such as the owner not perceiving the provision of preventive clinical care to be important (Downey & Ellis 2008; Habacher *et al* 2010; Sandøe *et al* 2016; Siracusa & Provoost 2016).

Flea (*Ctenocephalides felis*) infestation is another problem that has a substantial impact on the welfare of contaminated animals. The contamination and transmission can occur through contact with infested conspecifics or infected environments (Shaw *et al* 2001). In addition to welfare problems directly caused by fleas, such as itching and allergic dermatitis, contamination by these parasites can also have indirect impacts on the welfare of affected cats because endoparasites can also be transmitted through fleas, leading to double-agent infestations (Shaw *et al* 2001; Rochlitz & Yeates 2019; Tan *et al* 2020). In its turn, endoparasitosis can be harmful to welfare through general malaise, and even death in more severe infestations (Tan *et al* 2020), as well as being harmful to the welfare of the people who come into contact with them (Wierzbowska *et al* 2020). Free-roaming cats are more likely to be contaminated with ecto- and endoparasites than indoor cats (Wierzbowska *et al* 2020). Thus, we asked respondents about the frequency of flea contamination from their cats. Our results suggest that owners that reported allowing outdoor access were up to three times more likely to report frequent flea infestation than owners of indoor cats. Thus, the importance of preventing cats from acquiring fleas is evident, especially for outdoor cats, considering the implications for the welfare of the affected cats.

In Brazil, there has been an increase in the number of human sporotrichosis cases in recent years with a record of 782 hospitalisations between 1992 and 2015, and Rio de Janeiro is the most affected State (Boechat *et al* 2018; Poester *et al* 2018; Falcão *et al* 2019). We found that owners that reported allowing their cats to have outdoor access were twice as likely to report previous occurrences of cat sporotrichosis than owners of cats that were kept exclusively indoors. Epidemiological studies have revealed that outdoor access is a major risk factor for cat contamination and, consequently, human contamination (Boechat *et al* 2018). Contamination with cat-borne diseases is important in terms of feline welfare, because in addition to directly impacting feline welfare, they also indirectly affect it via negative owner perceptions which may lead to abandonment, relinquishment to shelters or euthanasia (Patronek *et al* 1996; Neidhart & Boyd 2002; Casey *et al* 2009).

It is known that despite the fact that the role of cats in society has changed over time (such as sacred creatures and pets), today, many people still have an aversion to cats (Sandøe *et al* 2018; Crowley *et al* 2020). Poisoning and mistreatment are among the most severe risks to outdoor animals, with these illegal practices being carried out by people who do not accept the presence of cats in their neighbourhood. Free-roaming cats are more likely to suffer from these injuries than cats kept indoors (Marlet & Maiorka

2010; Siracusa & Provoost 2016). In this study, the odds ratio for owners reporting previous cases of poisoning was twice as high for outdoor than indoor cats. It is important to highlight that the number of reports of cats being poisoned is likely to be even higher than found in this study, as many animals die before returning home. This may lead owners to think that the animal has chosen to 'move away' (Lockwood 2005; Noleto *et al* 2017). In this regard, several reasons prevent cats from returning to their homes. They may get lost on the way back, succumb to car accidents or suffer mistreatment by people (Machado *et al* 2019). Thus, we also asked if respondents had ever experienced a cat going missing, and 38.15% reported that they had had a cat that did not return to home. This situation was more frequently described by those who reported allowing outdoor access compared to indoor access (35.7 vs 20.6%). All these situations (poisoning, car accidents, and mistreatment) are critical in terms of feline welfare since they result in intense pain and suffering, and often death. In Brazil, cases of cruelty and abuse to domestic animals are frequent (Marlet & Maiorka 2010; Junqueira & Galera 2019). According to a study conducted in the city of São Paulo, through the analysis of autopsy data and criminal records of the mistreatment of companion animals (Marlet & Maiorka 2010), compared to dogs (11%), cats were more often victims of cruelty (34%). It should be noted that the most commonly used method was carbamate poisoning (a poison popularly known in Brazil as 'chumbinho') (Marlet & Maiorka 2010). Outdoor cats were related to causing disturbances by defaecating in residential gardens, emitting loud vocalisations at night (Tan *et al* 2020), scratching cars and furniture, and stealing food. In general, the main motivation leading people to mistreatment is related to cats visiting their homes (Lockwood 2005), as non-owners see free-roaming cats as a pests (Lord 2008).

Outdoor cats have been reported to be subject to other types of accidents, such as falls from high places (eg trees and buildings) and traffic accidents (Rochlitz 2003, 2004a,b, 2005; Loyd *et al* 2013). For this reason, we asked respondents about previous accidents their cats may have experienced. Our results showed that the odds ratio of the owners reporting an occurrence of accidents was eight times higher for outdoor compared to indoor cats. Indeed, many scientific papers assess accident occurrences, with traffic accidents being the most common (Moreau *et al* 2003; Rochlitz 2004a,b). A study in France showed cats to be up to three times more likely to be hit by cars than dogs (Moreau *et al* 2003). In many cases, injuries caused by this type of accident lead to the death of the cat. In another year-long study of cats involved in car accidents in Cambridgeshire, UK ($n = 128$), 16 cats were dead upon arrival at the clinic, and 16% of them did not survive after arrival. Another UK study, with 1,264 cats, found that 3.4% were victims of traffic accidents and, of these, 71.4% died (Wilson *et al* 2017). Outdoor access was the main risk factor for cats being involved in car accidents (Wilson *et al* 2017).

In spite of the present study having focused on the risks related to outdoor management, it does not mean that indoor manage-

ment invariably leads to optimal levels of welfare. Previous studies have evaluated the impacts of indoor management on feline welfare, suggesting that different risks may be present at home, including household accidents, such as stove burns and poisoning with cleaning products (Buffington 2002; Rochlitz 2005). Accidents involving cats falling from balconies and windows have also been reported (Rochlitz 2005; Elliott *et al* 2019). Other factors commonly reported by owners of confined cats are related to behavioural problems, such as inappropriate elimination, aggression and destructive behaviour (Herron & Buffington 2010, Sandøe *et al* 2017; Horwitz 2019; Machado *et al* 2020a). Feline obesity has also been associated with indoor management and has negative implications for the welfare of cats around the world (Rochlitz 2005; Wall *et al* 2019). For example, indoor cats can overeat as a way of dealing with boredom and predictability of the environment (Wall *et al* 2019). Consequently, an obese cat is more likely to have its welfare compromised since obesity has been epidemiologically associated with obstructive and non-obstructive feline idiopathic cystitis and diabetes (Cameron *et al* 2004; Rochlitz 2005; Sandøe *et al* 2017; Wall *et al* 2019). So, despite the popular belief that indoor cats are safer, as they are protected from hazards associated with the outdoors, if their needs are not met, these animals will suffer from poor welfare. Some measures are necessary to mitigate the impacts on the welfare of confined cats, such as environmental enrichment (Ellis 2009; Herron & Buffington 2010). An enriched environment generates mental stimulation, exploratory behaviour and display of the cat's natural behaviours (such as climbing, jumping and scratching). Thus, anxiety and boredom are reduced (Rochlitz 2005; Ellis 2009; Strickler & Shull 2014; Wall *et al* 2019).

This study has limitations that must be acknowledged. Despite all the impacts of outdoor management, keeping cats strictly indoors is not always feasible. Many owners may encounter difficulties when trying to keep their cats exclusively indoors. The questionnaire should have included questions that reveal if the outdoor permission was related to an intentional decision or due to the lack of possibilities to prevent cats from leaving the house. The survey also lacks some owner socio-demographic and economic information that could have been useful in explaining some of the results found. For example, an owner would not perform preventive medical care for cats as a consequence of a lack of economic resources. Thus, a shortcoming of the questionnaire was not including factors such as the area of the city where the respondent lives, pay-scale group/level, educational level, among others. Another limitation is regarding the use of a convenience sampling method and an online questionnaire. It was not possible to collect responses from cat owners without internet access. In Brazil, internet access varies from 69.1% (in the North-east region) to 84.8% of the population (South-east region), according to IBGE data (IBGE 2018). It imposed a source of bias in our sample. The respondents were most likely urban, from middle- and upper-class people compared to the general population. In addition, people who respond to surveys about cats are most like those who care most about their

cats. In both cases, it might have overestimated the percentage of indoor cats. Thus, the results of the present study regarding the percentage of owners allowing their cats to roam, probably, do not represent the frequency of outdoor cats in the Brazilian population as a whole.

Animal welfare implications

Discussions about the permission of outdoor access or indoor management are complex and involve an interaction between a series of welfare aspects, some that owners may be aware of and others that they are probably not aware of. There are situations whereby the type of management should be chosen with particular regard to each case. For example, outdoor cats living in places with low traffic, exhibit a less hunting-prone temperament, have little or no intra-specific contact and are neutered, are at a lower risk of being involved in traffic accidents and agonistic conflicts, acquiring infectious diseases, procreating and impacting the environment (Lepczyk *et al* 2015; Rochlitz & Yeates 2019). However, as reported by some previous studies and corroborated by our study, the allowance of outdoor access might be related to several problems for the integrity of cats. In any case, when opting for exclusively indoor management, owners need to keep in mind that indoor cats have demands that need to be met. They are required to meet their pets' basic behavioural and physiological needs and provide environmental enrichment and sufficient space for natural behaviours, such as exploration (Rochlitz 2005; Strickler & Shull 2014; Siracusa & Provoost 2016; Rochlitz & Yeates 2019). This prevents frustration and chronic stress, which can predispose cats to urinary tract diseases and behavioural problems, as well as to becoming overweight, which is a contributing factor to diabetes mellitus and more common in cats with low levels of exercise and those kept indoors (Amat *et al* 2016; Siracusa & Provoost 2016; Yeates & Yates 2017).

Conclusion

We conclude that the allowance of outdoor access by the Brazilian cat owners surveyed is related to several environmental and owner characteristics, such as type of residence, way in which the cat was acquired, cat neutering status, and number of cats in the household. Owners of outdoor cats are more likely to report that their animals get fleas, sporotrichosis, are poisoned, mistreated, suffer accidents, and go missing. Increasing public awareness through campaigns that highlight the risks associated with outdoor access could improve feline management practices and welfare.

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