

1 **ESTUDO CASO-CONTROLE DA OCORRÊNCIA DE DOENÇAS**
2 **INFECCIOSAS ASSOCIADAS AOS HÁBITOS SEMI-DOMICILIADOS DE**
3 **CÃES E GATOS DOMÉSTICOS**

4 **OCCURRENCE OF INFECTIOUS DISEASES IN ASSOCIATION WITH**
5 **THE OUTDOOR HABITS OF HOUSEHOLD DOGS AND CATS: A CASE-**
6 **CONTROL STUDY**

7
8 **RESUMO**

9 Muitos proprietários acreditam agir no melhor interesse de seus animais de estimação
10 permitindo-os o acesso ao ambiente externo, com ou sem supervisão. Entretanto, isso
11 aumenta consideravelmente o risco para a ocorrência de doenças e acidentes. Neste estudo, foi
12 avaliada a associação entre doenças infecciosas e hábitos semi-domiciliados de cães e gatos.
13 Dados epidemiológicos foram obtidos de arquivo de prontuários de cães e gatos atendidos na
14 Unidade Didática Clínico Hospitalar de Medicina Veterinária no município de Pirassununga,
15 estado de São Paulo, Brasil. Animais de estimação que apresentaram doenças infecciosas
16 foram incluídos no grupo de casos; animais sem doenças infecciosas, controles. Os animais
17 foram ainda divididos de acordo em domiciliados, domiciliados frequentemente levados a
18 passeios e semi-domiciliados. A razão de chances para a ocorrência de doenças infecciosas foi
19 calculada a partir da comparação dos grupos supracitados, fazendo uso do software estatístico
20 MedCalc. Encontrou-se um risco aumentado para a ocorrência de doenças infecciosas em cães
21 e gatos semi-domiciliados quando comparados aos animais domiciliados (OR de 4.735) e
22 quanto aos domiciliados guiados em passeios (OR de 2.303). À luz dos resultados se sugere

1 que campanhas de conscientização foquem também nos benefícios da criação domiciliada de
2 animais de estimação.

3 Palavras-chave: Doenças, Pets, Semi-domiciliados

4 **ABSTRACT**

5 Many owners believe to act in their pets' best interest by allowing them to go outside,
6 with or without supervision. However, outdoor exposure greatly increases the risk of disease
7 and accidents. In this study, we evaluated the association between infectious diseases and the
8 outdoor habits of pet dogs and cats. Epidemiological data were obtained from the records of
9 dogs and cats treated at the Teaching Clinic and Hospital Unit of Veterinary Medicine in the
10 city of Pirassununga, state of São Paulo, Brazil. Pets with any form of infection were included
11 in the case study group, and pets with no infectious diseases were used as controls. Animals
12 were further divided according to their habits into indoor animals, indoor animals taken for
13 walks, and outdoor animals. The odds ratio of having an infectious disease was calculated
14 from the comparisons among these groups using the MedCalc Statistical Software. We found
15 an increased risk for the occurrence of infectious diseases in outdoor dogs and cats when
16 compared to indoor animals (OR of 4.735) and to those taken for walks (OR of 2.303). In
17 light of our results, we suggest that awareness campaigns should also focus on the benefits of
18 keeping pets indoors.

19 **Keywords:** Diseases, Outdoor, Pets

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INTRODUCTION

Outdoor life can bring benefits to dogs, especially for athletic and energetic. However, depending on the environment and outdoor habits, this exposure may have more negative than positive consequences. Moreover, aggressive behavior between animals, may further potentiate direct transmission of diseases (PROCTER, 2012)

Many studies have suggested a close association between the outdoor habits of dogs and cats and the occurrence of several diseases. Previous work also pointed to the role played by stray animals in urban accidents and incidents, including bites and disease transmission (DUERR *et al.*, 2017). However, these studies rarely focus on household pets with an outdoor life, specifically as a target for prevention campaigns.

Results of previous case-control studies indicate that dogs tested positive for *Bartonella vinsonii* more commonly live in rural environments, and freely wander their surroundings, having a predominantly outdoor life (PAPPALARDO *et al.*, 1997). In another survey, revealed that positive serology for *Leishmania spp.* showed a significant association with the male gender of dogs and with their rural and outdoor life (ZAFFARONI *et al.*, 1999).

A bigger proportion of cats live outdoors in comparison to dogs, and owners take them less frequently to the veterinary physician (LUE *et al.*, 2008). Stray or outdoor cats succumb to illness, injury or hunger more frequently than indoor cats. They may also transmit diseases to humans and affect the native fauna, due to their predatory behavior (NEIJENHUIS; NIEKERK, 2015).

Few studies have compared the mortality of indoor and outdoor cats. Epidemiological evidence indicates that, while life indoors increases the risk of certain diseases among cats

1 (e.g., lower urinary tract disorders), greater risk lies outdoors due to aggression from other
2 cats, general injuries and exposure to infectious disease (BUFFINGTON, 2002).

3 Outdoor cats and kittens, in comparison with indoor animals, will more likely have
4 *Bartonella henselae* infections and flea infestations (Florin *et al.*, 2008). Moreover, wild cats
5 and outdoor cats, in comparison to indoor pets, have higher seroprevalence of *Toxoplasma*
6 *gondii* (NUTTER *et al.*, 2004).

7 The present study, conducted in the city of Pirassununga, São Paulo, Brazil aimed at
8 further evaluating the association between infectious diseases and the outdoor habits of pet
9 dogs and cats. We also discuss the underestimated risks posed by unsupervised outdoor pets.

10 MATERIAL AND METHODS

11 Epidemiological data were obtained from the records of dogs and cats treated at a
12 veterinary hospital the Teaching Clinic and Hospital Unit of Veterinary Medicine at the
13 School of Animal Science and Food Engineering (FZEA), University of São Paulo. The case
14 study group included pets diagnosed with an infectious disease. The control group included
15 pets with no infectious disease, and brought to the clinic for routine check-ups, vaccination,
16 elective surgery, neoplasms and idiopathic disorders.

17 Data were obtained from 490 animals, including 424 dogs and 66 cats between early
18 2014 and June 2016. We obtained information about the outdoor habits of 461 animals,
19 including 401 dogs and 60 cats. Animals were further divided into three groups: I (indoor
20 animals), W (indoor animals taken for outdoor walks) and O (outdoor animals). Data were
21 analyzed according to previously described methods, and submitted to the MedCalc Statistical
22 Software (MedCalc Software bvba, 2016). The study was approved by the Ethics Committee
23 on Animal Use (CEUA).

RESULTS AND DISCUSSION

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Among the 401 dogs included in the study, 122 were diagnosed with infectious diseases and included in the case study group and the remaining animals were included in the control group. Among the 60 cats, 22 were placed in the case study group and 38 in the control group. There were 195 indoor pets (I; 157 dogs/38 cats); 91 outdoor animals, (O; 73 dogs/18 cats); and 175 pets often taken for walks (W; 171 dogs/4 cats). An increased chance of infection was detected in O versus I dogs, with an odds ratio (OR) of 4.735 ($P < 0.0001$, Table 1). In the comparison between W and I dogs, an increase in risk was also detected, albeit with a odds ratio (OR) of 2.303 ($P = 0.0016$, Table 1). In cats, we only compared O and I animals and the risk of infection had an OR of 13.150 ($P = 0.0002$, Table 1).

We evaluated the risk of infection associated with the outdoor habits of dogs and cats in the city of Pirassununga, São Paulo, Brazil. We did not target a specific pathogen, but infections in general. Nevertheless, our results agree with those from numerous previous studies, and suggest that exposure to the outdoors increases the risk of infection among pet animals. Other authors indicate that pet owners cannot completely avoid pet exposure to pathogens, especially protozoans, but understanding risk factors and adopting preventive measures reduces disease incidence (ESCH; PETERSEN, 2013). In fact, many owners already have at least a partial understanding of these factors. According to a recent study about the public perception of parasitic diseases, most of the individuals interviewed pointed to the external environment, followed by direct transmission from infected animals, as potential sources of ectoparasites in pets (MATOS *et al.*, 2015). In Brazil and elsewhere, public awareness represents a first step towards early diagnosis, management and prevention of zoonotic diseases, which take a toll on the public health system of developing and developed countries (COLWELL *et al.*, 2011).

1 According to our results, pet dogs that are often taken for walks have increased risk of
2 infection in comparison with indoor dogs (OR = 2.303). However, in the comparison of
3 outdoor and indoor dogs, we found a twofold greater OR of 4.735. These findings suggest
4 that mere contact with the outdoors does not account for all the risk. Lack of supervision also
5 seems to play an important role in the infection of household pets. Memory biases often affect
6 case-control studies (MEDEIROS *et al.*, 2003), such as ours. In fact, our data did not allow
7 for a detailed analysis of the degree of freedom granted to pets during their walks. Moreover,
8 subjective evaluations by the pet owners did not allow us to stratify the data and discern
9 different conditions during the walks, including, for example, pavement quality and
10 cleanliness among others.

11 A large proportion of the studies regarding pet diseases focus on planning and
12 implementing control systems, such as vaccination campaigns. The effectiveness of such
13 preventive measures depends on the percentage of animals that receives immunization
14 (ROBINSON *et al.*, 1996). Thus, a successful program must count with the involvement of
15 the general population achieved through mass campaigns and, if possible, "door to door"
16 methods (BERAN, 1985). Moreover, preventive programs must occur periodically because of
17 the high reproduction rates among stray animals, which poses severe logistical challenges to
18 Sanitary Surveillance agencies. In parallel, an increasing body of work points to the benefits
19 of continuous monitoring of parameters such as the number of outdoor animals (SLATER,
20 2001).

21 Outdoor cats also had an increased risk of infection in comparison to indoor cats.
22 However, the OR (13.150) obtained from this comparison was three-fold greater than the OR
23 obtained from comparing O and I dog groups. The large difference observed may result from
24 feline behavior and from the fact that cat owner less frequently take them to the veterinary

1 physician (LUE et al., 2008). It should be noted that cats can also behave as carnivorous
2 animals, and as such the threat they may cause to the environment should also be taken in
3 consideration. The prevalence of infections also differs between stray and outdoor cats
4 because of distinctions in the behavior of these populations towards humans and other cats
5 (SLATER, 2015). A previous study indicated that outdoor cats that mingle with stray cats
6 often represent the primary source of pathogens (HELLARD *et al.*, 2011). Our study
7 population did not include stray cats making similar comparisons impossible.

8 Our results support the notion that keeping pet dogs and cats indoors has benefits to
9 the animals and to humans. To promote a change in pet owner behavior, one must understand
10 their reasons for keeping pets indoors or outdoors. A small study conducted in the United
11 States concluded that owners of indoor cats feel their pets are safer from disease, accidents
12 and fights with other animals. In contrast, owners of outdoor cats argue that their pets' lives
13 become richer outside their homes. They also state that their cats ceaselessly ask to go out
14 (MOSTELLER; KRAUS, 2013). Dog behavior also affects owner decisions. Dog owners will
15 often keep them indoors to avoid disturbing neighbors with the barks, or to avoid other
16 problems such as self-mutilation and the destruction of fences and other objects that may
17 occur due to a high level of anxiety and boredom by being without the company of the owner
18 (BRIDGE, 2000).

19 It has long been known that stray dogs and cats pose risks to animal and public health
20 (HILL, 2006). Our results suggest that pets with outdoor habits also pose risks, albeit to a
21 lesser extent. Thus, effective campaigns should target owners who, for their convictions,
22 living arrangements or other reasons, choose to allow their pets outdoors.

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CONCLUSIONS

1 We suggest that keeping pet animals indoors constitutes a key aspect of responsible
2 ownership. Outdoor exposure with or without supervision increases the risk of disease in dogs
3 and cats. Zoonotic diseases represent a health hazard to the animals, to the owners and to the
4 public in general. A change in pet owner habits can only come from a more consistent
5 discussion about public health and responsible ownership in the appropriate forums.

6 REFERENCES

- 7 BERAN, G. Ecology of dogs in developing countries in relation to rabies control programs, in
8 Rabies in the Tropics. Springer, 1985. 691-697.
- 9 BRIDGE, K. Bring the Dog In, in Dog's life magazine, September edition. 2000.
- 10 BUFFINGTON, C.A. External and internal influences on disease risk in cats. J Am Vet Med
11 Assoc, 2002. 220(7):994-1002.
- 12 COLWELL, D.D.; DANTAS-TORRES, F.; OTRANTO, D. Vector-borne parasitic zoonoses:
13 emerging scenarios and new perspectives. Vet Parasitol, v. 182, n. 1, p. 14-21, 2011.
- 14 DURR, S.; DHAND, N.K.; BOMBARA, C. et al., What influences the home range size of
15 free-roaming domestic dogs? Epidemiology & Infection, 2017. 145(7):1339-1350.
- 16 ESCH, K.J.; PETERSEN, C.A. Transmission and epidemiology of zoonotic protozoal
17 diseases of companion animals. Clin Microbiol Rev, 2013. 26(1):58-85.
- 18 FLORIN, T.A; ZAOUTIS, T.E.; ZAOUTIS L.B. Beyond cat scratch disease: widening
19 spectrum of *Bartonella henselae* infection. Pediatrics, 2008. 121(5):1413-25.

1 HELLARD, E.; FOUCHET, D.; SANTIN-JANIN, H. et al. When cats' ways of life interact
2 with their viruses: a study in 15 natural populations of owned and unowned cats (*Felis*
3 *silvestris catus*). *Prev Vet Med*, 2011. 101(3-4):250-64.

4 HILL, P.M. Population dynamics and management of free-roaming cats, Texas A&M
5 University, 2006.

6 LUE, T.W.; PANTENBURG, D.P.; CRAWFORD, P.M. Impact of the owner-pet and client-
7 veterinarian bond on the care that pets receive. *J Am Vet Med Assoc*, 2008. 232(4):531-40.

8 MATOS, M., ALHO, A.M.; OWEN, S.P. et al. Parasite control practices and public
9 perception of parasitic diseases: A survey of dog and cat owners. *Prev Vet Med*, 2015. 122(1-
10 2):174-80.

11 MEDCALC Statistical Software version 16.8 (MedCalc Software bvba, O., Belgium;
12 <https://www.medcalc.org>; 2016).

13 MEDEIROS, J.D.S.; RIVERA, M.A.A.; BENIGNA, M.J.C. et al. Estudo caso-controle sobre
14 exposição precoce ao leite de vaca e ocorrência de Diabetes Mellitus tipo 1 em Campina
15 Grande, Paraíba. *Rev. bras. saúde matern. infant*, 2003. 3(3):271-280.

16 MOSTELLER, J.; KRAUS, K. Cats Inside-Only or Inside and Out? Cat Owners Prevention
17 and Promotion Motivations. in International Society of Anthrozoology. July 13 Conference.
18 2013.

19 NEIJENHUIS, F.; NIEKERK, T. Als de kat van huis is...: zwerfkatten in Nederland: een
20 inventarisatie. 2015.

1 NUTTER, F.B.; DUBEY, J.P.; LEVINE, J.F. et al. Seroprevalences of antibodies against
2 *Bartonella henselae* and *Toxoplasma gondii* and fecal shedding of *Cryptosporidium* spp,
3 *Giardia* spp, and *Toxocara cati* in feral and pet domestic cats. *J Am Vet Med Assoc*, 2004.
4 225(9):1394-8.

5 PAPPALARDO, B.L.; CORREA, M.T.; YORK, C.C. et al. Epidemiologic evaluation of the
6 risk factors associated with exposure and seroreactivity to *Bartonella vinsonii* in dogs. *Am J*
7 *Vet Res*, 1997. 58(5): 467-71.

8 PROCTER, T.D. A walk in the park: zoonotic risks associated with dogs that frequent dog
9 parks in southern Ontario. 2012.

10 ROBINSON, L.E.; MIRANDA, M.E.; MIRANDA, N.L.; CHILDS, J.E. Evaluation of a
11 canine rabies vaccination campaign and characterization of owned-dog populations in the
12 Philippines. *Southeast Asian J Trop Med Public Health*, 1996. 27(2):250-6.

13 SLATER, M.R. Behavioral ecology of free-roaming/community cats. *Anim. Behav. Shelter*
14 *Vet. Staff*, First edn. John Wiley & Sons, Inc., USA, 2015:102-128.

15 SLATER, M.R. The role of veterinary epidemiology in the study of free-roaming dogs and
16 cats. *Prev Vet Med*, 2001. 48(4):273-86.

17 ZAFFARONI, E.; RUBAUDO, L.; LANFRANCHI, P.; MIGNONE, W. Epidemiological
18 patterns of canine leishmaniasis in Western Liguria (Italy). *Vet Parasitol*, 1999. 81(1):11-9.

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TABLES

2 Table 1. Comparison of the risk of infection among dogs and cats with different outdoor
3 habits.

Comparisons*	OR	z value	CI	Significance level
Dog: O vs. I	4,735	4,960	2,5615 to 8.7533	P<0,0001
Dog: W vs. I	2,303	3,159	1,3726 to 3,8660	P = 0,0016
Cat: O vs. I	13,150	3,717	3,3768 to 51,0145	P = 0,0002

4 *O = outdoor animals, I = indoor animals, W = indoor animals often taken for walks.