

Exploring the stray dog crisis: When the human–canine relationships breakdown



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Abstract The aim of this review is to analyze the causes that promote the increase in stray dogs, as well as to discuss responsible ownership or adoption and disruptions in human–dog interactions, consequences for dogs in streets, and alternatives to address the human–dog bond issue. Similarly, it analyzes the correct ownership and responsible acquisition, detects what has gone wrong in promoting positive bonds between man and dog, and suggests strategies to eliminate or lessen this problem. Finally, it is necessary to carry out joint actions instead of just opting for adoption but also offer education and awareness programs to caregivers, organize sterilization campaigns and take and apply measures to ensure animal well-being, which can lead to positive solutions for society, as well as improvements in the quality of animal life. Veterinarians are the key to disseminating the information and education on responsible ownership necessary to achieve this, as well as collaborating to reduce canine overpopulation jointly on the streets and, therefore, the problems that this entails.

Keywords: canine overpopulation, zoonoses, responsible adoption, responsible pet ownership

1. Introduction

Stray dogs are the manifestation of several cultural and socioeconomic factors that might differ according to the country. These include lack of education and legislation addressing responsible ownership (Malian and Marin, 2013; Mota-Rojas, 2017; Mota-Rojas, 2018; Gill et al., 2022). Currently, of the estimated worldwide canine population (400 million animals), 200 million dogs are homeless (Chandran and Azeez, 2016; Mendoza Roldan and Otranto, 2023). This represents a risk to the environment and public health because of the uncontrolled reproduction of stray dogs (Mota-Rojas et al., 2016; Broom, 2019; Mota-Rojas et al., 2024).

Demographic, sanitary, and environmental elements affect human–dog interactions (Gan et al., 2023). Therefore, the control of these animals is essential to safeguard human and animal health (Mota-Rojas et al., 2018).

It is estimated that millions of animals enter shelters after being abandoned by their owners (Herwijnen et al., 2018). Of the 4 million dogs that are abandoned in shelters, 2 million are euthanized annually (Patronek et al., 1996). Data are showing that the birth rate of dogs decreases by between 15% and 30% with the use of sterilization campaigns (Boey, 2017; Garcia et al., 2018), whereas the birth rate of control dogs decreases by 5% to 8% with the use of methods for the eradication of these animals (Hogasen et al., 2013). Therefore, it is important for governments to promote effective birth control strategies to prevent the presence of new puppies. Therefore, the objective of this review is to analyze the causes that promote the increase in stray dogs, as well as to discuss responsible ownership or adoption and disruptions in human–dog interactions, consequences for dogs in the streets, and alternatives to address the human–dog bond issue.

2. Associations Between the Human-Dog Relationship and an Increase in Stray Dogs

Dogs have been part of human lives for many years since domestication began. They participated in activities such as pulling sleds, hunting, and guarding houses and farm animals. It was not until the 7th century that dogs began to be considered a social symbol that gave prestige to man (Said, 2017). Afterward, dogs formed stronger ties with humans and were incorporated as a family member (Albert, 1988; Gómez et al., 2007; Guerrero et al., 2013; Mota-Rojas et al., 2021b).



Importantly, dogs cover different work activities with humans, such as herding livestock, capturing animals, guarding, protection, loading, accompanying therapy and support (Mills and De Keuster, 2009).

Pet abandonment is one of the main reasons for the increase in stray dogs (Mota-Rojas et al., 2021a). Behavioral problems in dogs are listed as the first reason why human–dog interactions are compromised (Mota-Rojas, 2017; Herwijnen et al., 2018), affecting the coexistence of domestic dogs and humans (Figure 1). Fear, separation anxiety, aggression, and compulsive disorders are some of the behavioral issues related to an inappropriate human–dog relationship (Barrera et al., 2009). Herwijnen et al. (2018) mentioned that dog ownership satisfaction is closely related to abandonment and unwanted behaviors of dogs, such as aggression. Behavioral problems were also highlighted by Cannas et al. (2018). By evaluating dogs with aggressive and anxious behavior. The authors reported that anxious animals were more likely to be surrendered by their owners to a shelter, as they require more time to be treated.



Figure 1 Stray dogs roaming the streets. Stray dogs wandering on public roads represent a public risk by causing road accidents that compromise their health and the safety of pedestrians and drivers. Similarly, stray dogs tend to have low body conditions (ribs and vertebral processes visible to the naked eye) that might predispose them to infectious diseases as they do not have a guaranteed daily food portion.

Carroll et al. (2022) also evaluated cases of relinquishment in the United Kingdom, the United States, Canada, and countries from Europe. It was found that 22.9 to 30.5% of the variance was due to behavioral concerns such as aggression, house soiling, and barking. However, the main reason for considering giving up a dog was financial constraints (43.8%). Similarly, Cendón et al. (2011) listed the lack of financial solvency to cover the expenses that the animal entails, the lack of novelty after acquiring a pet, the owners showing dissatisfaction with destructive behaviors, the lack of space, and the presence of children in the family (Duarte Cardoso et al., 2024). Despite this, the authors indicate that the main cause is unconsciousness, irresponsibility, and lack of ethics shown by the owners (Cendón et al., 2011). In Brazil, although Baquero et al. (2017) reported that 82.7% of 450 respondents do not consider abandoning their companion animal regardless of the behavioral issues that they might have (e.g., destroying objects in the house or inappropriate eliminatory behaviors), 4.4% and 2% mentioned that aggression and sickness might be two of the main reasons why someone would abandon their pet. During the COVID-19 pandemic, different authors reported that although daily dog adoption increased (from 17.3 ± 2.2 dogs to 26.1 ± 2.2 dogs), the monthly number of abandoned dogs did not decrease in Israel (Morgan et al., 2020).

Thus, pet abandonment arises when owners do not (Said, 2017). Understanding the root of the stray dog population increase is essential to improve owner awareness and prevent pet abandonment, together with the related consequences of dogs freely roaming the streets.

3. Consequences for Dogs in the Streets

Stray dogs cause various public health, social, economic, and ecological problems that affect their welfare (Zumpano et al., 2011; Garcia et al., 2012), especially in developing countries (Downes et al., 2009). Some of the problems that have been reported are nocturnal vocalizations and dog attacks on people (Manteca, 2003; Ratsitorahina et al., 2009).

Owing to the lack of preventive medicine in stray dogs (Szwabe and Blaszkowska, 2017; Taylor et al., 2017), they are susceptible to several diseases caused by protozoans, helminths, and arthropods (Otranto et al., 2017; Ashaolu et al., 2022; Gill et al., 2022).

For example, mange is a zoonotic parasitic dermatitis commonly present in stray dogs (Mindru et al., 2019). Currently, in Turkey, approximately ¼ of stray dogs are infected with *Demodex canis*, a mange-causing mite that is also a risk to public health (Kaya et al., 2018). Similarly, a 100% prevalence of ectoparasites (e.g., *Rhipicephalus sanguineus*) was reported in stray dogs in Brazil (Klimpel et al., 2010). Figure 2 shows a case of mange in a mongrel stray dog.



Figure 2 A case of sarcoptic mange in a stray dog. This type of inflammatory dermal infection caused by mites can present as hairless spots and thickened crusty patches that require veterinary treatment. In severe cases, the infection and lesions can advance throughout the body, causing itching and skin lesions that are usually very painful for the animal.

Another issue is the high prevalence of infection with parasites. Different countries have reported this when evaluating stray dog populations, and 43–91.4% of stray dogs are estimated to test positive for at least one species of intestinal parasite (Saldanha-Elias et al., 2019; Sulieman et al., 2020). In Brazil, stray dogs are positive for intestinal parasites, mainly *Ancylostoma caninum* (63.4%) and *Dipylidium caninum* (61.3) (Saldanha-Elias et al., 2019). Similar findings in the same country were reported by Klimpel et al. (2010), where 95.7% of dogs were infected with *A. caninum*, 45.7% with *D. caninum*, 8.7% with *Toxocara canis*, and 4.3% with *Trichuris vulpis*.

Similarly, in Nigeria, Jajere et al. (2022) reported an incidence of parasitosis in 77.9% of stray dogs, in which *A. caninum* (40.2%), *T. canis* (35.1%) and *T. vulpis* (26.6%) were the main agents. In regions of central Italy, 61.8% of stray dogs had intestinal helminths and 25.6% had protozoan helminths, mainly *Ancylostoma* (40.5%), *Giardia intestinalis* (21.4%), *T. canis* (20.6%) and *T. vulpis* (17.6%) (Liberato et al., 2018). Higher percentages of *T. canis* (57.14%) and *T. vulpis* (28.57%) were reported by Szwabe and Blaszkowska (2017) in Polonia, particularly in stray dogs between 6 and 12 months of age. In Nepal, blood studies carried out on stray dogs to detect vector-borne diseases have detected a prevalence between 27.14% and 12.86% of zoonoses, such as *Ehrlichia canis*, *Leishmania donovani*, and *Babesia vogeli* (Chandran and Azeez, 2016).

The risk of infection in these parasites is greater than that in companion dogs, as shown by Ashaolu et al. (2022). The authors determined that stray dogs had a greater risk of Helicobacter infection (92.13%) than did pets in Taipei (70.17%). Moreover, Mendoza and Otranto (2023) reported that owned dogs that have free access to streets are at risk of zoonotic diseases such as *Toxoplasma* or *Toxocara*, which is associated with a lack of preventive medicine and direct contamination between animals.

The feces of stray dogs contaminate soils, surfaces, and water sources, becoming a risk to other animals and human health (Szwabe and Blaszkowska, 2017). Studies have reported average feces production between 340 and 1074 grams (Katica et al., 2020; Ma et al., 2020). In Bosnia and Herzegovina, Katica et al. (2017) reported that 21,800 stray dogs produce 10,900 kilograms of feces and 13,080 liters of urine daily. This is a potential source of contamination because stray dogs do not receive deworming or vaccinations (Szwabe and Blaszkowski, 2017). In addition, stray dogs are at greater risk of acquiring parasitic and infectious diseases due to the environment where they grow and immunosuppression due to malnutrition and stress (Liberato et al., 2018).

Canine fractures and more serious issues are also observed in stray dogs due to traffic accidents, as shown in Figures 3 and 4. Uwagie-Ero et al. (2018) reported that the main cause of fractures in stray dogs in Nigeria was car accidents (66.3%). Murshidah et al. (2021) reported that 58% of animals with vertebral fractures and luxation were stray dogs in Malaysia.

Therefore, due to the uncontrolled increase in stray animal populations, dogs are at risk of infectious diseases and road traffic accidents (Choudhary and Palsaniya, 2024).



Figure 3 Fracture in a canine patient due to a traffic accident. A female stray dog of approximately 1 year of age presented with a medial open fracture of the radius and ulna due to a road accident. If not attended to, exposed fractures put the well-being and health of animals at risk since they become a source of infection that could quickly migrate to the bone marrow.



Figure 4 Vehicular trauma in a stray dog. A male homeless dog was presented with a burn in the antebrachium and carpus due to a road traffic accident. These burns are very common in patients involved in vehicular accidents and are generated by dragging the animal's limb when it gets stuck in one of the structures of the vehicle that runs over it. Most of the stray dog population is not referred to veterinary care in these cases where tissue necrosis and systemic infection can develop.

4. Alternatives to Address the Human–Dog Bond Issue

Adoption has been suggested as an alternative method to address the human–dog bond, together with sterilization campaigns. This process requires the future owner, to agree to sterilization, identification, and vaccination (Cendón, 2011; Mota-Rojas, 2018; Mota-Rojas et al., 2024). However, not all stray dogs can be reinserted into a home. The majority of stray dogs have behavioral problems that complicate their adoption and can end in the euthanasia (Lepper et al., 2005; Mota-Rojas et al., 2016; Mota-Rojas et al., 2018). Among the behavioral problems that owners report as a reason for leaving their dog in a shelter are being aggressive toward people, dirtying the house, destruction, escapes (Salman et al., 2000), hyperactivity, and vocalizations (Barrera et al., 2009).

In some countries such as India, eradication or sanitary rifles have been chosen to control canine overpopulation on the streets. However, as indicated by the World Health Organization, this method does not directly address the increase in the stray dog population, so alternative methods such as owner-centered education and sterilization are recommended (Dalla et al., 2010). Given this recommendation, new include reproductive control, education on responsible ownership, legislation, and registration of animals. According to a systemic review these alternatives have a positive effect, by significantly reducing the growth of the stray dog population (Smith et al., 2019; Amaku, 2009).

The above findings show that strategies aimed at avoiding abandonment because human–animal bonds fail must have a common objective, such as managing population growth in general. They also must focus on improving the health and well-being of the population, promoting responsible ownership, reducing the transmission of diseases toward humans, and preventing damage to the environment and animals (Ratsitorahina et al 2009; Menor–Campos et al 2023).

One of the main strategies used to help improve the bonds between humans and dogs is providing information and education on responsible ownership (Mota-Rojas, 2017; Mota-Rojas et al., 2018; Mota-Rojas et al., 2024). Neidhart and Boyd (2002) compared the effects of providing information and advice on animal health and education on pet care among adopters in three different shelters. The results showed that the pet’s relationship with the family had an effect on the amount of veterinary care they receive and that the personality and foresight of the owner also influences the retention of the pet.

Currently, the “responsible pet ownership” program has been implemented in some countries, which refers to taking responsibility for the actions carried out by the animals, such as collecting waste on public roads, damage to belonging, and possible attacks on the community (Soberanis-Ramos et al., 2018; Mota-Rojas et al., 2021a; Mota-Rojas et al., 2024). An example of this is Spain, where legislation has been established to regulate the responsible ownership of pets. This regulation establishes the responsibilities to ensure animal’s well-being, including adequate nutrition, minimum living space, cleaning, vaccination and deworming, spaying or neutering, clear identification of animals, control of mobility on the streets and registration of animals in a centralized database (Cendón et al., 2011).

In Mexico, the Law Against Animal Abuse was established in its capital in 2013, in addition to carrying out education campaigns focused on the owner called “be a responsible owner” (Said, 2017). However, in this sense, this problem becomes complex where scientific evidence has shown that there are multiple factors involved, from cultural to economic (Slater, 2001), and a single isolated measure will not help solve the problem (Mota-Rojas et al., 2024).

Finally, the role of the veterinarian in disseminating education to guardians is essential to improve the human–animal bond (Mota-Rojas et al., 2020; Menor-Campos et al., 2023; Mota-Rojas et al., 2023). Likewise, the participation of the veterinarian must involve four key points, including the clinical area, nutrition, animal health and education for pet owners about their management (Gómez et al., 2007), It is also important to consider the relationship that exists between domestic violence and animal abuse, recognizing abandonment as a form of animal abuse (Mota-Rojas et al., 2022). On the basis of the above, the veterinarian plays a fundamental role in the problem, given the influence on the education of the owners due to the misinformation shown by them (Mota-Rojas et al., 2020; Menor-Campos et al., 2023; Mota-Rojas et al., 2023). Weng et al. (2006) reported that many people grasp information from health professionals to a greater extent than written material does.

When considering the desire to acquire a pet, the guidance of a veterinarian is relevant to make the best decision, considering not only the place where the pet will be housed but also the age of the person who will live with it (Pacheco 2003; Mota-Rojas et al., 2022). In this situation, veterinary associations, colleges, and veterinarians must spread information on responsible pet ownership via the media in collaboration with local governments, humane societies, schools, and citizens interested in providing animal welfare to communicate massively to the population (Feldmann and Carding, 1973; Mota-Rojas, 2017; Mota-Rojas et al., 2024).

5. Final Considerations

The continuously increasing stray dog population is a problem closely related to the human–dog relationship. Most of the dogs wandering in the streets are pets that were abandoned by their owners. Behavioral and financial issues are among the main reasons for abandoning dogs. This not only perpetuates the public hazard associated with stray dogs but also has consequences for the animals. The high prevalence of infectious diseases and traffic accidents in homeless dogs affects their welfare and poses a risk for zoonotic diseases. Currently, although programs are focused on stray dog population management, the key to preventing and reducing the number of stray dogs is through responsible pet ownership

interventions. Humans must be aware of the compromise and duty of having a pet dog. It is a commitment where pet owners need to recognize that dogs require time and money investment, particularly in those cases where the human–dog relationship is severed.

Another important point to consider is to consider the socio-economic and cultural conditions according to each country, and aspects that influence dog ownership. Therefore, it is important to acknowledge that some strategies and solutions used in First World Countries may not be viable in Developing Countries, where the economy is limited. That is why responsible owner education is one of the most viable alternatives around the world.

Ethical Considerations

Not applicable.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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References

- Albert, A., & Bulcroft, K. (1988). Pets, families, and the life course. *Journal of Marriage and Family*, 50(2), 543. <https://psycnet.apa.org/doi/10.2307/352019>
- Amaku, M., Dias, R., & Ferreira, F. (2009). Dinâmica populacional canina: potenciais efeitos de campanhas de esterilização. *Revista Panamericana de Salud Pública*, 25, 300–304. <https://doi.org/10.1590/S1020-49892009000400003>
- Ashaolu, J. O., Tsai, Y.-J., Liu, C.-C., & Ji, D.-D. (2022). Prevalence, diversity and public health implications of *Helicobacter* species in pet and stray dogs. *One Health*, 15, 100430. <https://doi.org/10.1016/j.onehlt.2022.100430>
- Baquero, O. S., Chiozzotto, E. N., Garcia, R. de C. M., et al. (2017). Abandonment of dogs and cats: Public opinions as population management indicators. *Journal of Applied Animal Welfare Science*, 20, 289–295. <https://doi.org/10.1080/10888705.2017.1317251>
- Barrera, G., Elgier, A., Jakovcovic, A., Mustaca, A., & Bentosela, M. (2009). Problemas de comportamiento en los perros domésticos (*Canis familiaris*): Aportes de la psicología del aprendizaje. *Revista de Psicología de la Universidad de Chile*, 123–146.
- Boey, J. (2017). Working with communities to improve the quality of life of British Columbia's free-roaming dogs and their people (Tesis de maestría). University of Victoria, Canadá, 72 p.
- Broom, D. M. (2019). Animal welfare complementing or conflicting with other sustainability issues. *Applied Animal Behaviour Science*, 219, 104829. <https://doi.org/10.1016/j.applanim.2019.06.010>
- Cannas, S., Talamonti, Z., Mazzola, S., et al. (2018). Factors associated with dog behavioral problems referred to a behavior clinic. *Journal of Veterinary Behavior*, 24, 42–47. <https://doi.org/10.1016/j.jveb.2017.12.004>
- Cendón, P., Holm, A., & Balague, E. (2011). Abandono de animales de compañía. *Universitat Autònoma de Barcelona*, 1–22.
- Chandran, E., & Azeez, P. (2016). Stray dog menace: Implications and management. *Economic and Political Weekly*, 51, 58–65.
- Choudhary, K., & Palsaniya, V. K. (2024). Overview of the stray animals in India and their regulation. *Journal of Advanced Biology and Biotechnology*, 27, 893–899. <https://doi.org/10.9734/jabb/2024/v27i71049>
- Dalla, P., Kahn, S., Stuardo, L., et al. (2010). Free-roaming dog control among OIE-member countries. *Preventive Veterinary Medicine*, 97, 58–63. <https://doi.org/10.1016/j.prevetmed.2010.07.001>
- Downes, M., Canty, M., & More, S. (2009). Demography of the pet dog and cat population on the island of Ireland and human factors influencing pet ownership. *Preventive Veterinary Medicine*, 92, 140–149. <http://dx.doi.org/10.1016/j.prevetmed.2009.07.005>
- Feldmann, B., & Carding, T. (1973). Free-roaming urban pets. *Health Services Reports*, 88, 956–962. <https://doi.org/10.2307/4594959>
- Gan, H., Hou, X., Wang, Y., et al. (2023). Global burden of rabies in 204 countries and territories, from 1990 to 2019: Results from the Global Burden of Disease Study 2019. *International Journal of Infectious Diseases*, 126, 136–144. <https://doi.org/10.1016/j.ijid.2022.10.046>
- García, R. C. M., Amaku, M., Biondo, A. W., et al. (2018). Dog and cat population dynamics in an urban area: Evaluation of a birth control strategy. *Pesquisa Veterinária Brasileira*, 38, 511–518. <https://doi.org/10.1590/1678-5150-PVB-4205>
- García, R., Calderón, M., & Ferreira, F. (2012). Consolidação de diretrizes internacionais de manejo de populações caninas em áreas urbanas e proposta de indicadores para seu gerenciamento. *Revista Panamericana de Salud Pública*, 32, 140–144.
- Gill, G. S., Singh, B. B., Dhand, N. K., et al. (2022). Stray dogs and public health: Population estimation in Punjab, India. *Veterinary Sciences*, 9, 75. <https://doi.org/10.3390/vetsci9020075>
- Gómez, L., Atehortua, C., & Orozco, P. (2007). La influencia de las mascotas en la vida humana. *Revista Colombiana de Ciencias Pecuarias*, 20, 377–386.
- Guerrero, F., Tigreros, Q., & Falconi, G. (2013). Campaña de mercadeo social: Anímate no tengo raza, acógeme en tu casa. (Tesis de licenciatura). Universidad San Francisco de Quito, Perú, 66 p.
- Herwijnen, I. R. van, van der Borg, J. A. M., Naguib, M., & Beerda, B. (2018). Dog ownership satisfaction determinants in the owner-dog relationship and the dog's behaviour. *PLOS One*, 13, e0204592. <https://doi.org/10.1371/journal.pone.0204592>
- Hogasen, H. R., Er, C., Di Nardo, A., et al. (2013). Free-roaming dog populations: A cost-benefit model for different management options, applied to Abruzzo, Italy. *Preventive Veterinary Medicine*, 112, 401–413. <https://doi.org/10.1016/j.prevetmed.2013.07.010>
- Jajere, S. M., Lawal, J. R., Shittu, A., et al. (2022). Epidemiological study of gastrointestinal helminths among dogs from Northeastern Nigeria: A potential public health concern. *Parasite Research*, 121, 2179–2186. <https://doi.org/10.1007/s00436-022-07538-z>



- Katica, M., Obradović, Z., Ahmed, N. H., et al. (2020). Interdisciplinary aspects of possible negative effects of dogs on humans in Bosnia and Herzegovina. *Medical Glas*, 246-251. <https://doi.org/10.17392/1187-20>
- Kaya, Ö. M., Akkücüük, Ş., Karagöz, M., et al. (2018). A survey of mange-mite in stray dogs from Hatay Province. *Van Veterinary Journal*, 29, 67–70.
- Klimpel, S., Heukelbach, J., Pothmann, D., & Rückert, S. (2010). Gastrointestinal and ectoparasites from urban stray dogs in Fortaleza (Brazil): High infection risk for humans? *Parasite Research*, 107, 713–719. <https://doi.org/10.1007/s00436-010-1926-7>
- Lepper, M., Kass, P. H., & Hart, L. A. (2002). Prediction of adoption versus euthanasia among dogs and cats in a California animal shelter. *Journal of Applied Animal Welfare Science*, 5, 29–42. https://doi.org/10.1207/s15327604jaws0501_3
- Liberato, C. de, Berrilli, F., Odorizi, L., et al. (2018). Parasites in stray dogs from Italy: Prevalence, risk factors and management concerns. *Acta Parasitologica*, 63, 27–32. <https://doi.org/10.1515/ap-2018-0003>
- Ma, J., Shu, H., & Kannan, K. (2020). Fecal excretion of perfluoroalkyl and polyfluoroalkyl substances in pets from New York state, United States. *Environmental Science & Technology Letters*, 7, 135–142. <https://doi.org/10.1021/acs.estlett.9b00786>
- Malian, A., & Marin, V. (2013). Caracterización de algunas poblaciones urbanas de perros vagabundos en Montevideo y Ciudad de la Costa. (Tesis doctoral). Universidad de la República, Facultad de Veterinaria, Uruguay, 43 p.
- Manteca, X. (2003). *Etología clínica veterinaria del perro y del gato* (pp. 57-66). Multimédisica.
- Mendoza Roldan, J. A., & Otranto, D. (2023). Zoonotic parasites associated with predation by dogs and cats. *Parasites & Vectors*, 16, 55. <https://doi.org/10.1186/s13071-023-05670-y>
- Mills, D. S., & De Keuster, T. (2009). Dogs in society can prevent society going to the dogs. *Veterinary Journal*, 79, 322–323. <https://doi.org/10.1016/j.tvjl.2008.07.014>
- Mindru, R., Roman, C., Lupu, A. C., et al. (2019). Epidemiology and clinical presentation of dogs infected with sarcoptic mange. *Lucrări Științifice Seria Medicină Veterinară*, 62, 1–8.
- Morgan, L., Protopopova, A., Birkler, R. I. D., et al. (2020). Human–dog relationships during the COVID-19 pandemic: Booming dog adoption during social isolation. *Humanities & Social Sciences Communications*, 7, 155. <https://doi.org/10.1057/s41599-020-00649-x>
- Mota-Rojas, D. (2017). El bienestar de los animales de compañía: La eutanasia. *Zoo Rev Vet*, 3, 8–12.
- Mota-Rojas, D. (2018). El bienestar del perro abandonado, calidad de vida y calidad de muerte. 4to Simposio de “Ética y bienestar animal”. Auditorio Tania Larrauri. Universidad Autónoma Metropolitana, México.
- Mota-Rojas, D., Broom, D., Orihuela, A., Velarde, A., Napolitano, F., & Alonso-Spilsbury, M. (2020). Effects of human-animal relationship on animal productivity and welfare. *Journal of Animal Behavior and Biometeorology*, 8, 196–205. <http://dx.doi.org/10.31893/jabb.20026>
- Mota-Rojas, D., Calderón-Maldonado, N., Lezama-García, K., et al. (2021a). Abandonment of dogs in Latin America: Strategies and ideas. *Veterinary World*, 14, 2371–2379. <https://doi.org/10.14202/vetworld.2021.2371-2379>
- Mota-Rojas, D., Lezama-García, K., Domínguez-Oliva, A., Olmos-Hernández, A., Verduzco-Mendoza, A., Casas-Alvarado, A., Torres-Bernal, F., & Martínez-Burnes, J. (2023). Neurobiology of emotions in animal relationships: Facial expressions and their biological functions in mammals. *Journal of Animal Behavior and Biometeorology*, 11, e2023ss01. <https://10.31893/jabb.23ss01>
- Mota-Rojas, D., Lezama-García, K., Domínguez-Oliva, A., Sepiurka, L., Reyes-Sotelo, B., & Ghezzi, D. (2024). El perro en situación de calle: Contaminación ambiental y salud pública. *Sociedad Rurales Producción Médica Ambiental*, 23(47), in press.
- Mota-Rojas, D., Mariti, C., Zdeinert, A., Riggio, G., Mora-Medina, P., del Mar Reyes, A., Gazzano, A., Domínguez-Oliva, A., Lezama-García, K., José-Pérez, N., et al. (2021b). Anthropomorphism and its adverse effects on the distress and welfare of companion animals. *Animals*, 11, 3263. <https://doi.org/10.3390/ani11113263>
- Mota-Rojas, D., Monsalve, S., Lezama-García, K., Mora-Medina, P., Domínguez-Oliva, A., Ramírez-Necoechea, R., & Garcia, R. C. M. (2022). Animal abuse as an indicator of domestic violence: One Health, One Welfare approach. *Animals*, 12, 977. <https://doi.org/10.3390/ani12080977>
- Mota-Rojas, D., Orihuela, A., Strappini-Asteggiano, A., Cajiao-Pachón, M. N., Agüera-Buendía, E., Mora-Medina, P., Ghezzi, M., Alonso-Spilsbury, M. L. (2018). Teaching animal welfare in veterinary schools in Latin America. *International Journal of Veterinary Science and Medicine*, 6, 131–140. <https://doi.org/10.1016/j.ijvsm.2018.07.003>
- Mota-Rojas, D., Velarde, A., Maris-Huertas, S., & Cajiao, M. N. (2016). *Bienestar animal: Una visión global en Iberoamérica* (3rd ed.). Elsevier.
- Murshidah, M. A., Fong, L. S., Ikhwan, S. A., & Shafie, I. N. F. (2021). A retrospective study of vertebral fracture and luxation in dogs presented to University Veterinary Hospital, Universiti Putra Malaysia in 2015 to 2017. *Tropical Agricultural Science*, 44, 643–653.
- Neidhart, L., & Boyd, R. (2002). Companion animal adoption study. *Journal of Applied Animal Welfare Science*, 5, 175–192. https://doi.org/10.1207/S15327604JAWS0503_02
- Otranto, D., Dantas-Torres, F., Mihalca, A. D., et al. (2017). Zoonotic parasites of sheltered and stray dogs in the era of the global economic and political crisis. *Trends in Parasitology*, 33, 813–825. <https://doi.org/10.1016/j.pt.2017.05.013>
- Pacheco, R. (2003). Mascotas en los hogares: Enfermedades de los niños adquiridas por convivencia con animales. *Enfermedades Infecciosas y Microbiología*, 23, 137–148.
- Patronek, G., Glickman, L., Beck, A., et al. (1996). Risk factors for relinquishment of dogs to an animal shelter. *Journal of American Veterinary Medicine Association*, 209, 572–581.
- Ratsitorahina, M., Rasambainarivo, J. H., Raharimanana, S., et al. (2009). Dog ecology and demography in Antananarivo. *BMC Veterinary Research*, 5, 21. <https://doi.org/10.1186/1746-6148-5-21>
- Said, C. K. (2017). Políticas públicas de control en población canina en la Ciudad de México. (Tesis de Maestría). Universidad Autónoma de Barcelona, España, 59 p.
- Saldanha-Elias, A. M., Silva, M. A., Silva, V. O., et al. (2019). Prevalence of endoparasites in urban stray dogs from Brazil diagnosed with Leishmania, with potential for human zoonoses. *Acta Parasitologica*, 64, 352–359. <https://doi.org/10.2478/s11686-019-00043-x>
- Salman, M. D., Hutchison, J., Ruch-Gallie, R., et al. (2000). Behavioral reasons for relinquishment of dogs and cats to 12 shelters. *Journal of Applied Animal Welfare Science*, 3(2), 93–106. http://dx.doi.org/10.1207/S15327604JAWS0302_2

- Slater, M. R. (2001). The role of veterinary epidemiology in the study of free-roaming dogs and cats. *Preventive Veterinary Medicine*, *48*, 273–486. [https://doi.org/10.1016/s0167-5877\(00\)00201-4](https://doi.org/10.1016/s0167-5877(00)00201-4)
- Smith, L. M., Hartmann, S., Munteanu, A. M., et al. (2019). The effectiveness of dog population management: A systematic review. *Animals*, *9*, 1020. <https://doi.org/10.3390/ani9121020>
- Soberanis-Ramos, O., Arvizu-Tovar, L. O., Pérez-Rivero, J. J. (2018). Tenencia responsable de perros en la Ciudad de México. *Salud Pública México*, *60*, 128.
- Suliman, Y., Zakaria, M. A., & Pengsakul, T. (2020). Prevalence of intestinal helminth parasites of stray dogs in Shendi area, Sudan. *Annals of Parasitology*, *66*, 115–118. <https://doi.org/http://dx.doi.org/10.17420/ap6601.03>
- Sundari, G., & Sadiq, M. (2020). Economic losses due to stray dogs. *Indian Journal of Economics and Development*, *8*, 1017–1021. <https://doi.org/10.5958/2322-0430.2020.00515.2>
- Tucker, R., & Koszler, P. (2018). The urban stray dog: A public health concern. *Journal of Urban Health*, *94*, 41–46. <https://doi.org/10.1007/s11524-018-0290-8>
- Uwagie-Ero, E. A., Abiaezute, C. N., Okorie-Kanu, O. J., et al. (2018). Retrospective evaluation of canine fractures in southern Nigeria. *Companion and Clinical Pathology*, *27*(5), 1127–1132. <https://doi.org/10.1007/s00580-018-2708-3>
- Weng, H.-Y., Kass, P. H., Chomel, B. B., et al. (2006). Educational intervention on dog sterilization and retention in Taiwan. *Preventive Veterinary Medicine*, *76*(3–4), 196–210. <https://doi.org/10.1016/j.prevetmed.2006.05.002>
- Zumpano, R., Tortosa, A., & Degregorio, O. (2011). Estimación del impacto de la esterilización en el índice de crecimiento de la población de caninos. *Revista de Investigación Veterinaria de Perú*, *22*(4), 336–341. <http://dx.doi.org/10.15381/rivep.v22i4.333>