Effect of COVID-19 Lockdown on Small Animal Trauma Patterns in Australia: A Multicentre Study

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Objective: To determine whether patterns of trauma changed following the start of local lockdowns due to COVID-19.

Design: Multi-institutional retrospective study assessing patients presenting within 2 years prior to local lockdown due to COVID-19 and 1 year following lockdown inclusive.

Setting: Two university teaching hospitals and one private referral center in Australia.

Animals: Dogs and cats with a presenting complaint of known or suspected trauma.

Interventions: Patient signalment, date of presentation, trauma type, treatment interventions and patient outcome (survival to discharge, cardiopulmonary arrest, or euthanasia) were recorded in a web-based data capture system (REDCap).

Measurements and Main Results: Three thousand one hundred eighty-nine patients (682 cats and 2,507 dogs) were included in the study. Overall trauma prevalence was 2.9% with pre-lockdown prevalence of 2.8% and post-lockdown prevalence of 3.1% (p < 0.001). Cats had higher rates of blunt trauma while penetrating trauma was more prevalent in dogs (p < 0.001). Juvenile patients were also more likely to have blunt trauma when compared to adult patients (p < 0.001). Patient age and sex characteristics did not differ when comparing the 2 time periods. Compared to pre-lockdown, blunt and penetrating trauma patterns changed post-lockdown in dogs and cats (p < 0.001 for both). Interventions were performed more frequently (p = 0.039) in the post-lockdown with surgical procedures having a significant increase (p = 0.015). Survival rates increased post-lockdown for both species (p < 0.001) with financially driven euthanasia being less common than in pre-lockdown for dogs (p = 0.02).

Conclusions: Trauma patterns changed for cats and dogs in the post-lockdown period. Compared to pre-lockdown, trauma prevalence was higher with a decrease in mortality rate. No increase in juvenile patients was identified post-lockdown. A decrease in financially driven euthanasia and an increase in interventions suggest no negative financial effect from COVID-19 lockdown on trauma patient care in Australia.

Keywords: trauma, COVID, cats, dogs, financial effect
INTRODUCTION

Trauma patterns in cats and dogs have been reported multiple times with some differences in the types of trauma dependent on species, age, sex/reproductive status and regional population differences (urban vs. suburban vs. rural) (1–8). Cats most commonly present with blunt trauma while dogs more frequently present with penetrating trauma, with head trauma more likely leading to death in cats when compared to dogs (1–7). Trauma occurs in a higher proportion of male cats and dogs than female ones, and younger animals are more likely to experience traumatic injury than older animals (4, 8).

The coronavirus (COVID-19, hereafter referred to a COVID) pandemic (9) and subsequent lockdowns have had a significant impact on the lifestyle and regular day to day activities of Australians (10) and those around the globe (11) since March 2020. In Australia, government-mandated lockdowns (12) were controlled at the regional or municipal level with mildly different levels of movement restriction. Overall, the population was confined to their homes. Only essential workers were allowed to travel locally for work; all others were permitted out of the home for exercise (including walking the dog), to seek medical care, and to obtain food and necessities.

Data from human studies have identified a reduction in the presentation of trauma patients during lockdown periods in Australia with the Royal Adelaide Hospital and Westmead Hospital Sydney reporting decreases of 33% and 23–34%, respectively (13, 14). Notably, there was a decrease in road traffic accidents, likely due to reduced movement and vehicle transport. With changes in human-pet interactions (with owners home with their pets more of the time) and increased interactions between dogs (with owners walking them more frequently to leave the confines of home), we hypothesized that the prevalence of trauma and trauma patterns for cats and dogs would differ when comparing pre-lockdown periods (BEFORE) with periods during lockdown (AFTER).

Increases in pet ownership have been definitively reported for Australia during the pandemic, with an increase of 20–45% in adoptions (15), leading to 69% of Australian households owning pets (16). With social media identifying a “puppy boom” and anecdotal reports of increased adoption of kittens, we hypothesized that the ages of patients presenting for traumatic injuries would be lower in the AFTER period compared to the BEFORE.

Finally, due to reports of changes in income (17) due to job losses, we hypothesized that expensive interventions such as oxygen administration, blood transfusions, surgical procedures and mechanical ventilation would be performed at different rates BEFORE vs. AFTER, also leading to different rates of euthanasia being performed for financial reasons.

MATERIALS AND METHODS

Electronic medical records of the University Veterinary Teaching Hospital Sydney (SYD), the University of Melbourne (MEL) and the Animal Referral & Emergency Centre (AREC) were reviewed. Cases were identified from the 3-year study period using one of two ways: by querying records for the term “trauma” in the history text or by searching the hospital’s emergency case log. The study period consisted of two subsets: a pre-lockdown period when each hospital was conducting normal business functions and no limits were placed on human activities, and a post-lockdown period when local public health orders restricted human activities and each hospital ceased entry of clients into the building (curb-side service). The start of curb-side service for each hospital was defined as the date of lockdown and was the first day of the 1-year post-lockdown period. The pre-lockdown time period was a 2-year period ending the day before the date of lockdown. The date of lockdown varied between hospitals based on local public health orders.

Exclusion criteria included any of the following diagnoses: identification of a fish hook on or in the body, corneal abrasion, lameness due to a misstep, torn nail, abscess, self-trauma, or bandage-related trauma. Incomplete medical records were a reason for exclusion, but patients were not excluded from the study if their age or sex was unrecorded. Patients that presented dead on arrival were included in the study.

Information collected included the hospital location, date of visit, patient signalment (species, age, sex), trauma type (blunt, penetrating, unknown or polytrauma), interventions (blood transfusion, oxygen administration, surgical procedure, mechanical ventilation), patient outcome (survival to discharge or death), the cause of death [cardiopulmonary arrest (CPA) vs. euthanasia], and the reason for euthanasia if performed (financial only, poor prognosis only, both financial and prognosis, other, and unknown if the reason could not be identified from the medical record). The behavior leading to the trauma event was not reported as this was not commonly recorded in the medical record. As one of the goals of this study was to identify if there were any financial repercussions from the lockdown, only interventions associated with high cost were identified; minor wound care, medication administration and IV fluids, for example, were not included. Three of the four major interventions were included as they are the primary interventions recorded in the VetCOT trauma registry (5) and oxygen administration was chosen as the fourth intervention as the cost for this increases hospitalization fees by 50% in the participating hospitals, indicating a major financial impact.

Data were collected with a web-based data capture system (REDCap) (18).

STATISTICAL METHODS

Data were visually inspected, and calculations of skewness & kurtosis were performed to evaluate for normality. When continuous data were assessed for normality, no normally distributed data were identified. These data were therefore reported as the median with an interquartile range (IQR). Categorical data were reported as frequency or proportion. Trauma prevalence was calculated as the mean prevalence for all participating hospitals. Patients were grouped into time categories [BEFORE (pre-lockdown) and AFTER (post-lockdown)], age categories [juvenile (< 1 year) or adult (≥1 year)], species [dog or cat], location [urban, suburban, rural], date of visit [pre-lockdown, lockdown], and patient outcome [survival to discharge or death]. The number of patients in each group was calculated, and a chi-square test was performed to determine if there was a statistically significant difference in the outcome of patients. The significance level was set at p < 0.05.
RESULTS

Overall Patient Population

A total of 3,189 patients fulfilled inclusion criteria with 415 from SYD, 1,287 from MEL and 1,487 from AREC. **Table 1** shows data for cats and dogs over the three-year period of the study. Cats comprised 21.4% of all patients enrolled in the study, and dogs, 78.6%. The median age of all species was 4 years of age (IQR 7), with 20% of all patients categorized as juvenile. The majority of patients were male animals (53.3%), followed by female animals (46.3%) with 11 patients (0.4%) having no recorded sex. The number of desexed patients were approximately double that of non-desexed patients (66.2% of males and 69.0% of females reported as desexed).

Penetrating trauma was most commonly reported (52.8%), followed by blunt trauma (42%), unknown trauma (3.7%), and polytrauma (1.5%). Hit by vehicle (HBC) was the most common cause of blunt injury at 48.5% and bites were the most common cause of penetrating injury at 66.2%.

For 76.7% of patients, no interventions were performed. Oxygen supplementation was administered to 15.8% of patients, 13.3% of patients received one or more blood transfusions, 18.4% of patients underwent a surgical procedure, and mechanical ventilation was performed on 0.13% of patients. A number of patients had more than one intervention.

Most patients survived (89.1%) with 7.5% of all patients euthanized and 3.4% dying from cardiopulmonary arrest. Poor prognosis was the most commonly cited reason for euthanasia (53.1%).

The overall trauma prevalence was 2.9%.

BEFORE vs. AFTER

Lockdown at SYD started on 23/03/2020, at AREC on 16/03/2020, and at MEL on 25/03/2020. Total patients enrolled BEFORE numbered 1,917 and 1,272 patients were enrolled AFTER.

**Table 2** shows data according to time period. There was no significant difference in the proportions of cats and dogs, median age, sex distribution and neuter status in the two periods.

Proportions of trauma types significantly differed BEFORE vs. AFTER \((p < 0.01)\), while penetrating trauma remained the most common \((Figure 1)\). Distribution of subtypes of both penetrating and blunt trauma significantly changed AFTER vs. BEFORE \((p = 0.025 \text{ and } p = 0.028, \text{ respectively})\) as detailed in **Figure 2**.

Rates of interventions differed between time periods, with rates of surgical procedures significantly increased AFTER \((p = 0.015)\). The number of patients without interventions significantly decreased AFTER compared to BEFORE \((p = 0.039)\).

### TABLE 1 | Patient characteristics, interventions, and outcomes over the 3-year study period.

| Count (%) or median (IQR) |
|----------------------------|
| Total count                | 3,189 (100%) |
| **Location**               |              |
| AREC                       | 1,487 (46.6%)|
| MEL                        | 1,287 (40.4%)|
| SYD                        | 415 (13%)    |
| **Species**                |              |
| Feline                     | 682 (21.4%)  |
| Canine                     | 2,507 (78.6%)|
| **Age**                    |              |
| Juvenile                   | 635 (19.9%)  |
| Adult                      | 2,554 (80.1%)|
| **Sex & desexing status**  |              |
| Male entire                | 572 (17.9%)  |
| Male desexed               | 1,126 (35.3%)|
| Male unreported            | 2 (0.06%)    |
| Female entire              | 449 (14.1%)  |
| Female desexed             | 1,021 (32%)  |
| Female unreported          | 8 (0.3%)     |
| Unknown                    | 11 (0.3%)    |
| **Trauma type**            |              |
| Penetrating                | 1,684 (52.8%)|
| Blunt                      | 1,340 (42%)  |
| Polytrauma                 | 47 (1.5%)    |
| **Penetrating subtypes**   |              |
| Bite                       | 1,114 (34.9%)|
| Impalement                 | 59 (1.9%)    |
| Laceration                 | 475 (14.9%)  |
| Non-accidental             | 13 (0.4%)    |
| Unknown                    | 27 (0.8%)    |
| Other                      | 4 (0.1%)     |
| **Blunt subtypes**         |              |
| HBC                        | 650 (20.4%)  |
| Fall                       | 296 (9.3%)   |
| Crush                      | 168 (5.3%)   |
| Ran into object            | 50 (1.6%)    |
| Struck by object           | 40 (1.3%)    |
| Non-accidental             | 13 (0.4%)    |
| Unknown                    | 102 (3.2%)   |
| Hanging                    | 10 (0.3%)    |
| Other                      | 10 (0.3%)    |
| **Interventions**          |              |
| None                       | 2,447 (76.7%)|
| Oxygen                     | 505 (15.8%)  |
| Transfusion                | 423 (13.3%)  |
| Surgical procedure         | 586 (18.4%)  |
| Mechanical ventilation     | 4 (0.1%)     |

(Continued)
Survival rates significantly increased to 91% AFTER ($p = 0.013$) leading to a decrease in mortality rates from 12.2 to 9%.

Trauma prevalence was significantly different ($p < 0.0001$) between the time periods, with a BEFORE prevalence of 2.8% which increased to 3.1% AFTER.

**Feline vs. Canine**

The proportion of feline patients to canine patients was not significantly different BEFORE vs. AFTER, with cats continuing to make up $\approx$20% of all trauma patients included in the study ($p = 0.595$). Table 3 provides information on feline and canine patients both over the entire study as well as divided into BEFORE and AFTER. While median age was not significantly different between species and time periods, when comparing age categories there were significant differences with juvenile cats making up a higher proportion than juvenile dogs overall ($p = 0.002$). In addition, the juvenile population increased during the AFTER for dogs only ($p = 0.032$). While sex distribution and neuter status was significantly different between dogs and cats ($p < 0.001$), no significant differences were identified within each species through the time periods.

Overall types of trauma significantly differed between the species ($p < 0.001$) with cats having blunt trauma as the most common cause of injury (57.9%) and dogs having penetrating trauma most commonly (58.2%). Cats had significant changes ($p < 0.001$) in trauma categories BEFORE (58.4% blunt, 36.3% penetrating, 3.6% unknown, 1.7% polytrauma) vs. AFTER (57.1% blunt, 27.8% penetrating, 9.8% unknown, 5.3% polytrauma). Canine patients also had significant differences ($p < 0.001$) in trauma BEFORE (60.4% penetrating, 37.4% blunt, 1.9% unknown, 0.3% polytrauma) and AFTER (55% penetrating, 38.2% blunt, 4.8% unknown, 2.1% polytrauma). When trauma subtypes were examined between the time periods, only canine patients showed a significant difference ($p = 0.002$) (Figure 3).
TABLE 2 | Continued

| Time period: | BEFORE | AFTER | Significance* |
|--------------|--------|--------|---------------|
|              | Count (% of total) | Significance* |
|              | or median (IQR) | (Values ≤ 0.05 are in bold italics) | |
| **Interventions** |        |        |               |
| None         | 1,490 (77.7%) | 957 (75.2%) | 0.038 |
| Oxygen       | 293 (15.3%)  | 212 (16.7%) | 0.299 |
| Transfusion  | 239 (12.5%)  | 184 (14.5%) | 0.110 |
| Surgical procedure | 326 (17%) | 260 (20.4%) | 0.015 |
| Mechanical ventilation | 2 (0.1%) | 2 (0.02%) | 0.523 |
| **Outcome** |        |        | 0.013 |
| Survival     | 1,683 (87.8%) | 1,158 (91%) | 0.091 |
| Mortality    | 234 (12.2%)  | 114 (9%) | |
| Euthanasia   | 158 (8.2%)  | 81 (6.4%) | |
| Cardiopulmonary arrest | 76 (4%) | 33 (2.6%) | |
| **Reason for euthanasia** | Reported as count | | |
| Poor prognosis | 87 (55.1%) | 40 (49.4%) | 0.091 |
| Financial    | 41 (25.9%)  | 17 (21%) | |
| Both financial & prognosis | 37 (23.4%) | 14 (17.3%) | |
| Unreported   | 18 (11.4%)  | 20 (24.7%) | |
| Other        | 1 (0.6%)    | 1 (1.2%) | |

Adult, patients ≥ 1 year of age; AFTER, 1 year period including the first day of local hospital lockdown; AREC, Animal Referral & Emergency Centre; BEFORE, 2-year time period prior to local hospital lockdown; HBC, hit by vehicle; Juvenile, patients < 1 year of age; MEL, University of Melbourne Veterinary Hospital; Overall, entire 3 year of study; SYD, University Veterinary Teaching Hospital Sydney.

*Significance from Chi Square or Fisher’s Exact Test.

The frequency of interventions differed between species with the proportion of patients receiving no interventions being higher for dogs than cats (79% and 68.3% respective, p = 0.022). Cats had higher prevalence of oxygen administration (7.5% cats, 4.3% dogs, p = 0.001) and transfusions (1.5% cats, 0.6% dogs, p = 0.015); there was no significant difference in the prevalence of surgical procedures (9.4% cats, 10.9% dogs, p = 0.292) or mechanical ventilation (0.3% cats, 0.08% dogs, p = 0.202) between the species.

Survival rates for cats were lower than dogs through the 3-year period (77.6% cats, 92.2% dogs, p < 0.001), with 15.1% of cats and 5.4% of dogs euthanized and 7.3% of cats and 2.4% of dogs dying from CPA. Reported reasons for euthanasia did not differ between species (p = 0.59) with poor prognosis listed as the most frequent reason (48.4% cats, 44% dogs). When comparing species across time periods, there was a significant difference in reasons for euthanasia for dogs only, with a decrease in financial or financial/prognosis reasons for euthanasia (p = 0.02).

**Juvenile vs. Adult**

Cats and dogs <1 year of age made up 18.7% of patients BEFORE and 21.7% AFTER but this difference was not significant (p = 0.595). Table 4 outlines differences between age groups over the entire study period as well as between time periods. Species distribution was significantly different between age groups across the 3 years of the study. The majority of juvenile patients were dogs (74.2% dogs, 25.8% cats), as was most of the adult population (79.7% dogs, 25.8% cats) (p = 0.002). Not surprisingly, median age between groups was significantly different but this was not significant when time periods per age group were compared. Sex distribution and neuter status was significantly different between juveniles and adults (p < 0.001), with 33.7% of juvenile patients being entire males compared to 14.0% of adult patients, while 14.3% of juveniles were entire females compared to 36.4% of adult patients. When comparing age groups through time periods, there was a significant difference (p = 0.01) in sex and reproductive status for adult patients with the BEFORE population containing 14.2% entire males and 10.7% entire females while the AFTER population contained 13.8% entire males and 7.6% entire females.

Overall types of trauma significantly differed between the age groups (p < 0.001) with blunt trauma being the most common form of juvenile trauma (61.9%) and penetrating trauma the most common in adult patients (57.3%). Comparing age groups between time periods found changes in trauma categories only significantly (p < 0.001) affecting adult patients with BEFORE patterns including 59.3% penetrating, 37.6% blunt, 2.4% unknown, and 0.6% polytrauma while AFTER patterns were 54.2% penetrating, 36.2% blunt, 6.4% unknown, and 3.1% polytrauma. When trauma subtypes were examined, significant differences were identified both overall and when comparing age groups between time periods (Figure 4).

The frequency of interventions differed between age groups with juveniles having increased rates of oxygen administration (6.8% juvenile, 4.6% adult, p = 0.032); there was no difference in the rates of transfusions, surgical procedures, or mechanical ventilation between the age groups.

Survival rates for juveniles were significantly higher than adults (92.6% juvenile, 88.2% adult, p = 0.001) through the 3-year period. Similarly, there was a difference in euthanasia rates (4.1% juvenile, 8.3% adult) but not in the occurrence of CPA (3.3% juvenile, 3.4% adult). Adult patients had differences in survival and death rates between time periods with 86.8% surviving, 9.1% being euthanized and 4% suffering CPA BEFORE while 90.4% survived, 7.1% were euthanized and 2.5% suffering CPA AFTER (p = 0.02). Reported reasons for euthanasia did not differ between age groups with poor prognosis as the most frequently reported reason (44.1% juvenile, 46.3% adult, p = 0.24). Adult patients also showed a significant difference between time periods with decreases in all reported reasons except for unreported and other categories (p = 0.045).

**DISCUSSION**

Trauma prevalence has been reported in varying percentages and permutations. They vary from 2.7% of dogs in a group of small animal primary care practices in Korea and 4.6% of cats in multiple veterinary practices in the UK, to 11.4% of all dogs at government and private practice hospitals in Nigeria and 13% of...
all dogs and cats at an urban referral hospital in the USA (19–22). The current study, focused on referral hospitals in an urban and suburban environment in Australia, identified a relatively low trauma prevalence which significantly increased follow the onset of lockdown. Pre-lockdown trauma patterns in both species in this study closely mirrored those patterns reported in...
other studies, with cats more likely to experience blunt trauma and dogs, penetrating trauma (1–8). However, the distribution of trauma categories changed once lockdown started, with an overall decrease in penetrating injuries and an increase in unknown trauma. These findings parallel that which has been reported in the human literature, where the social restrictions of lockdown had led to a change in the pattern and number of trauma presentations but not in prevalence (13, 14). Reasons for the changes in overall trauma distribution and trauma prevalence are not clear. Possible factors include changes in human interactions with animals as well as interactions between animals.

When trauma subtypes were examined, there were no apparent differences in the types of penetrating traumas between time periods. However, in the category of blunt trauma, there was a decrease in the proportion of vehicular related traumas but an increase in the proportion of falls. This change was across species. The former is likely to be due to societal restrictions during lockdown; there was a significant decrease in travel by the population for work and recreation which translated into less vehicles on the road (23, 24). This was a similar finding in the human literature (13, 14). In contrast, an increase in trauma at home is expected due to increased human-animal interaction for prolonged periods of time in potentially confined spaces. For example, children playing with and chasing their pet dogs in a small apartment may lead to accidental injury and falls. This increase in certain subtypes of trauma paired with an increase in pet adoptions may be the reason for the increase in trauma prevalence post-lockdown (25).

When comparing trauma subtypes between cats and dogs, significant differences were identified. With blunt trauma, cats had a lower proportion of HBC than dogs and higher proportions of unknown trauma. Similarly, with penetrating trauma, cats had less bite wounds but more unknown trauma than dogs. While the trauma subtypes changed within species when comparing time periods, only canine trauma subtype changes were significant. This may be due to the canine population making up the majority of the study population, resulting in a smaller feline population unable to reflect significant differences. Similar to reasons for the overall change in trauma subtypes with combined species, the locations where trauma occurred (at home vs. outside of the home) could have been affected by changes in human movement.

Juvenile patients of both species had trauma patterns that were closer to feline trauma pattern than canine patterns, with blunt trauma being most common when compared to adults of both species. This comparison continues when evaluating the blunt trauma subtypes, with juveniles having much higher rates of falls and crush injury; for adult patients, HBC is the most common blunt trauma subtype. Interestingly, penetrating trauma subtypes did not differ significantly between age groups. While many studies have investigated correlations of trauma with age, no major studies have focused on differences in trauma patterns between juvenile and adult patients. One study (26) identified that juvenile dogs had higher rates of death from trauma when compared to adult dogs while another study (27) showed that risks of road traffic accidents were highest for juvenile cats when compared to adult cats. The differences in trauma patterns and trauma subtypes identified in the current study are likely due to restricted roaming of juveniles, as they are less likely to be out of the house or yard, or walked off lead, while adults are more likely to either escape or roam freely, increasing their interaction with vehicles and risk of HBC trauma.

This study supports anecdotal reports of an increase in puppy ownership during lockdowns (15, 16). However, a similar increase in kittens presenting for trauma during lockdown was not evident. This may be due to an increase in feline ownership occurring across all age ranges, a decreased likelihood for kittens to experience trauma compared to puppies or the relatively small feline population leading to a Type II error. The juvenile population showed lower rates of desexing during lockdown when compared to pre-lockdown. This may be a reflection of the lack of availability for desexing at veterinary clinics or a knowledge deficiency of owners with an increase in new pet ownership (15, 16).

While there was a concern that owner finances would contribute to poorer outcomes and reduced interventions due to job losses during COVID, this was not supported by the study results. Fewer patients in the post-lockdown group received no intervention. Among interventions, surgical procedures significantly increased AFTER while oxygen therapy, blood transfusions and mechanical ventilation did not. When comparing rates of interventions by species and age groups, there are significant differences. The number of cats not receiving interventions was lower than dogs overall. While no significant difference for this was found with cats between time periods, the number of dogs not receiving interventions decreased AFTER. Over both time periods, cats were more likely to receive oxygen supplementation and blood transfusions than dogs. No difference in type of interventions was found with cats between time periods while dogs AFTER had decreases in rates of oxygen administration but increases in blood transfusions. The number of juvenile patients not having interventions was statistically unchanged between time periods. Adult patients without interventions decreased in number AFTER. Juvenile patients were significantly more likely to get oxygen supplementation than adults at all time periods. No differences were found in the rates of individual interventions by age group between time periods. It is possible that lockdowns have led to a strengthening of the human-animal bond, resulting in an increase in presentations to emergency and a greater willingness to pursue interventions aimed at improving survival. The financial effect of pet insurance might also have played a role, but information about the frequency of pet insurance was not obtainable due to the retrospective nature of this study. The relatively low numbers of interventions across both time periods indicates that this study included patients with mild trauma, which makes up the majority of trauma patients, as well as more severe trauma, which follows a pattern previously reported (5). Less expensive interventions were not included in this study as they were deemed unlikely to be affected by any negative financial effects from lockdown. This may have led to bias and including information on less expensive interventions may have given more insight to financial effects which were not evident with the selected major interventions.
### TABLE 3
Patient characteristics, interventions, and outcomes by species.

| Species: | Cat | Dog |
|----------|-----|-----|
| **Time period:** | **Overall** | **BEFORE** | **AFTER** | **Overall** | **BEFORE** | **AFTER** |
| **Count (% of total) or Median (IQR)** | | | | | | |
| **Significance* between time periods per species** | (P-values ≤ 0.05 are in bold italics) | | | | | |
| **Total count** | 682 | 416 | 266 | 2,507 | 1,501 | 1,006 |
| **Patient signalment** | | | | | | |
| **Age** | 3 (6) | 3 (6) | 3 (6.075) | P = 0.395 | 4 (7) | 4 (6) | 4 (6.5) | P = 0.069 | P = 0.069 |
| **Age group** | | | | | | |
|**Juvenile** | 164 (24%) | 98 (23.6%) | 66 (24.8%) | P = 0.714 | 471 (18.9%) | 261 (17.4%) | 210 (20.9%) | P = 0.032 | P = 0.002 |
|**Adult** | 518 (7%) | 318 (76.4%) | 200 (75.2%) | | 2,036 (81.1%) | 1,240 (82.6%) | 796 (79.1%) | | |
| **Sex & desexing status** | | | | | | |
|**Male entire** | 86 (12.6%) | 59 (14.2%) | 27 (10.2%) | 486 (19.4%) | 291 (19.4%) | 195 (19.4%) | | |
|**Male desexed** | 294 (43.1%) | 176 (42.3%) | 118 (44.4%) | 832 (33.2%) | 513 (34.2%) | 328 (32.6%) | | |
|**Male unreported** | 1 (0.1%) | 0 (0%) | 1 (0.4%) | 1 (<0.1%) | 0 (0%) | 1 (0.1%) | | |
|**Female entire** | 75 (11%) | 52 (12.5%) | 23 (8.6%) | 374 (14.9%) | 218 (14.5%) | 156 (15.5%) | | |
|**Female desexed** | 220 (32.2%) | 125 (30%) | 95 (35.7%) | 801 (32%) | 473 (31.5%) | 328 (32.6%) | | |
|**Female unreported** | 1 (0.1%) | 0 (0%) | 1 (0.4%) | 1 (<0.1%) | 0 (0%) | 1 (0.1%) | | |
|**Unknown** | 5 (0.7%) | 4 (1%) | 1 (0.4%) | 6 (0.2%) | 4 (0.3%) | 2 (0.2%) | | |
| **Trauma type** | | | | | | |
|**Penetrating** | P < 0.001 | P < 0.001 | P < 0.001 | 1,459 (58.2%) | 906 (60.4%) | 553 (55%) | | |
|**Blunt** | 395 (57.9%) | 243 (58.4%) | 152 (57.1%) | 945 (37.7%) | 561 (37.4%) | 384 (38.2%) | | |
|**Unknown** | 41 (6%) | 15 (3.6%) | 26 (9.8%) | 77 (3.1%) | 2 (0.1%) | 5 (0.5%) | | |
|**Polytrauma** | 21 (3.1%) | 17 (1.7%) | 14 (5.3%) | 26 (1%) | 5 (0.3%) | 21 (2.1%) | | |
| **Trauma subtypes** | | | | | | |
|**Penetrating subtypes** | P = 0.361 | P = 0.002 | P < 0.001 | 979 (39.1%) | 618 (41.2%) | 361 (35.9%) | | |
|**Bite** | 135 (19.8%) | 93 (22.4%) | 42 (15.8%) | 979 (39.1%) | 618 (41.2%) | 361 (35.9%) | | |
|**Impalement** | 7 (1%) | 6 (1.4%) | 1 (0.4%) | 52 (2.1%) | 39 (2.6%) | 13 (1.3%) | | |
|**Laceration** | 68 (10%) | 41 (9.9%) | 27 (10.2%) | 407 (16.2%) | 239 (15.9%) | 188 (16.3%) | | |
|**Non-accidental** | 1 (0.1%) | 0 (0%) | 1 (0.4%) | 12 (0.5%) | 2 (0.1%) | 10 (1%) | | |
|**Unknown** | 20 (3%) | 12 (2.9%) | 8 (3%) | 7 (0.3%) | 4 (0.3%) | 3 (0.3%) | | |
|**Other** | 1 (0.1%) | 1 (0.2%) | 0 (0%) | 3 (0.1%) | 3 (0.2%) | 0 (0%) | | |
|**Blunt subtypes** | 395 (57.9%) | 243 (58.4%) | 152 (57.1%) | 945 (37.7%) | 561 (37.4%) | 384 (38.2%) | | |
|**HBC** | 164 (24%) | 113 (27.2%) | 51 (19.2%) | 486 (19.4%) | 319 (21.3%) | 167 (16.6%) | | |
|**Fall** | 85 (12.5%) | 43 (10.3%) | 42 (15.8%) | 211 (8.4%) | 105 (7%) | 106 (10.5%) | | |
|**Crush** | 60 (8.8%) | 38 (9.1%) | 22 (8.3%) | 108 (4.3%) | 62 (4.1%) | 46 (4.6%) | | |
|**Ran into object** | 7 (1%) | 3 (0.7%) | 4 (1.5%) | 43 (1.7%) | 26 (1.7%) | 17 (1.7%) | | |
|**Struck by object** | 4 (0.6%) | 3 (0.7%) | 1 (0.4%) | 36 (1.4%) | 19 (1.3%) | 17 (1.7%) | | |
|**Non-accidental** | 4 (0.6%) | 2 (0.5%) | 2 (0.8%) | 9 (0.4%) | 5 (0.3%) | 4 (0.4%) | | |
|**Unknown** | 63 (9.2%) | 36 (8.7%) | 27 (10.2%) | 39 (1.6%) | 18 (1.2%) | 21 (2.1%) | | |
|**Hanging** | 4 (0.6%) | 3 (0.7%) | 1 (0.4%) | 6 (0.2%) | 5 (0.3%) | 1 (0.1%) | | |
|**Other** | 3 (0.4%) | 1 (0.2%) | 2 (0.8%) | 7 (0.3%) | 2 (0.1%) | 5 (0.5%) | | |
| **Interventions** | | | | | | |
|**None** | 466 (68.3%) | 283 (68%) | 183 (68.8%) | P = 0.540 | 1,981 (79%) | 1,207 (80.4%) | 774 (76.9%) | P = 0.019 | P = 0.022 |
|**Oxygen** | 51 (7.5%) | 29 (7%) | 22 (8.3%) | P = 0.553 | 109 (4.3%) | 71 (4.7%) | 38 (3.8%) | P = 0.273 | P = 0.001 |
|**Transfusion** | 10 (1.5%) | 9 (2.2%) | 1 (0.4%) | P = 0.098 | 14 (0.6%) | 7 (0.4%) | 7 (0.7%) | P = 0.586 | P = 0.015 |
|**Surgical procedure** | 64 (9.4%) | 38 (9.1%) | 26 (9.8%) | P = 0.789 | 273 (10.9%) | 153 (10.2%) | 120 (11.9%) | P = 0.191 | P = 0.292 |
|**Mechanical ventilation** | 2 (0.3%) | 1 (0.2%) | 1 (0.4%) | P = 1.00 | 2 (<0.1%) | 1 (<0.1%) | 1 (0.1%) | P = 1.00 | P = 0.202 |

(Continued)
Despite an increase in trauma prevalence AFTER, survival rates increased significantly from 87.8 to 91%. With the social changes during lockdown including pet owners spending more time with and observing their pets at home, it is likely that cases of trauma were identified earlier. Early presentation of trauma was associated with improved outcomes and therefore survival (1, 4). Another contributing factor for increased survival is the interventions that were performed. As has been previously reported, dogs had higher survival rates than cats. While survival rates increased within the individual species between time periods, these changes were not significant, potentially due to insufficient case numbers. Reasons for the continued differences in survival rates between species include differences in body size, physiology, owner attachment, and the types of trauma experienced. Juvenile patients had a significantly higher survival rates than adults. This may be due to the nature of the age distribution, with the adult population containing animals with poorer health and increased comorbidities as well as geriatric patients and those with chronic diseases. Other reasons for higher survival rates for juveniles include improved healing ability in the young and potentially a decreased willingness for owners to euthanize a young pet. While juveniles did not have a significant increase in survival between time periods, adults had a significant improvement in survival. When the reasons for euthanasia were reported, there was no significant difference between species or age groups across time periods. While it can be difficult to elucidate the reason for euthanasia in a retrospective study, the participating hospitals commonly reported this in the medical records and the proportion of patients with an unreported reason for euthanasia was low across time periods. Dogs and adult patients had decreases in euthanasia for financial or financial and prognosis reasons AFTER, with adult patients also having a decrease in euthanasia for prognosis alone AFTER. These findings, combined with the increase in interventions, suggests that there was not a negative financial impact of care for these trauma patients. It is likely that lockdowns have led to a stronger bond between owners and their pets, resulting in an increase in presentations to emergency and interventions improving survival of trauma patients.

This study has several limitations. As a retrospective study involving multiple hospitals, treatment protocols may have differed, leading to bias. In addition, the lack of trauma scores such as Acute Trauma Triage Score or modified Glasgow Coma Scale in the medical records prevented any analysis of the effects of trauma severity on patient interventions and outcome in this population as well as identify if the changes in trauma subtypes were associated with more or less severe injuries between the time periods. Similarly, no information on hospital costs was collected, which might have correlated with the severity of injury. Behaviors leading to the patient’s trauma were not recorded, so true changes in human traffic and exercise patterns could not be directly investigated between the time periods. Lastly, all patients presented to referral hospitals, which means these results may not represent a true trauma prevalence or identify trauma patterns accurately for the pet population.

Data collection occurred at hospitals in the two largest cities (SYD, MEL) and a smaller city with semirural clients (AREC); a larger sample size including a diverse range of clinics may have resulted in further statistically significant changes in prevalence between time periods. Although there have been studies in the human literature assessing trauma prior to and after lockdowns during COVID, this is the
TABLE 4 | Patient characteristics, interventions, and outcomes by age groups.

| Age group: | Juvenile | | | Adult | | | | Significance* between time periods by age groups (P-values ≤ 0.05 are in bold italics) | Significance* between age groups (P-values ≤ 0.05 are in bold italics) |
|-----------|----------|---|---|--------|---|---|---|---|---|
| Time period: | Overall | BEFORE | AFTER | Overall | BEFORE | AFTER | Overall | BEFORE | AFTER |
| Count (% of total) or Median (IQR) | | | | | | | | | |
| Total count | 635 | 359 | 276 | 2,554 | 1,558 | 996 | | | |
| Patient signalment | | | | | | | | | |
| Species | | | | | | | | | |
| P = 0.361 | P = 0.880 | P = 0.002 |
| Feline | 164 (25.8%) | 98 (27.3%) | 66 (23.9%) | 518 (20.3%) | 318 (20.4%) | 200 (20.1%) |
| Canine | 471 (74.2%) | 261 (72.7%) | 210 (76.1) | 2,036 (79.7%) | 1,240 (79.6%) | 796 (79.9%) |
| Age | 0.5 (0.4) | 0.5 (0.4) | 0.5 (0.4) | P = 0.452 | 5 (6) | 5 (6) | 5 (7) | P = 0.110 | P < 0.001 |
| Sex & desexing status | | | | | | | | | |
| Male entire | 214 (33.7%) | 129 (35.9%) | 85 (30.8%) | 358 (14%) | 221 (14.2%) | 137 (13.8%) |
| Male desexed | 120 (18.9%) | 69 (19.2%) | 51 (18.5%) | 1,006 (39.4%) | 620 (39.8%) | 386 (39.8%) |
| Male unreported | 0 (0%) | 0 (0%) | 0 (0%) | 2 (<0.1%) | 0 (0%) | 2 (0.2%) |
| Female entire | 207 (32.6%) | 104 (29%) | 103 (37.3%) | 242 (9.5%) | 166 (10.7%) | 76 (7.6%) |
| Female desexed | 91 (14.3%) | 55 (15.3%) | 36 (13%) | 930 (36.4%) | 543 (34.9%) | 387 (38.9%) |
| Female unreported | 0 (0%) | 0 (0%) | 0 (0%) | 8 (0.3%) | 2 (0.1%) | 6 (0.6%) |
| Unknown | 3 (0.5%) | 2 (0.6%) | 1 (0.4%) | 8 (0.3%) | 6 (0.4%) | 2 (0.2%) |
| Trauma type | | | | | | | | | |
| Penetrating | 220 (34.6%) | 33 (9.2%) | 87 (31.5%) | 1,464 (57.3%) | 924 (59.3%) | 540 (54.2%) |
| Blunt | 393 (61.9%) | 218 (60.7%) | 175 (63.4%) | 947 (37.1%) | 586 (37.6%) | 361 (36.2%) |
| Unknown | 16 (2.5%) | 6 (1.7%) | 10 (3.6%) | 102 (4%) | 38 (2.6%) | 64 (6.4%) |
| Trauma subtypes | | | | | | | | | |
| Penetrating subtypes | | | | | | | | | |
| Bite | 146 (23%) | 92 (25.6%) | 54 (19.6%) | 968 (37.9%) | 619 (39.7%) | 349 (35%) |
| Impalement | 8 (1.3%) | 5 (1.4%) | 3 (1.1%) | 51 (2%) | 40 (2.6%) | 11 (1.1%) |
| Laceration | 60 (9.4%) | 34 (9.5%) | 26 (9.4%) | 415 (16.2%) | 246 (15.8%) | 169 (17%) |
| Non-accidental | 3 (0.5%) | 2 (0.6%) | 1 (0.4%) | 24 (0.9%) | 15 (0.9%) | 9 (0.9%) |
| Unknown | 1 (0.2%) | 1 (0.3%) | 0 (0%) | 3 (0.1%) | 3 (0.2%) | 0 (0%) |
| Blunt subtypes | | | | | | | | | |
| HBC | 99 (15.6%) | 65 (18.1%) | 34 (12.3%) | 551 (21.6%) | 367 (23.6%) | 184 (18.5%) |
| Fall | 142 (22.4%) | 63 (17.5%) | 79 (28.6%) | 154 (6%) | 85 (5.5%) | 69 (6.9%) |
| Crush | 85 (13.4%) | 53 (14.8%) | 32 (11.6%) | 83 (3.2%) | 47 (3%) | 36 (3.6%) |
| Ran into object | 17 (2.7%) | 8 (2.2%) | 9 (3.3%) | 33 (1.3%) | 21 (1.3%) | 12 (1.2%) |
| Struck by object | 10 (1.6%) | 7 (1.9%) | 3 (1.1%) | 30 (1.2%) | 15 (1%) | 15 (1.5%) |
| Non-accidental | 5 (0.8%) | 2 (0.6%) | 3 (1.1%) | 8 (0.3%) | 5 (0.3%) | 3 (0.3%) |
| Unknown | 28 (4.4%) | 16 (4.5%) | 12 (4.3%) | 74 (2.9%) | 38 (2.4%) | 36 (3.6%) |
| Hanging | 5 (0.8%) | 4 (1.1%) | 1 (0.4%) | 5 (0.2%) | 4 (0.3%) | 1 (0.1%) |
| Other | 2 (0.3%) | 0 (0%) | 2 (0.7%) | 8 (0.3%) | 3 (0.3%) | 5 (0.5%) |
| Interventions | | | | | | | | | |
| None | 474 (74.6%) | 271 (75.5%) | 203 (73.6%) | 1,973 (77.3%) | 1,219 (78.2%) | 754 (75.7%) |
| Oxygen | 43 (6.8%) | 29 (8.1%) | 14 (5.1%) | 117 (4.6%) | 71 (4.6%) | 46 (4.6%) |
| Transfusion | 6 (0.9%) | 3 (0.8%) | 3 (1.1%) | 18 (0.7%) | 13 (0.8%) | 5 (0.5%) |
| Surgical procedure | 67 (10.6%) | 38 (10.6%) | 29 (10.5%) | 270 (10.6%) | 153 (9.8%) | 117 (11.7%) |
| Mechanical ventilation | 1 (0.1%) | 1 (0.3%) | 0 (0%) | 3 (0.1%) | 1 (<0.1%) | 2 (0.2%) |

(Continued)
TABLE 4 | Continued

| Age group: | Juvenile | | Adult |
|---|---|---|---|
| Time period: | Overall | BEFORE | AFTER |
| Count (% of total) or Median (IQR) | Count (% of total) or Median (IQR) | Count (% of total) or Median (IQR) |
| Significance* between time periods by age groups (P-values ≤ 0.05 are in bold italics) | Significance* between time periods by age groups (P-values ≤ 0.05 are in bold italics) | Significance* between age groups (P-values ≤ 0.05 are in bold italics) |
| **Outcome** | **Survival** | 588 (92.6%) | 330 (91.9%) | 258 (93.5%) |
| | Overall | 2,253 (88.2%) | 1,353 (86.8%) | 900 (90.4%) |
| | BEFORE | 301 (11.8%) | 205 (13.1%) | 96 (9.6%) |
| | AFTER | 213 (8.3%) | 142 (9.1%) | 71 (7.1%) |
| | Median (IQR) | 88 (3.4%) | 63 (4%) | 25 (2.5%) |
| **Total mortality** | 47 (7.4%) | 29 (8.1%) | 18 (6.5%) |
| | Overall | 301 (11.8%) | 205 (13.1%) | 96 (9.6%) |
| | BEFORE | 213 (8.3%) | 142 (9.1%) | 71 (7.1%) |
| | AFTER | 88 (3.4%) | 63 (4%) | 25 (2.5%) |
| **Euthanasia** | 26 (4.1%) | 16 (4.5%) | 10 (3.6%) |
| | Overall | 213 (8.3%) | 142 (9.1%) | 71 (7.1%) |
| | BEFORE | 88 (3.4%) | 63 (4%) | 25 (2.5%) |
| | AFTER | 13 (3.6%) | 8 (2.9%) |  |  |
| **Cardiopulmonary arrest** | 21 (3.3%) | 13 (3.6%) | 8(2.9%) |
| | Overall | 213 (8.3%) | 142 (9.1%) | 71 (7.1%) |
| | BEFORE | 88 (3.4%) | 63 (4%) | 25 (2.5%) |
| | AFTER | 13 (3.6%) | 8 (2.9%) |  |  |

Significance via Chi Square or Fischer’s Exact Test.

*Significance via Chi Square or Fischer’s Exact Test.

FIGURE 3 | Penetrating and Blunt Trauma subtype distribution of cats and dogs for all time periods.

In conclusion, this study identified that cats and dogs have different trauma patterns, with cats more likely to suffer blunt trauma and dogs, penetrating trauma, and different survival rates.
(77.6% cats, 92.2% dogs). Trauma patterns changed for cats and dogs in the post-lockdown period with cats having a decrease in penetrating trauma but an increase in unknown trauma while dogs had a decrease in penetrating trauma and an increase in unknown and polytrauma. Juvenile patients also have different trauma patterns and survival rates than adults. Compared to pre-pandemic times, COVID lockdown was associated with a higher trauma prevalence but improved survival rates regardless of species or age category. A decrease in financially driven euthanasia and an increase in interventions suggest no negative financial effect of lockdown on trauma veterinary patient care in Australia.

**AUTHOR’S NOTE**

Partial results were presented at the 2021 Australia New Zealand College of Veterinary Scientists Emergency and Critical Care Chapter’s virtual Science Week and at the American College of Veterinary Emergency and Critical Care Veterinary Committee on Trauma conference in March 2022.

**DATA AVAILABILITY STATEMENT**

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

**ETHICS STATEMENT**

Ethical review and approval was not required for the animal study because this was a retrospective study of privately-owned animals presenting to veterinary hospitals for medical care. Written informed consent for participation was not obtained from the owners because this was a retrospective study.

**AUTHOR CONTRIBUTIONS**

MH was responsible for study design, data collection, statistical analysis, and draft writing/editing. EN and HO performed data collection, draft writing, and editing. All authors contributed to the article and approved the submitted version.

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REFERENCES

1. Horney T, Gurney M, Gibson S. A retrospective study of feline trauma patients admitted to a referral centre. *J Small Anim Pract.* (2018) 59:243–7. doi: 10.1111/jsap.12815

2. Zulauf D, Kaser-Hotz B, Hässig M, Voss K, Montavon PM. Radiographic examination and outcome in consecutive feline trauma patients. * Vet Comp Orthop Traumatol.* (2008) 21:36–40. doi: 10.3415/VCOT-07-01-0012

3. Conroy M, O'Neill D, Boag A, Church D, Brodbelt D. Epidemiology of road traffic accidents in cats attending emergency-care practices in the UK. * J Small Anim Pract.* (2019) 60:146–52. doi: 10.1111/jsap.12941

4. Cabon Q, Deroy C, Ferrand FX, Pillard P, Cachon T, Fau D, et al. Thoracic bite trauma in dogs and cats: a retrospective study of 65 cases. * Vet Comp Orthop Traumatol.* (2015) 28:448–54. doi: 10.3415/VCOT-15-01-0001

5. Hall KE, Boller M, Hoffberg J, McMichael M, Raffe MR, Sharp CR, et al. ACVECC-veterinary committee on trauma registry report 2013-2017. * J Vet Emerg Crit Care.* (2018) 28:497–502. doi: 10.1111/vetc.12766

6. Ash K, Hayes GM, Goggs R, Sumner JP. Performance evaluation and validation of the animal trauma triage score and modified Glasgow Coma Scale with suggested category adjustment in dogs: a VetCOT registry study. * J Vet Emerg Crit Care.* (2018) 28:192–200. doi: 10.1111/vetc.12717

7. Lapley J, Hayes GM, Sumner JP. Performance evaluation and validation of the Animal Trauma Triage score and modified Glasgow Coma Scale in injured cats: a Veterinary Committee on Trauma registry study. * J Vet Emerg Crit Care.* (2019) 29:478–83. doi: 10.1111/vetc.12885

8. Risselada M, de Rooster H, Taeymans O, van Bree H. Penetrating injuries in dogs and cats. A study of 16 cases. * Vet Comp Orthop Traumatol.* (2008) 21:434–9. doi: 10.3415/VCOT-07-02-0019

9. World Health Organization. WHO Director-General's Opening Remarks at the Media Briefing on COVID-19. (2020). Available online at: https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19--11-march-2020 (accessed March 28, 2022).

10. Australian Institute of Health and Welfare. The First Year of COVID-19 in Australia: Direct and Indirect Health Effects. (2021). Available online at: https://www.aihw.gov.au/reports/burden-of-disease/the-first-year-of-covid-19-in-australia/summary (accessed March 28, 2022).

11. World Health Organization. Impact of COVID-19 on People's Livelihoods, Their Health and Our Food Systems. (2020). Available online at: https://www.who.int/news/item/13-10-2020-impact-of-covid-19-on-people-s-livelihoods-their-health-and-our-food-systems (accessed March 28, 2022).

12. Australian Government. National Plan to Transition Australia’s National COVID-19 Response. (2021). Available online at: https://www.australian.gov.au/national-plan (accessed March 28, 2022).

13. Jacob S, Mwagiru D, Thakur I, Moghadam A, Oh T, Hsu J. Impact of societal restrictions and lockdown on trauma admissions during the COVID-19 pandemic: a single-centre cross-sectional observational study. *ANZ J Surg.* (2020) 90:2227–31. doi: 10.1111/jans.16307

14. Harris D, Ellis DY, Gorman D, Foo N, Haustead D. Impact of COVID-19 on primary healthcare participation in New Zealand. * ANZ J Surg.* (2021) 91:357–62. doi: 10.1111/ans.16380

15. Seilinger-Morris S. They've Wanted a Dog for Years. Lockdown Has Finally Made It Happen. *The Sydney Morning Herald* (2020). Available online at: https://www.smh.com.au/lifestyle/life-and-relations/they-ve-wanted-a-dog-for-years-lockdown-has-finally-made-it-happen-20200424-p54tn0.html (accessed March 28, 2022).

16. Pendrick D. Australian Pet Ownership Reaches Record High During Covid Pandemic. The Daily Telegraph (2021). Available online at: https://www.dailymail.co.uk/news/article-9618413/Australian-pet-ownership-reaches-record-high-during-covid-pandemic-news-story-3d8bfa280bd27f15056c28a84961aceed.html (accessed March 28, 2022).

17. Australian Bureau of Statistics. One Year of COVID-19: Aussie Jobs, Business and the Economy. (2021). Available online at: https://www.abs.gov.au/articles/one-year-covid-19-aussie-jobs-business-and-economy (accessed March 28, 2022).

18. Harris PA, Taylor R, Thielen R, et al. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform.* (2009) 42:377–81. doi: 10.1016/j.jbi.2008.08.010

19. Kim E, Choe C, Yoo JG, Oh S, Jung Y, Cho A, et al. Major medical causes by breed and life stage for dogs presented at veterinary clinics in the Republic of Korea: a survey of electronic medical records. *PeerJ.* (2018) 6:e5161. doi: 10.7717/peerj.5161

20. O’Neill DG, Church DB, McGreedy PD, Thomson PC, Brodbelt DC. Prevalence of disorders recorded in cats attending primary-care veterinary practices in England. * Vet J.* (2014) 202:286–91. doi: 10.1016/j.tvjl.2014.08.004

21. Udegbunam SO, Sokci C, Udegbunam RI, Nnaji TO, Onuoha AC, Akai LO. Prevalence of traumatic injuries in dogs presented at the veterinary clinics in Enugu and Anambra States of South Eastern Nigeria. *Nigerian Vet J.* (2008) 29:13–20. doi: 10.4314/vkj.v29i1.3599

22. Kolata R. Trauma in dogs and cats: an overview. * Vet Clin N Am Small Anim Pract.* (1980) 10:515–22. doi: 10.1016/0305-6080(80)90051-3

23. KPMG. Spreading the Peak? COVID-19 and Travel Patterns. (2022). Available online at: https://home.kpmg/en/en/home/insights/2022/02/transport-economics-covid-19-travel-patterns.html (accessed March 28, 2022).

24. Munawar HS, Khan SI, Qadir Z, Kiani YS, Kouzani AZ, Mahmud MAP. Insights into the mobility pattern of Australians during COVID-19: Sustainability. (2021) 13:9611. doi: 10.3390/su13179611

25. BSAVA. The Coronavirus Puppy Boom: Nation Seeks Creature Comfort as One in Four Admit Impulse Buying a Pandemic Puppy. (2020). Available online at: https://www.bsaava.com/News/ArticleID/2790/The-Coronavirus-puppy-boom-Nation-seeks-creature-comfort-as-one-in-four-admit-impulse-buying-a-pandemic-puppy (accessed March 28, 2022).

26. Fleming JM, Creevy KE, Promislow DEL. Mortality in North American dogs from 1984 to 2004: an investigation into age-, size-, and breed-related causes of death. *JIVM.* (2011) 25:187–98. doi: 10.1111/j.1939-1676.2011.0695.x

27. Wilson JL, Gruffydd-Jones TJ, Murray JK. Risk factors for road traffic accidents in cats up to age 12 months that were registered between 2010 and 2013 with the UK pet cat cohort ('Bristol Cats'). *Vet Record.* (2017) 180:195. doi: 10.1136/vr.103859

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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