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Pandemic Puppies: Man’s Best Friend or Public Health Problem? A Multidatabase Study

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ABSTRACT

Introduction: The public health implications of the COVID-19 pandemic reach beyond those of the disease itself. Various centers have anecdotally reported increases in the incidence of dog bite injuries which predominate in pediatric populations. The reasons for this increase are likely multifactorial and include an increase in canine adoptions, remote learning, and psychosocial stressors induced by lockdowns. We hypothesized that there was a significant increase in the proportion of dog bite injuries at our institution and within a nationally representative cohort.

Methods: We queried our electronic health record and the National Electronic Injury Surveillance System (NEISS) for all records pertaining to dog bites between 2015 and 2020, and the annual incidence was calculated. Poisson regression was then used to estimate whether there was a significant difference in the adjusted risk ratio for each year.

Results: The institutional and national cohorts revealed relative increases in the incidence of dog bite injury of 243 and 147.9 per 100,000 over the study period, respectively. Both cohorts observed significant increases of 44% and 25% in the annual incidence relative to 2019, respectively. Poisson regression revealed a significantly elevated adjusted relative risk in the institutional cohort for 2020 (2.664, CI: 2.076-3.419, \( P < 0.001 \)). The national cohort also revealed an increase (1.129, CI: 1.091-1.169, \( P < 0.001 \)).

Conclusions: A nationwide increase in the incidence of dog bite injuries among children was observed during COVID-19 in 2020. These findings suggest that dog bites remain a public health problem that must be addressed by public health agencies.

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The lockdowns due to COVID-19 have driven behavioral changes in the lives of Americans. These daily life changes have clinical and public health implications that have taken a toll on mental health. Dogs have been one of the ways people and families have mitigated the emotional stresses of the pandemic. In addition, shelter in place orders have led more people to stay home from school and other activities. Increased dog ownership and time spent confined with dogs may be contributing to the reports of increased dog bites among pediatric centers. Our center also observed a similar increase in the proportion of dog bite cases presenting to our emergency department (ED).

We report herein the incidence of pediatric dog bite patients at our center and in a nationally representative database during the COVID-19 pandemic. We hypothesized that multiple factors during this time period were associated with an increase in the volume of dog bite injuries seen in the ED setting both locally and nationally.

Materials and Methods

Study design, data source, and population

An institutional review board approval was obtained to perform a retrospective study using the National Electronic Injury Surveillance System (NEISS) (national sample) and an informed consent waiver to query our own electronic health record (EHR) (institutional sample).

The NEISS is a database of injury encounters at 100 reporting EDs, maintained by the Centers for Disease Control (CDC) and the Consumer Product Safety Commission (CPSC). The participating hospitals are stratified into four strata based on size and a fifth for children’s hospitals. They are located in various geographic regions within the United States and are considered a representative probability sample of all 5000+ EDs across the United States when performing analyses using the supplied probability sample weights. We queried the years 2015-2020 and used the narrative field to identify the records pertaining to initial dog bite visits. We then excluded patients based on age (<18 y).

Our own institutional EHR was queried for all patients presenting with dog bite injuries to our ED (defined by the International Classification of Diseases, ninth revision, Clinical Modification [ICD-9-CM] diagnosis code E906.0 and International Classification of Diseases, 10th revision, Clinical Modification [ICD-10-CM] diagnosis code W54.0XXA). Patients were then excluded based on age (<18 y).

This study was designed in accordance with the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines for observational studies (Supplemental Fig. 1).

Covariates

Relevant covariates extracted from both databases included age, gender, and race.

Outcome measures

The total number of dog bites was used along with the total number of ED visits in each respective cohort to calculate the incidence per 100,000 visits. The change in incidence was evaluated using the previous year’s data. Poisson regression was then used to estimate the adjusted relative risk for each year using 2015 as a baseline.

Table 1 – Demographic data of institutional and NEISS dog bite presentations from 2015 to 2020.

| Covariate         | Year          | Median (IQR)/n (%) |
|-------------------|---------------|--------------------|
|                   | 2015          | 2016               | 2017          | 2018          | 2019          | 2020          |
| Institutional cohort, n = 621 |
| Age, Y            | 7 (4-11)      | 8 (4-11)           | 5 (2-9)       | 7 (3-12)      | 8 (5-11)      | 8 (4-12)      |
| Gender            |               |                    |               |               |               |               |
| Male              | 109 (56)      | 61 (53)            | 58 (54)       | 72 (55)       | 74 (54)       | 75 (57)       |
| Race              |               |                    |               |               |               |               |
| White             | 124 (64)      | 65 (57)            | 65 (61)       | 84 (65)       | 86 (63)       | 87 (66)       |
| Black             | 36 (18)       | 28 (24)            | 22 (21)       | 19 (15)       | 26 (19)       | 27 (20)       |
| Other             | 36 (18)       | 22 (19)            | 20 (19)       | 27 (20)       | 25 (18)       | 18 (14)       |
| National cohort, n = 25,592 |
| Age, Y            | 8 (3-13)      | 8 (3-13)           | 8 (3-13)      | 8 (3-13)      | 8 (3-13)      | 6 (2-12)      |
| Gender            |               |                    |               |               |               |               |
| Male              | 3627 (61)     | 3940 (64)          | 4558 (60)     | 4077 (59)     | 4230 (58)     | 3834 (59)     |
| Race              |               |                    |               |               |               |               |
| White             | 921 (15)      | 914 (15)           | 1918 (25)     | 1571 (23)     | 1481 (20)     | 1523 (24)     |
| Black             | 3425 (57)     | 3404 (55)          | 3835 (51)     | 3685 (53)     | 3928 (54)     | 3539 (55)     |
| Other             | 1612 (27)     | 1860 (30)          | 1823 (24)     | 1662 (24)     | 1843 (25)     | 1401 (22)     |

NEISS = National Electronic Injury Surveillance System.
Statistical analysis

Counts and proportions were used to summarize categorical variables and non-normally distributed continuous variables were reported as medians with interquartile ranges (IQR). Pearson’s chi-squared test was used to compare each year’s incidence with the previous year’s data. Poisson regression was used to evaluate whether there was an increase in the relative number of dog bite presentations during the pandemic in both cohorts. Adjusted relative risk ratios were estimated to reveal significant departures from the general trend. Model validation was then performed using deviance and Pearson’s goodness-of-fit tests. There were no missing data on outcomes of interest; a complete case analysis was undertaken. The threshold for statistical significance was set at $P < 0.01$. Statistical analyses were performed using StataMP release 16 (College Station, TX).

Results

Within the institutional cohort, there were 817 of 336,387 ED visits due to dog bite injuries from 2015 to 2020 (Table 1). Overall, the median age was 7 y (IQR: 4-11), 55% were male, and 62% were White. There was a relative increase of 243 per 100,000 during the study period which translated to 41 per 100,000 per year. In 2020, the incidence increased relative to 2019 by 44% to 324 per 100,000 ($P = 0.003$). The adjusted relative risk increased significantly in 2020 ($2.664$, CI: $2.076-3.419$, $P < 0.001$; Fig. and Table 2).

Within the national sample, we identified 40,343 dog bite presentations of 27,281,076 ED visits over the study period. Overall, the median age was 9 y (IQR: 5-13), 55% were male, and 45% were White (Table 1). There was a relative increase of 147.9 per 100,000 from 2015 to 2020 which translated to 25 per 100,000 per year. In 2020, there was a 25% increase in the incidence relative to 2019 ($P = 0.001$). The adjusted relative risk increased significantly ($1.129$, CI: $1.091-1.169$, $P < 0.001$; Fig. and Table 3).

Discussion

The impact of the COVID-19 pandemic on the United States healthcare system extends beyond the healthcare utilization directly related to the disease. The pandemic has affected many

| Year | Number of bites | Number of ED visits | Incidence (per 100,000) | $P$ value | Adjusted risk ratio | 95% CI | $P$ value |
|------|-----------------|---------------------|-------------------------|-----------|---------------------|-------|-----------|
| 2015 | 196             | 59,034              | 332.0                   | Ref.      | 2.413               | 1.884-3.090 | $<0.001$ |
| 2016 | 115             | 58,150              | 197.8                   | $<0.001$ | 0.771               | 0.625-0.951 | 0.015     |
| 2017 | 107             | 58,552              | 182.7                   | 0.556     | 0.696               | 0.568-0.854 | 0.001     |
| 2018 | 130             | 59,146              | 219.8                   | 0.156     | 0.821               | 0.679-0.994 | 0.043     |
| 2019 | 137             | 60,758              | 225.5                   | 0.834     | 0.741               | 0.603-0.911 | 0.005     |
| 2020 | 132             | 40,747              | 324.0                   | 0.003     | 2.664               | 2.076-3.419 | $<0.001$ |

* Change in incidence determined with Pearson’s chi-squared test performed using previous year’s data.

Fig. – Adjusted relative risk and incidence of dog bite presentations from 2016 to 2020. (A) Institutional database. (B) NEISS. Ratios estimated using Poisson regression model. * denotes significance value in adjusted relative risk of $P < 0.01$. ** denotes significant difference in incidence from previous year of $P < 0.01$. NEISS = National Electronic Injury Surveillance System.
facets of our lives and has driven behavioral changes for coping with the associated lockdowns and social-distancing measures. Our study found that there was a significant increase in the incidence and risk ratio of dog bite presentations to the ED during the pandemic both within an institutional cohort and a nationally representative sample. These results have important public health implications that warrant further investigation to develop and implement preventive measures to mitigate the associated morbidity and burden on the healthcare system.

Other studies have anecdotally reported increases in the incidence of dog bite injuries at various centers.\textsuperscript{10-12} Although our study also uses institutional level data to add to this evidence, we evaluated a nationally statistically representative sample which showed similar results. This observed increase is likely multifactorial. As schools across the country closed and began delivering education to children at home on devices, it is likely that children spent a greater time in proximity to family dogs. Other evidence has shown that a greater number of canine adoptions occurred during the pandemic, presumably leading to increased children and dog cohabitation.\textsuperscript{6,8,13} In addition, some studies indicate that a dog’s behavior can reflect those of their owners and that stressful situations, such as those observed during lockdowns, can lead to an increased aggressive behavior.\textsuperscript{14} As public health agencies at the state and local level are coping with the consequences of COVID-19, less emphasis may have been placed on providing a proportional effort to public health education regarding dog safety and animal control enforcement which may be an additional contribution.

This study has the inherent limitations of a retrospective review. The NEISS, although funded by the federal government and characterized as a nationally representative probability sample, is still subject to bias in terms of the limited number of hospitals that participate. In addition, our institutional data contain the inherent bias of being an exclusively pediatric sample. Dog bite incidence is higher in children and our results may be affected by these factors. The study is also possibly limited by the number of years used. Poisson regression relies on the expected changes based on data trends and results could differ depending on how much data are used to build the model. Finally, the multifactorial nature of these population level changes should inform the interpretation of our results.

In summary, 2020 saw an increase in the incidence of dog bite injury in children. Various factors such as “pandemic puppies”, remote learning, and psychosocial stressors may have played a role in this increase. Prior to the pandemic, pediatric dog bites were considered a public health problem. The increase we have observed during the pandemic should inform public health agencies to expand prevention and public education measures. In addition, although emergency departments are seeing a decreased volume, hospitals should be aware of the possibility of an increased proportion of dog bite presentations as a result of the greater number of household dogs now and in the future.

### Supplementary Materials

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jss.2022.02.041.

### Author Contributions

Conception and design of the study: T.E.H.M., A.J.R.D., and E.J.C. Data acquisition: T.E.H.M., A.J.R.D., and E.J.C. Data analysis: T.E.H.M. and A.J.R.D. Data interpretation: T.E.H.M., A.J.R.D., and E.J.C. Drafting of the article: T.E.H.M., A.J.R.D., and E.J.C. Critical revisions of the manuscript: T.E.H.M., A.J.R.D., and E.J.C. All authors approved the final version.

### Disclosure

None declared.

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| Year | Number of bites | Number of ED visits | Incidence (per 100,000) | P value* | Adjusted risk ratio | 95% CI | P value |
|------|-----------------|---------------------|-------------------------|----------|---------------------|-------|---------|
| 2015 | 5958            | 5,111,192           | 116.6                   | Ref.     | 1.032               | 0.996-1.070 | 0.082   |
| 2016 | 6178            | 5,011,974           | 123.3                   | 0.249    | 0.954               | 0.926-0.982 | 0.002   |
| 2017 | 7576            | 5,023,094           | 150.8                   | 0.069    | 1.083               | 1.056-1.111 | <0.001  |
| 2018 | 6916            | 4,593,440           | 150.6                   | 0.634    | 0.949               | 0.924-0.973 | <0.001  |
| 2019 | 7251            | 4,406,314           | 164.5                   | 0.548    | 0.916               | 0.891-0.942 | <0.001  |
| 2020 | 6463            | 3,134,462           | 206.2                   | 0.001    | 1.129               | 1.091-1.169 | <0.001  |

NEISS = National Electronic Injury Surveillance System.

* Change in incidence determined with Pearson’s chi-squared test performed using previous year’s data.

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