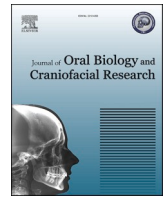




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COVID-19 pandemic and lockdown increase the frequency and severity of periorbital dog bite injuries in children

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ABSTRACT

Objective: To determine whether the COVID-19 pandemic and lockdown increase the risk of head, neck, and face (HNF) dog bite injuries in children.

Methods: Using a retrospective cohort study design, the investigators enrolled a sample of children presenting with HNF dog bite injuries during 22 weeks before and 22 weeks during the COVID-19 pandemic in a German level 1 trauma center. The predictor variables were COVID-19 pandemic and lockdown. The outcome variables were grouped into demographic, anatomic, injury-related, and therapeutic. Appropriate statistics were computed, and statistical significance was set at $P \leq .05$.

Results: The sample included 36 subjects (19.4% girls; 97.2% Caucasians; 50% isolated periorbital injuries; 61.1% during the lockdown; 16.7% after the lockdown) with an average age of 8 ± 3.3 years. Compared to the pre-COVID-19 period, pediatric HNF dog bite injuries increased ca. 5.5- and 1.5-fold during and after the lockdown, respectively. The COVID-19 pandemic was significantly associated with severe household injury from a pet dog, number of inpatients and treatments in the operating room, and prolonged hospitalization. Isolated periorbital injury was common during the COVID-19 pandemic ($P = 0.04$; relative risk [RR], 4.86; 95% confidence interval [95% CI], 0.76 to 31.12), especially during the lockdown ($P = 0.02$; RR, 4.36; 95% CI, 0.72 to 26.6).

Conclusion: During the COVID-19 pandemic, especially during the lockdown, there is an increasing tendency of frequency and severity of domestic HNF dog injuries in children, and periorbital region is the most injury-prone.

1. Introduction

The use of emergency lockdown is an important governmental device used worldwide to reduce the rate of the novel Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) disease (COVID-19), and to prevent overwhelming restraint on health care.¹ In a recent Belgian report, Hernigou et al.² found that the injury frequency during the “staying home” paradigm decreased by ca. 33%, compared to the

previous year before the pandemic. Surgical patient care with reduced time to surgery and length of hospital stay can also compensate the limited medical resources during the COVID-19 pandemic. However, domestic injuries seem more common.

Dog-human interactions have been proved positive. Pet dogs can decrease stress and anxiety, and young owners will have increased responsibility and compassion, a sense of security and pride, and improved immunity against atopy. Living with a dog, on the other hand, poses a potential threat to children. The US Centers for Disease Control and

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List of abbreviations

AAP	American Academy of Pediatrics	MSSA	Methicillin-sensitive <i>Staphylococcus aureus</i>
ADHD	Attention deficit hyperactivity disorder	NHS	UK's National Health Service
CDC	US' Centers for Disease Control and Prevention	ODD	Oppositional defiant disorder
COVID-19	Coronavirus Disease 2019 (SARS-CoV-2 infection)	OMFS	Oral-maxillofacial surgery (discipline)
CTA	Isolated central target area of the face (i.e. nose, lips, and cheeks)	OR	Operating room
DTS	Department of Trauma surgery	ORL	Otorhinolaryngology, or Ear Nose Throat (discipline)
ED	Emergency departments	RR	Relative risk
HNF	Head, neck, and face	SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus-2
HPA	Hypothalamic-pituitary-adrenal (axis)	SPSS V27	Statistical Package for the Social Sciences, Version 27
ICMJE	International Committee of Medical Journal Editors	STROBE	The STrengthening the Reporting of OBservational studies in Epidemiology (guidelines)
		95% CI	95% confidence interval

Prevention (CDC) estimated >900 daily dog bite injuries admitted to emergency departments (ED) across the country and >40% are juvenile cases. Contrary to other injuries, an early American research at Children's Hospital Colorado showed an almost 3-fold increase in pediatric dog bite injuries during the statewide "stay-at-home" restrictions. Dogs might experience untoward stress via (1) children staying at home 24 h a day, 7 days a week for months, and/or (2) "emotional contagion" (i.e. dogs mirror emotions and stress levels of their caregivers).³ To the best of our knowledge, head, neck, and face (HNF) dog bite injury in children during the COVID-19 pandemic and lockdown has not been studied before.

The purpose of this study was to answer the following research question: "Among children with HNF dog bite injury, does the rate of pediatric HNF dog bite injury increase during the COVID-19 pandemic and lockdown?" The null hypothesis was that there is no difference in the rate of pediatric HNF dog bite injury before and during the COVID-19 pandemic and lockdown. Our specific aims were (1) to record and compare the characteristics of HNF dog bite injuries among children seeking medical attention before the COVID-19 pandemic, and during and after the COVID-19 lockdown, (2) to identify HNF regions at increased risk of pediatric HNF dog bite injury during the COVID-19 pandemic, and (3) to raise discussion concerning prevention and management of these injuries. In this article, the terms "children", "juvenile" and "pediatric" referred to patients at the age group of interest (<18 years).

2. Materials and methods

1. Study Design and Sample Description

This was a retrospective evaluation of a pediatric cohort (<18 years) at a German level 1 trauma center with HNF dog bite injury before and during the COVID-19 pandemic (Level of Evidence III after the Oxford's Centre of Evidence-Based Medicine 2011). Potential subjects were identified through ED and trauma surgery records. Patients were included, if they had HNF dog bite injury treated by surgical residents under supervision of a consultant oral-maxillofacial or plastic surgeon (mostly the first author, P.P.) at ED, or treated by the primary author (P. P.) in an operating room (OR) of the Department of Trauma surgery (DTS), with a minimal follow-up of 2 weeks after hospital discharge by the first author (P.P.) only. We excluded patients with systemic diseases interfering with wound healing, e.g. diabetic children, or those with duplicate records, insufficient data, or dog bite injury in other body regions.

After attaining the institutional review board approval, the study was performed and conformed to the tenets of the World Medical Association's Declaration of Helsinki Version 2008 and the ICMJE and STROBE guidelines. Parents/caregivers of every patient gave prospective consent for their anonymous data in future researches and publications. Our study design was based on a report by Hurst et al.,⁴ and our strategic

planning for maxillofacial trauma patient care during the COVID-19 pandemic, and craniomaxillofacial symptoms of the SARS-CoV-2 infection were recently described elsewhere.^{5,6}

2. Study Variables

The primary predictor variables were COVID-19 pandemic and lockdown, which were recorded as nominal scales. We primarily selected the first German lockdown (March 22, 2020–June 5, 2020), to compare with the period after the easing of lockdown restrictions (June 6, 2020–August 22, 2020).¹ The pre-COVID-19 study period was chosen from the same period in 2019 (March 22, 2019–August 22, 2019). The total study periods included 44 weeks; i.e. 22 weeks before the COVID-19 pandemic, 11 weeks during the lockdown, and 11 weeks after the lockdown in the COVID-19 pandemic.

The main outcome variable was HNF dog injury in children. This variable was composed of 4 sets of parameters: (1) demographic: age at the time of injury, gender (female vs. male), and race (Caucasian vs. other), (2) anatomic: location of injury (isolated periorbital region vs. isolated central target area [CTA; nose, lips, and cheeks] vs. both periorbital and CTA vs. other HNF regions [neither periorbital nor CTA]), (3) injury-related: household injury (yes [injury occurring inside, in the yard, or within the property boundaries of any home or dwelling, regardless of it being the patient's home] vs. no [any location not meeting the definition of home]), dog ownership (within family [dogs owned by the patient or a relative] vs. other [dogs belonged to a friend, neighbor, or a stranger, or without an apparent owner]), and dog breed (Pit bull vs. Labrador vs. German shepherd vs. Rottweiler vs. other), and (4) therapeutic: hospital admission status (inpatient [patient was admitted to the hospital at any time for injuries related to a dog bite attack] vs. outpatient [patient was discharged from the ED or post-anesthesia/recovery care unit on the day of presentation]), treatment place (OR of DTS vs. ED), length of stay (≥ 1 days; 0 days for outpatients), antibiotics, and complications/adverse events.

3. Data Management and Statistical Analysis

Data were entered into Microsoft Excel 2007 (Microsoft, Redmond, WA, USA) and SPSS V27 (SPSS, Chicago, IL, USA) over the course of the study. Appropriate statistics were computed. Chi-square or Fisher's exact test was used to analyze categorical data, while unpaired *t*-test was applied to prove the significances among continuous data. We used medians of patient's age (i.e., 8 years) and length of hospital stay (i.e., 5 days) to dichotomize the continuous data before entering analyses, and Mann Whitney *U* test was utilized to compare medians of the continuous data. For all analyses, $P \leq .05$ was considered statistically significant.

3. Results

The study sample included 36 subjects (28 during the COVID-19 pandemic, and 8 before the COVID-19 pandemic) who met the inclusion criteria (Fig. 1; Table 1); none was excluded and there was no bite injury from animals other than dogs. The mean patients' age was 8 ± 3.3 years (range, 1–14) and there were 7 girls (19.4%). No significant differences were observed between the during-lockdown and after-lockdown groups for age, gender, race, injury location other than isolated periorbital injury, injury place, dog owner and breed, surgical place, admission status and length, antibiotics used, and complications/adverse events. Comparisons between the pre-COVID-19 and the COVID-19 groups, the victims were significantly more likely to be bitten by a family-owned dog ($P = 0.04$; relative risk [RR], 4.57; 95% confidence interval [95% CI], 0.71 to 29.4), to be assaulted at home ($P = 0.016$; RR, 5.14; 95% CI, 0.81 to 32.84), to undergo treatments in the OR ($P = 0.036$; RR, 2.86; 95% CI, 0.84 to 9.71), and be admitted to the hospital ($P = 0.04$; RR, 2.1; 95% CI, 0.84 to 5.23), and to longer stay in the hospital (5.1 ± 3.1 vs. 1.5 ± 2.5 days; $P = 0.005$; 95% CI, 1.19 to 6.02). The number of patients with hospital stay ≥ 5 days during the COVID-19 pandemic was significantly higher than that before the pandemic ($P = 0.0047$; RR, 5.71; 96% CI, 0.9 to 36.28).

Concerning the anatomical variables, significant differences were found only for isolated periorbital injury between the pre-COVID-19 and the COVID-19 groups ($P = 0.04$; RR, 4.86; 95% CI, 0.76 to 31.12), and between the during-lockdown and after-lockdown groups ($P = 0.02$; RR, 4.36; 95% CI, 0.72 to 26.6). There were orbital fractures in two periorbital injury patients during the lockdown, which were intra-operatively discovered and repaired with a resorbable 0.25 mm-thick

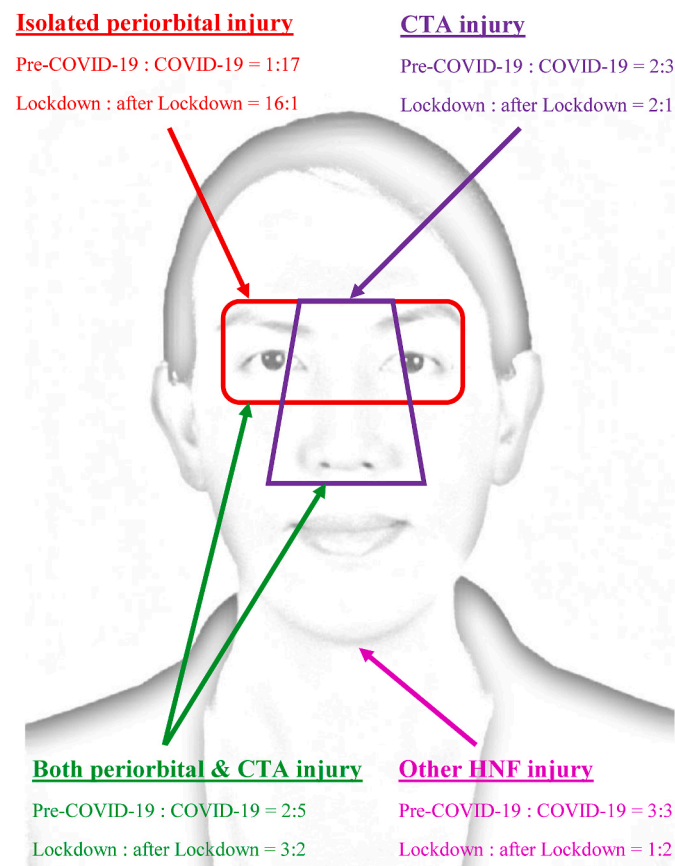


Fig. 1. Distribution of pediatric HNF dog bite injuries before and during the COVID-19 pandemic: pre-COVID-19 (8) and during COVID-19 (28; 22 of which during the lockdown, and the other 6 after the lockdown). Courtesy of one author's own picture; used with permission.

polydioxanone implant (PDS® Folie, Ethicon/Johnson & Johnson Medical Devices, Norderstedt, Germany). All open wounds were closed with resorbable suture materials: Vicryl and Monocryl (Ethicon/Johnson & Johnson Medical Devices, Norderstedt, Germany). Rubber drains were placed *in situ* for 2–3 days, if the wound was dirty and/or tended to be infected. The judgment on primary closure or drainage placement depended on the treating surgeon's decision/preference. The most commonly used intravenous and oral preparations were ampicillin/sulbactam, and amoxicillin/clavulanate, respectively. Only one patient received clindamycin because of his penicillin allergy.

Concerning complications/adverse events, all except three patients had prolonged swelling > 2 weeks without signs of an infection. The other two patients developed a wound infection caused by *Staphylococcus aureus* ± *Pasteurella*, and one had hypertrophic scarring, giving the infection rate of 5.6%. We could not identify significant differences of HNF dog bite injury complications related to the COVID-19 pandemic. Prolonged swelling was conservatively treated, and postoperative infections were managed with oral antibiotics according to the sensitivity test. The course of preemptive antibiotic prophylaxis lasted 3–7 days, and antibiotics were prescribed for 7–14 days for infected wounds. We treated hypertrophic scarring with silicone adhesive sheets (Scarban Light®, Rölke Pharma GmbH, Hamburg, Germany) for 3 months with good healing. No surgical revision was performed in all cases with complications. It is also noteworthy that one boy was bitten twice in a 4-month interval by the same pet dog of his family.

In the subgroup analyses (Table 2), there was no statistically significant difference in treatment outcomes between sets of other study parameters: demographic (age < 8 vs. ≥ 8 years; girls vs. boys), anatomic (isolated periorbital injury vs. others), and injury-related (household injury vs. others; family own dog vs. others; German shepherd vs. others) in any study periods, alluding to the profound effect of COVID-19 pandemic and lockdown on pediatric HNF dog bite injury.

4. Discussion

The present study has been one of the first attempts providing the comprehensive assessment of HNF dog bite injury in children in relation to the COVID-19 pandemic, with the null hypothesis that there is no difference between groups. Our specific aims were (1) to analyze HNF dog bite injuries in children before the pandemic, and during and after the lockdown, (2) to identify risky HNF regions, and (3) to raise the discussion concerning injury prevention and management.

The results of this study refute the null hypothesis, i.e. the weekly pre-COVID-19 and COVID-19 pediatric HNF dog bite injury rates were 0.36 and 1.27, and the COVID-19 lockdown and post-lockdown rates were 2 and 0.55 cases per week. In other words, compared to the pre-COVID-19 era, there were 5.5- and 1.5-fold increases in juvenile HNF dog bite rates during and after lockdown, respectively. Clinically, isolated periorbital injury was incessant during the COVID-19 pandemic ($P = 0.04$; RR, 4.86; 95% CI, 0.76 to 31.12), especially during the lockdown ($P = 0.02$; RR, 4.36; 95% CI, 0.72 to 26.6). These findings complement those of earlier studies. Based on recent data from Children's Hospital Colorado, the incidence of ED visits for dog bites during the COVID-19 pandemic was more than double that of summer rates, when dog bite injuries are typically most common.³

The increased pediatric HNF dog bite injuries during the COVID-19 pandemic may result from (1) increased dog-child exposure, (2) children's inability to correctly interpret dog behaviors, especially unintentionally threatening behavior (e.g. playing too close to the dog's face, or pulling its tail), fear-related behaviors, and attacks in response to food guarding, stepping on the dog, tugging the dog's hair or body, falling on the dog, or punishing the dog by hitting, (3) greater dog's stress due to increased child presence and amplified household stress, (4) children's small stature and convenient proximity of the head to the mouth level of medium- and large-sized dogs, and (5) decreased adult supervision of children around dogs.^{3,4,7,8} However, approximately 60% of HNF dog

Table 1
Summary of study samples, and descriptive, uni- and bivariate analyses.

Variable	During Lockdown	After Lockdown	P-value (RR; 95% CI)	During pandemic (year 2020)	Before pandemic (year 2019)	P-value (RR; 95% CI)
Sample	22	6	N/A	28	8	N/A
Duration (weeks)	11	11	N/A	22	22	N/A
Demographic						
Age (mean ± SD, years)	7.8 ± 3.6	8.5 ± 2.4	0.65 (N/A; −3.98 to 2.53)	7.9 ± 3.4	8.25 ± 3.5	0.82 (N/A; −3.11 to 2.46)
Age (median, year)	8	8.5	0.57 (N/A; −3.99 to 2.0)	8	8.5	0.77 (N/A; −3.0 to 2.99)
Age <8 years	10 (45.5)	2 (33.3)	0.67 (1.36; 0.4 to 4.62) [§]	12 (42.9)	3 (37.5)	1.0 (1.14; 0.42 to 3.1) [§]
Girls	4 (18.2)	2 (33.3)	0.58 (0.55; .13 to 2.3)	6 (21.4)	1 (12.5)	1.0 (1.71; 0.24 to 12.24)
Caucasian	22 (100)	6 (100)	1.0 (1.0; 1.0 to 1.0)	28 (100)	7 (87.5)	0.22 (1.14; 0.88 to 1.49)
Anatomic						
Isolated periorbital injury	16 (72.7)	1 (16.7)	0.02 (4.36; 0.72 to 26.6)[§]	17 (60.7)	1 (12.5)	0.04 (4.86; 0.76 to 31.12)[§]
Isolated CTA injury	2 (9.1)	1 (16.7)	0.53 (0.55; 0.06 to 5.04) [§]	3 (10.7)	2 (25)	0.3 (0.43; 0.09 to 2.14) [§]
Injury of both periorbital and CTA	3 (13.6)	2 (33.3)	0.29 (0.41; 0.09 to 1.92) [§]	5 (17.9)	2 (25)	0.64 (0.71; 0.17 to 3.01) [§]
Other HNF regions	1 (4.5)	2 (33.3)	0.11 (0.14; 0.01 to 1.26) [§]	3 (10.7)	3 (37.5)	0.11 (0.29; 0.07 to 1.15) [§]
Periorbital injury with/without CTA	19 (86.4)	3 (50)	0.09 (1.73; 0.76 to 3.91) [§]	22 (78.6)	5 (62.5)	0.38 (1.26; 0.71 to 2.22) [§]
Injury-related						
Household injury	15 (68.2)	3 (50)	0.63 (1.36; 0.58 to 3.19)	18 (64.3)	1 (12.5)	0.016 (5.14; 0.81 to 32.84)
Dog within family	12 (54.5)	4 (66.7)	0.67 (0.82; 0.41 to 1.62)	16 (57.1)	1 (12.5)	0.04 (4.57; 0.71 to 29.4)
Breed						
Pit bull	4 (18.2)	1 (16.7)	1.0 (1.09; 0.15 to 8.03) [§]	5 (17.9)	2 (25)	0.64 (0.71; 0.17 to 3.01) [§]
Labrador	3 (13.6)	1 (16.7)	1.0 (0.82; 0.1 to 6.52) [§]	4 (14.3)	1 (12.5)	1.0 (1.14; 0.15 to 8.84) [§]
German shepherd	9 (40.9)	2 (33.3)	1.0 (1.23; 0.36 to 4.23) [§]	11 (39.3)	3 (37.5)	1.0 (1.05; 0.38 to 2.87) [§]
Rottweiler	4 (18.2)	1 (16.7)	1.0 (1.09; 0.15 to 8.03) [§]	5 (17.9)	1 (12.5)	1.0 (1.43; 0.19 to 10.54) [§]
Other breeds	2 (9.1)	1 (16.7)	0.53 (.055; 0.059 to 5.04) [§]	3 (10.7)	1 (12.5)	1.0 (0.86; 0.1 to 7.16) [§]
Therapeutic						
Inpatient	17 (77.3)	5 (83.3)	1.0 (0.93; 0.61 to 1.42)	22 (78.6)	3 (37.5)	0.04 (2.1; 0.84 to 5.23)
Operation in OR	16 (72.7)	4 (66.7)	1.0 (1.09; 0.59 to 2.03)	20 (71.4)	2 (25)	0.036 (2.86; 0.84 to 9.71)
Length of hospital stay (mean ± SD, days)	5.2 ± 3.3	4.7 ± 2.4	0.7 (N/A; −2.39 to 3.51)	5.1 ± 3.1	1.5 ± 2.5	0.005 (N/A; 1.19 to 6.02)
Length of hospital stay (median, days)	7	5	0.37 (N/A; −2.0 to 2.99)	5.5	0	0.011 (N/A; 0 to 6.99)
Length of hospital stay ≥5 days	15 (68.2)	5 (83.3)	(0.64; .052 to 1.29) [§]	20 (71.4)	1 (12.5)	0.0047 (5.71; 0.9 to 36.28)[§]
Treated with ampicillin/sulbactam or amoxicillin/clavulanic acid	22 (100)	6 (100)	1.0 (1.0; 1.0 to 1.0) [§]	28 (100)	7 (87.5)	0.22 (1.14; 0.88 to 1.49) [§]
Complications/adverse events	5 (22.7)	1 (16.7)	1.0 (1.36; 0.19 to 9.57) [§]	6 (21.4)	0	0.3 (4.03; 0.25 to 64.87) [§]

Note: Continuous data are listed as mean ± SD or mean. Categorical data are presented as number (percentage). Statistically significant P-values are indicated in bold typeface. [§] adjusted to be binary before entering analyses. CTA: central target area, HNF: head, neck, and face; OR: operating room; N/A: not applicable.

bite injuries in our cohort occurred with the presence of parents, and the majority of victims were middle and older children (≥7 years), conforming to the UK Dog Trust’s data.⁷ Apart from the abovementioned 5 reasons, “the periorbital region as the most injury-prone area” may be due to the fact that children’s staring or close distance to a dog or kiss a dog could be perceived as threatening or submissive.⁴

Negative mental health outcomes in children during the COVID-19 pandemic are well recognized.⁹ Preschoolers may suffer from behavioral, emotional, and family problems, leading to physical abuse, neglect, and/or sexual abuse. Injuries, especially head trauma, in younger children (3–6 years) are often linked to stressful environments, e.g. single and/or unemployed parenthood, an impoverished family, limited living space, living with multiple siblings under the age of 11, or

not living with either biological parent, or poor family functioning (especially maternal depression). Conversely, compared to their younger counterpart, middle and older children are more psychologically prone to disruptive behavior disorders, attention deficit hyperactivity disorder (ADHD), oppositional defiant disorder (ODD), and anxiety disorders in frequent conjunction with major depressive symptoms/episodes.¹⁰ An early US cohort study from University of New Mexico Health Sciences Center discovered ADHD in 29% of children with HNF dog bite injuries; whose risk factors were young boys attacked by a familiar dogs in their home or neighborhood.¹¹ Another study from the University of Michigan demonstrated depression in 41.3% of patients with cat bites and 28.7% of those with dog bites.¹² The recent German nationwide, population-based “COPSY” study conducted at

Table 2
Multivariate comparison of therapeutic parameters by demographic, anatomic, and injury-related parameters.

Variable	Inpatient			Treatment in OR			Length of hospital stay ≥5 days			Complications/adverse events														
	During lockdown	After lockdown	P value (RR; 95% CI)	During pandemic	After pandemic	P value (RR; 95% CI)	During lockdown	After lockdown	P value (RR; 95% CI)	During pandemic	After pandemic	P value (RR; 95% CI)	During lockdown	After lockdown	P value (RR; 95% CI)	During pandemic	After pandemic	P value (RR; 95% CI)						
Sample	17	5	N/A	22	3	N/A	16	4	N/A	20	2	N/A	15	5	N/A	20	1	N/A	5	1	N/A	6	0	N/A
Age <8 years	10 (58.8)	2 (40)	0.62 (1.47; 0.47 to 4.62)	12 (54.5)	3 (100)	0.25 (0.55; 0.37 to 0.8)	10 (62.5)	2 (50)	1.0 (1.25; 0.44 to 3.58)	12 (60)	2 (100)	0.52 (0.6; 0.42 to 0.86)	10 (66.7)	2 (40)	0.35 (1.67; 0.54 to 5.17)	12 (60)	1 (100)	1.0 (0.6; 0.86)	5 (100)	1 (100)	1.0 (1.0; 1.0)	6 (100)	0	1.0 (1.86; 0.26 to 13.33)
Girl	4 (23.5)	2 (40)	0.59 (0.59; 0.15 to 2.32)	6 (27.3)	1 (33.3)	1.0 (0.82; 0.14 to 4.66)	4 (25)	1 (25)	1.0 (1.0; 0.15 to 6.67)	5 (25)	1 (50)	0.48 (0.5; 0.1 to 2.43)	3 (20)	2 (40)	0.56 (0.5; 0.11 to 2.19)	5 (25)	0	1.0 (1.05; 0.09 to 12.83)	2 (40)	1 (100)	1.0 (0.4; 0.14 to 1.17)	3 (50)	0	1.0 (1.0; 0.12 to 8.13)
Isolated periorbital injury	12 (70.6)	1 (20)	0.12 (3.53; 0.6 to 20.92)	13 (59.1)	0	0.096 (4.7; 0.34 to 64.2)	11 (68.8)	1 (25)	0.26 (1.69; 0.29 to 9.79)	12 (60)	0	0.19 (3.57; 0.28 to 45.96)	11 (73.3)	1 (20)	0.11 (3.67; 0.62 to 21.73)	12 (60)	0	0.43 (2.38; 0.21 to 26.94)	4 (80)	0	0.33 (3.0; 0.26 to 34.58)	4 (66.7)	0	1.0 (1.29; 0.17 to 9.85)
Household injury	12 (70.6)	2 (40)	0.31 (1.76; 0.58 to 5.39)	14 (63.6)	1 (33.3)	0.54 (1.91; 0.37 to 9.76)	12 (75)	1 (25)	0.1 (3.0; 0.54 to 16.77)	13 (65)	1 (50)	1.0 (1.3; 0.31 to 5.39)	11 (73.3)	2 (40)	0.29 (1.83; 0.6 to 5.6)	13 (65)	0	0.38 (2.57; 0.23 to 28.96)	3 (60)	0	1.0 (2.33; 0.19 to 28.25)	3 (50)	0	1.0 (1.0; 0.12 to 8.13)
Dog within family	9 (52.9)	3 (60)	1.0 (0.88; 0.38 to 2.05)	12 (54.5)	1 (33.3)	0.59 (1.64; 0.32 to 8.48)	9 (56.3)	2 (50)	1.0 (1.13; 0.39 to 3.28)	11 (55)	1 (50)	1.0 (1.1; 0.26 to 4.65)	8 (53.3)	3 (60)	1.0 (0.89; 0.38 to 2.1)	11 (55)	0	0.48 (2.19; 0.19 to 24.93)	2 (40)	1 (100)	1.0 (0.4; 0.14 to 1.17)	3 (50)	0	1.0 (1.0; 0.12 to 8.13)
German shepherd	8 (47.1)	1 (20)	0.36 (2.35; 0.38 to 14.58)	9 (40.9)	1 (33.3)	1.0 (1.23; 0.23 to 6.57)	8 (50)	1 (25)	0.59 (2.0; 0.34 to 11.7)	9 (45)	0	0.49 (2.71; 0.21 to 35.6)	8 (53.3)	1 (20)	0.32 (2.67; 0.43 to 16.39)	9 (45)	0	1.0 (1.81; 0.16 to 20.89)	2 (40)	0	1.0 (1.67; 0.13 to 22.0)	2 (33.3)	0	1.0 (1.29; 0.17 to 9.85)

Note: Continuous data are listed as mean ± SD or mean. Categorical data are presented as number (percentage). Statistically significant P-values are indicated in bold typeface. OR: operating room; N/A: not applicable.

University Hospital of Hamburg-Eppendorf revealed that nearly a one-third of children had mental health problems and decreased quality of life in relation to the COVID-19 pandemic.¹³ Hence, coupled with emotional stress (e.g. due to school closures, home confinement, and social distancing) and increased animal contact, children's mental health problems may be left untreated (probably due to closure of pediatric outpatient services), deteriorates dog-human interactions and subsequently explains the higher frequency of HNF dog bite injuries among schoolers staying home.¹³

On the other hand, it remains unknown whether hen is first or egg is first. Social stigmata may arise from posttraumatic scarring and facial deformities. Childhood trauma can also dysregulate the physiological stress response system, causing alterations in hypothalamic-pituitary-adrenal (HPA) axis and lowered tolerance to stressors and later stressful life events (so-called the "stress sensitization effect").⁹ The link between HNF dog injury during the COVID-19 outbreak and parental backgrounds, pediatric mental health, as well as posttraumatic psychological problems, are beyond our study's scope.

Another important issue is posttraumatic infections. The incidence of infection after overall dog bite injuries ranges from 2% to 25%.¹⁴ However, infection rates after HNF animal bite injury accounts for 5.7%–9.7% only,¹⁵ which is consistent with the wound infection rate in our study, i.e. 5.6%. Methicillin-sensitive *S. aureus* (MSSA) was identified in both infected cases. This finding confirmed the hypothesis of Greene and Fritz¹⁵ that infections from dog bites are more often caused by human skin flora, while cat's oral/oropharyngeal flora are commonly found from wound cultures, e.g. *Pasteurella* spp (most often *P. Multocida*, subspecies *multocida* and *septica*), *Capnocytophaga*, *Erysipelothrix rhusiopathiae*, and *Sporothrix schenckii*. Despite the fact that many authors considered HNF dog bite injury risky to wound infection,^{3,14,15} the low infection rate in our study can be explained by (1) immediate antibiotic bombardment on patient's presentation, (2) treatments without delay (within 30–120 min on patient's arrival), (3) intraoperative wound irrigation and drainage placement as indicated, and (4) daily wound care and monitoring. Moreover, the highly vascularized nature of the facial tissue could help lower rates of infection and promote healing after dog bite injuries.¹⁵

It should be borne in mind that manifestations suggestive of bite wound infection may include pain, erythema and swelling without serosanguineous or purulent discharge, fever, or lymphadenitis/lymphangitis.⁸ Appropriate wound management and close patient follow-ups are essential. Amoxicillin/clavulanate and ampicillin/sulbactam are the first-line prophylactic therapy for animal bite wounds. Doxycycline or a combination of clindamycin plus a fluoroquinolone can be used in case of penicillin allergy.^{8,11–16} However, doxycycline and fluoroquinolone are not amenable to pediatric patients in Germany.¹⁷ One of our cases with clindamycin prophylaxis developed a wound infection. This can be partially explained by the fact that clindamycin does not cover for *Pasteurella* spp during the primary wound care,¹⁶ although the serial sensitivity tests confirmed an MSSA infection only.

Deep wound irrigation with Octenisept® (0.1% w/w Octenidine/2% w/w Phenoxyethanol, Schülke & Mayr GmbH, Norderstedt, Germany) can cause aseptic tissue necrosis and chronic inflammation.¹⁸ The Drug Commission of the German Medical Association ("Arzneimittelkommission der Deutschen Ärzteschaft") has recommended employing Octenisept® for surface antiseptics only since 2017.¹⁹ Thereafter, we used 0.04% polyhexanide antiseptics (Lavanid®, Serag-Wiessner KG, Naila, Germany) for every intra- and postoperative lavage, including in this patient cohort. However, the risk of severe anaphylaxis on account of polyhexanide should not be overlooked.¹⁸

One particular concern regarding cervicofacial dog bite injury may link to shortage and/or unequal distribution of facial trauma specialists: i.e. oral-maxillofacial surgery (OMFS; the main specialty responsible for facial injuries in European countries), plastic surgery, and otorhinolaryngology (ORL). In Germany, there are 1914 hospitals; only 596 (or

31.1%) of those have ORL departments, 564 hospitals (or 29.5%) have plastic surgeons, and an OMFS department can be found in 158 hospitals (or 8.3%) (<https://klinikradar.de/>). Simply speaking, over half of the hospitals in this country have been lacking for head and neck specialists. It was also personal experience of the first author (P.P.) over the past 7 years that approximately 1–2% of facial fracture patients were left undiagnosed or untreated until complications developed; most of them were primarily managed by medical/surgical colleagues other than head and neck specialists (unpublished data). This could imply that if the COVID-19 pandemic continues much longer, the incidence of undiagnosed/untreated facial injury patients might be higher in this country in the near future.

This study must be viewed within its limitations. The retrospective study design based on medical charts/databases lessens the probability of retrieving deep details, e.g. familial and socioeconomic environments related to the injury, psychological backgrounds of the patients and caregivers. Children with minor injury such as scratch may not be apt to medical care. In addition, future studies should prospectively assess the child and family using standardized instruments and multiple assessment procedures at different time points, including injury cause, and follow-up outcomes in details.

Last but not least, the authors from Alder Hey Children's NHS Foundation Trust and University of Liverpool, UK,⁷ recently recommended three preventive interventions against dog bite injury in children: (1) safety education for children and caregivers in many forms, including books, websites, primary school teaching resources and posters with the concept "Any dog can bite, regardless of breed and owner.", (2) close supervision of dog-child interactions by an adult, and (3) household promotion of environmental safety measures, including implementation of 'leash laws' mandating owners to keep their dog within specific areas to improve public safety.⁷ The potentially risky behaviors such as interfering with food, hugging, kissing, staring, or playing roughly should be discouraged.⁴ The American Academy of Pediatrics (AAP) Committee on Infectious Diseases dissuades the acquisition and ownership of nontraditional pets in households with young children, and children themselves should be counseled "to never handle unfamiliar, wild, or domestic animals, even if animals appear friendly".⁸ Anyhow, the effectiveness of these measures to prevent HNF dog bite injuries during the COVID-19 pandemic remains unknown and thereby warrants further investigations.

5. Conclusions

This research is the first that objectively examines the HNF dog bite injury among children during the COVID-19 pandemic in comparison to the pre-COVID-19 time. Our most obvious findings provide additional support to prior research findings and suggestions indicating that during the COVID-19 pandemic, the frequency and severity of pediatric HNF dog bite injury, especially periorbital injuries, have been exponentially striking. We also refer interested readers to our review on HNF conditions in COVID-19 patients⁵, and our research series regarding the effects of COVID-19 on HNF surgery.^{6,20–23}

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Availability of data and material

Deidentified individual participant data are not available. Based on the current patient data protection law in Germany, open access to the raw data is not allowed. The datasets generated and analysed during this study are available from the corresponding author upon reasonable request.

Code availability

N/A.

Authors' contributions

Conception and design: P.P., P.A., K.S., N.S., C.T., J-P.M., R.M.-P., A.N.

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Agreement to all aspects of the work: P.P., P.A., K.S., N.S., C.T., J-P.M., R.M.-P., A.N.

Declaration of Competing interest

The authors indicate full freedom of investigation and manuscript preparation. They have no conflict of interest relevant to this article to disclose.

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