


## Systematic Review

# Animal bite injuries in pediatric population: a systematic review

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**Abstract – Objectives:** To assess the scientific literature pertaining the risk factors for injuries among victims of animal bite injuries. **Data and sources:** A systematic review of scientific literature published until May 2020 was carried out in the following databases: PubMed, Cochrane Library, Google Scholar and Journals@ovid. **Study selection:** A total of 924 records were found, of which 29 articles fulfilled the inclusion criteria and were analyzed. There was a male preponderance in most of the studies with male/female ratio ranging from 0.75:1 to 2.1:1. The age range varies from 0 to 19 years with the mean age varying from 3.6 to 8 years. Pitbulls, Rottweiler's, German shepherds, Bull terriers, Labradors and Dobermans were breeds with higher risk of attack. The animals were familiar to the victim (own, friends, neighbors) in 27–98% instances. Most cases of animal bite injuries were recorded during Summer and Spring months. Head and neck followed by extremities was found to be most inflicted area. **Conclusions:** The sociodemographic characteristics of victim as well as the biting animal affect the circumstances leading to biting episode. However, the results should be interpreted with caution due to the high heterogeneity among studies and moderate quality evidence.

## Introduction

Animals are an indispensable part of the human ecosystem. The animals might display many kinds of behavioral traits towards humans like loyalty, affection or aggression. Animal bite injuries in children of all ages represent an unsatisfactorily understood but significant medical and public health issue. Unaesthetic soft-tissue and skeletal injuries, scars and disfigurements are outcome of such incidents [1]. It is estimated that 50% of population in the United States experience an animal or human bite wound at least once in their lifetime, and 45% of children had been bitten during their lifetimes [2–4]. These types of injuries are ever-growing burden for public health, especially in developing and third world countries. Amongst bites caused by domestic animals, dog bites account 80–90% [5,6], whereas cat bites account for 5% and 15% [7,8], as second common cause. Children are especially susceptible to dog bite injuries of the head and neck region [4,9–12]. The kind of wounds afflicted span from insignificant scratches to fatal injuries and/or infections [13]. These injuries are considerably preventable by studying the

attributes of the children who are traumatized, the characteristics of biting animals and the detailed features of biting incident. Accurate reporting of animal bites to authorities is important for framing appropriate prevention strategies, identifying the traumatic load and development of a more efficacious planning of resource allocation and to provide care [14–16]. Various studies have been conducted in different regions of the world to elucidate and characterize injuries resulting from animal-inflicted bites [17–20]. However, there are significant scientific controversies in literature, and no consensus on risk factors and optimal management. Therefore, this systematic review aims to explore the literature to understand the nature and severity of outcomes of bites from animals, and identify the risk factors for injuries among young victims of animal bite.

## Method

### Preliminary search

The databases PROSPERO, the Cochrane Database of Systematic Reviews, the JBI Database of Systematic Reviews and Implementation Reports and MEDLINE were searched and no systematic reviews (completed or in process) on this topic were identified.

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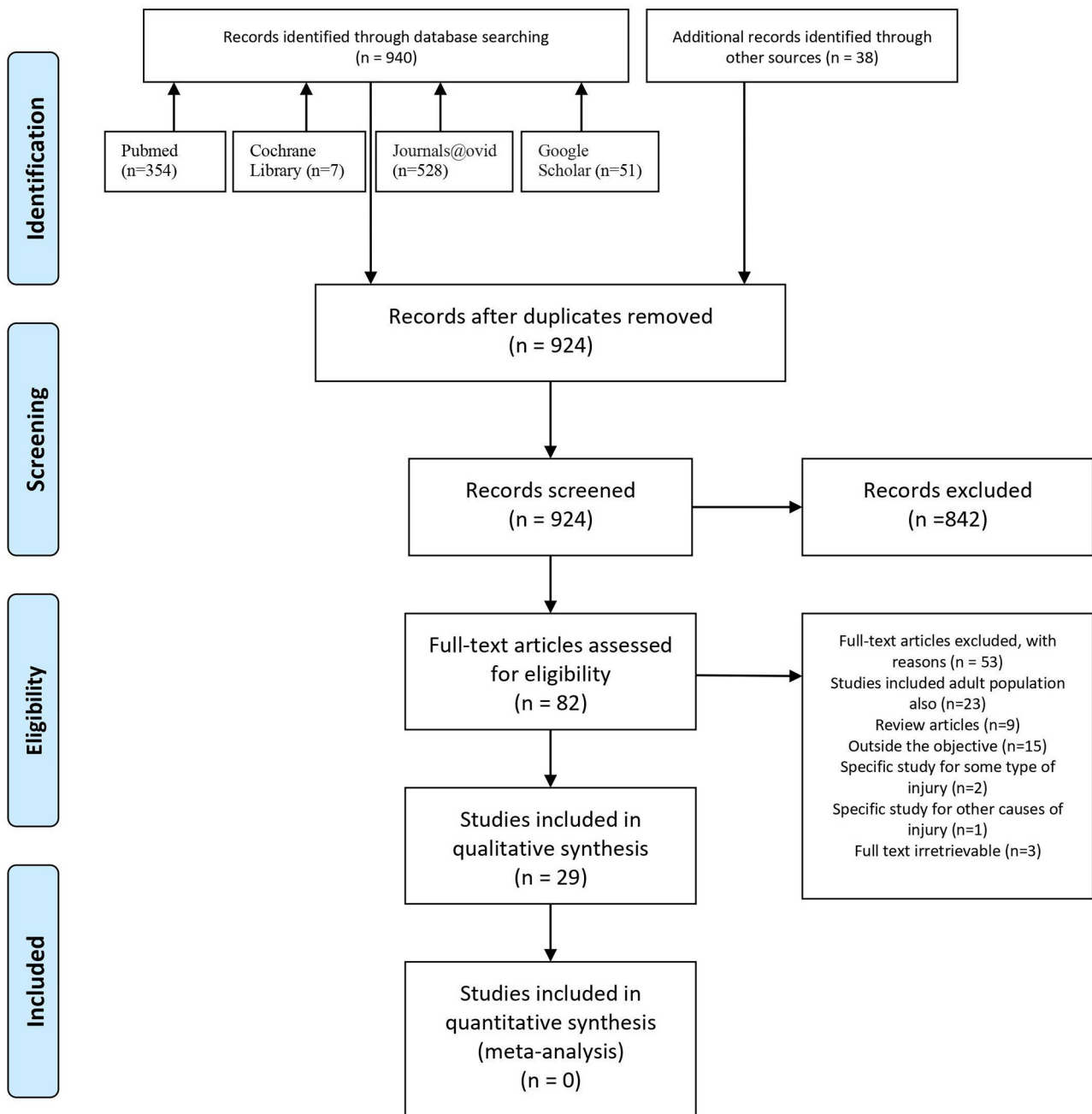


Fig. 1. PRISMA flowchart.

**Protocol and registration**

The systematic review was conducted following the PRISMA Statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) and the Cochrane’s Guidelines. The proposed systematic review was registered in PROSPERO under registration number # CRD42020177845.

The primary review question was, “What is the epidemiology of animal-inflicted injuries in children and associated risk factors?” PECO strategy as proposed by Maia and Ant6nio was followed instead of PICO [21]. The PECO used was Population

(patients ≤ 19 years of age), Exposure (animal bite), Comparison (sociodemographic and bite wound characteristics) and Outcome (injury pattern and characteristics).

**Eligibility criteria**

Inclusion criteria were observational studies (prospective studies, retrospective, cohort, case-control and cross-sectional) in which risk factors for animal bite in children and adolescents (≤19 years) were reported. There was no restriction of year, or publication status (Epub ahead of print).

Exclusion criteria were: (1) review articles, opinion articles and single case reports; (2) studies with no apparent aim of studying risk factors for injuries caused by animals; (3) studies on adults with age >19 years and injuries caused by human bites; and (4) studies addressing other etiologies (*e.g.*, interpersonal violence).

### Sources of information and research

The primary study source, PubMed/MEDLINE, Cochrane Library, Google Scholar and Journals @ Ovid were used. The descriptors were searched in the MeSH database (Medical Subject Headings). With the help of the Boolean operators "AND" and "OR", the research strategy was developed. The keywords searched were (((("maxillofacial injuries" OR "facial injuries"))) AND (("wounds and injuries" OR bites and stings OR trauma OR soft tissue injuries OR wounds OR lacerat\* OR injuries OR wounds))) AND ((animal OR mammal\* OR dog OR cat OR domestic OR non domestic OR pet OR stray OR wild))) AND ((infan\* OR child\* OR adolescen\* OR pediater\* OR human)).

The search strategy was modified for each included information source. In addition, reference lists of literature, existing networks and websites, were scrutinized to enhance procurement of documents. Following initial search, all the citations were transferred to EndNote 9 (Clarivate Analytics) and duplicates were removed.

### Selection of studies

To minimize inter-examiner variability, 2 reviewers applied the eligibility criteria to 20% of retrieved studies as calibration exercise and a good agreement level was achieved ( $\kappa=0.841$ ). The studies were assessed in two main phases: (1) two reviewers (RS and NS) systematically analyzed titles and abstracts, and when they fulfilled the inclusion criteria for the review, articles were selected for the next phase and (2) full texts of eligible studies were obtained and evaluated. Reasons for exclusion of full text studies that do not meet the inclusion criteria were documented. Any disagreements between the reviewers during selection process were resolved through discussion, or with a third reviewer. The whole procedure was presented stepwise in a Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow chart.

### Data collection and extraction process

Two evaluators (RS and NS) performed data extraction independently using a spreadsheet specially created to extract the necessary information including the following items: article identification (author, location, duration of study, source of information, type of study and case definition); victim characteristics (age and sex); causative animal characteristics (breed, familiarity, provoked/unprovoked) and results (area and types of injuries and months of year when incidence is at peak) and other relevant variables.

### Methodological quality appraisal

After data extraction of all relevant articles, an objective appraisal process was initiated. The process of appraisal aims to assess the quality of the study by evaluating the design and methodology. The quality assessment of included studies were independently rated by two reviewers using an adapted version of the NIH Scale for case series and JBI prevalence critical appraisal tool having 7 questions, assigning Y/N/U (Yes/No/Unclear) for each question. The higher the score, the better was the methodological quality of the study.

### Synthesis of result

The variability among studies was appraised by parameters such as the outcome analyzed, sample attributes, predictor measures, statistical tests and summary variables. This prevented the pooling of data for meta-analysis.

## Results

### Selected studies

A sum total of 924 potentially relevant articles were recognized. Of the 924 articles, 842 were excluded after the analysis of titles and abstracts. Full-text analysis was done for eighty two articles, out of which twenty nine were included in the systematic review according to the eligibility criteria. [Figure 1](#) shows the stepwise process of searching, evaluation, inclusion and exclusion of articles.

### Characteristics of included studies

The prime characteristic features of eligible studies are summarized in [Tables I–III](#). The time span assessed in the studies ranged from 1985 to 2017 [[4,9,11,22–47](#)]. Majority of the included studies in the review were retrospective studies except 4 studies (2 were prospective studies [[11,25](#)] and 2 were cross-sectional questionnaire-based surveys [[38,43](#)]). The animals involved in the biting episode were dogs in all the included studies. The male/female ratio ranged from 0.75:1 to 2.1:1. Most of the included studies depict males are more prone to animal bite injuries except only 3 studies which showed female preponderance [[22,33,47](#)]. The age range varies from 0 to 19 years with the mean age varying from 3.6 to 8 years [[25,26](#)]. The usual age in all studies analyzed corresponded to preschool and grade school children being the most affected group [[22,24,25,27–33,37,40,43,46](#)]. The list of breeds commonly causing ABI are given in [Table II](#). Pitbulls, Rottweiler's, German shepherds, Bull terriers, Labradors and Dobermans were breeds with higher risk of attack. The animals were familiar to the victim (own, friends, neighbors) in 27–98% instances. Provocation was seen to be a risk factor for animal bite. Most cases of animal bite injuries were recorded during summer and spring months. Head and neck in younger children followed by extremities in older children was found to be the most inflicted area [[22,24,25,27–33,37,46](#)]. Among head and

**Table 1.** Demographic characteristics of patients included in studies.

Author/Country	Duration of study	Source	Design	Number of patients	Age	Gender	Case definition	Age Classification
1 Abraham JT <i>et al.</i> 2019/ USA	5 Y (October 2011 to October 2016)	Pediatric trauma registry Texas A&M University Health Science Center, Temple, Texas.	RS	102	3 D – 16 Y Mean 5.84 Y	43:57 (0.75:1)	Individuals ≤ 18 years who sustained a dog bite and presented to the ED directly or as a transfer from a regional center for continued care.	0–1Y: 11, 2–5 Y: 44, 6–12 Y : 42, >13Y : 5
2 Akhtar N <i>et al.</i> 2006/ 5 Y (1998–2002) UK	5 Y (1998–2002)	Plastic Surgery Department at the Sheffield's Children Hospital, UK	RS	118	1 – 15 Y Mean 6.6 Y	70:48 (1.4:1)	Patients with a dog bite injury admitted under the care of the Plastic Surgery Department at the Sheffield's Children Hospital.	
3 Alizadeh K <i>et al.</i> 2017/ USA	3 Y (January 2012–December 2014)	Maria Fareri Children's Hospital of Westchester Medical Center, USA	RS	108	0 – 18 Y Mean 6.5 ± 4.9 Y	61:47 (1.30:1)	All the pediatric patients (age, 0–18 years old) who sustained dog bites	Infant : 17.5%, Preschool : 33.3%, Grade School : 31.4%, Teenage : 17.5%
4 Avner RJ <i>et al.</i> 1991/ 1 Y (January 1989–December 1989) USA	1 Y (January 1989–December 1989)	The Children's Hospital of Philadelphia Emergency Department	PS	168	7 Mo – 17 Y, Mean 8 Y	60:40 (1.5:1)	Children younger than 19 years of age who presented to ED for evaluation of dog bite injuries	≤ 5 Y : 54 >5 Y : 114
5 Bernardo LM <i>et al.</i> 1998/ USA	6 Y (January 1990–December 1995)	Registry of the Pennsylvania Trauma Outcome Study (PTOS)	RS	183	<18 Y Mean 3.6 Y	106:77 (1.38:1)	Individuals 18 years of age or younger whose injuries were associated with a dog bite	
6 Bernardo LM <i>et al.</i> 2000/ USA	1 Y (January 1997–December 1997)	ED records of Children Hospital of Pittsburgh	RS	204	2 D – 19 Y Mean 6.8±4.2 49% <5 Y	124:80 (1.55:1)	(1) the biting episode was caused by a dog, and (2) the dog bite occurred less than 24 hours before the ED visit.	≤ 5 Y: 49%
7 Bernardo LM <i>et al.</i> 2002/ USA	2 Y (January 1999–December 2000)	Patient records from ED of Children's Hospital of Pittsburgh (CHP)	RS	386	7 Mo to 19 Y Mean 6.7 Y	200:186 (1.07:1)	1) the biting episode was caused by a dog, and 2) the dog bite	< 6 Y : 52.8%, >7 Y : 47.2%

**Table I.** (continued).

Author/Country	Duration of study	Source	Design	Number of patients	Age	Gender	Case definition	Age Classification
8 Chen HH <i>et al.</i> 2013/ USA	5 Y (January 2003–December 2008)	Children’s Hospital (Denver, CO)	RS	537	0.5 – 17 Y Mean 4.59±3.36 Y	52:48 (1.08:1)	occurred less than 24 hours prior to the ED visit. Patients with a diagnosis of dog bite were identified by a search for medical records containing Code E906.0. Each record was evaluated to identify children with bites to the face	0–5 Y : 68%, 6–12 Y : 28%, 13–17 Y : 4%
9 Chiam SC <i>et al.</i> 2014/ Australia	2 Y (January 2009–December 2011)	Women’s and Children’s Hospital, Adelaide, Australia.	RS	277	1 Mo – 17 Y, Mode 2 Y, Median 5 Y	160:117 (1.37:1)	Children aged 0–17 years presenting with dog bites	0–4 Y : 120, 5–8 Y : 67, 9–12 Y : 58, 13–17 Y : 32
10 Daniels DM <i>et al.</i> 2009/ USA	7 Y (1999–2006)	Two Level I Trauma Centers	RS	1347	<18 Y Mean age 7.28 ±4.44 Y	1.32:1	The study population included all visits by children younger than 18 years who were evaluated and treated for dog bite – related injuries	< 5 Y : 34%, 5–10 Y : 40%, 11–17 Y : 26%
11 Dwyer JP <i>et al.</i> 2007/ South Africa	15 Y (4 <sup>th</sup> March to October 2004)	Child Accident Prevention Foundation of South Africa (CAPFSA) trauma registry	RS	1871	2.5 Mo to 18.5 Y Mean 6.84 ±3.30	1265:606 (2.09:1)	Children (<12 years of age) with dog bites above the clavicles	< 6 Y : 797, ≥6 Y : 1065, Unknown : 9
12 Eppley BL <i>et al.</i> 2013/ USA	10 Y (1995–2005)	Riley Hospital for Children	PS	107	6 Wk to 11.5 Y Mean 5.7±2.9 Y	56:51 (1.1:1)	Children (<12 years of age) with dog bites above the clavicles	0–2Y : 30%, 3–5 Y : 27%, 6–12 Y : 34%, 13– 17 Y : 6%
13 Fien J <i>et al.</i> 2018/ California/ USA	8 Y (2007–2014)	Research data sets of NTDB	RS	7912	<18 Y Mean 5.4 Y	43:57 (0.75:1)	Dog bite patients included in the trauma database if they are evaluated by the trauma team or arrive to the ED	0–2Y : 30%, 3–5 Y : 27%, 6–12 Y : 34%, 13– 17 Y : 6%
14 Garvey EM <i>et al.</i> 2014/ USA	7 Y 2 mo	Phoenix Children’s Hospital Level I Trauma Centers	RS	282	2 mo to 17 Y Median 5 Y	54.6:45.4 (1.20:1)		

**Table I.** (continued).

Author/Country	Duration of study	Source	Design	Number of patients	Age	Gender	Case definition	Age Classification
15 Greenhalgh C <i>et al.</i> 1991 Australia	18 Mo (January 1986 to June 1987)	Emergency Department (ED) at the Adelaide Children's Hospital	RS	159	100:59 (1.69:1)		Injury to the head and neck region by a dog in children of 16 years of age or under	
16 Kasbekar AV <i>et al.</i> 2013/ UK	10 Y (September 2001–August 2011)	Alder Hey Children's Hospital Hospital Liverpool/ UK	RS	436	1 Mo – 16 Y Median 6 Y	1.2:1	Children presenting to the Hospital with ICD 9 <sup>th</sup> revision diagnosis code E906.0 (dog bite injury)	Infant 0–1 Y : 4.5%, Preschooler 2–5 Y : 24%, Grade School 6–12 Y : 51%, Teenager 13–18 Y : 20.5%
17 Kaye AE <i>et al.</i> 2009/ USA	4 Y (April 2001–December 2005)	Children's Hospital of Philadelphia Emergency Department	RS	551	5 Mo – 18 Y Mean 8.41 Y for Males Mean 8.666 Y for females	346:205 (1.7:1)	The children younger than 16 years old, had been bitten by a dog less than 72 h earlier, and agreed to answer a questionnaire or an adult care – giver agreed to answer on their behalf.	
18 Kahn A <i>et al.</i> 2003 / Belgium	9 Mo (April 15 to December 31, 2001)		Questionnaire based survey	100	<16 Y, 3 Mo – 15 Y Median 7 Y	1.38:1	Children < 16 years of age presenting with a dog bite	
19 Lang, ME <i>et al.</i> 2005 /Canada	4 Y (1998–2002)	2 tertiary EDs in Edmonton, Alta.	RS	287	4 Mo to 16.9 Y Mean 7.4±4.2	145:142 (1.02:1)	ICD – 10 – CA(Tenth edition) Code W54, Corresponding to bitten by Dog	
20 McGuire C <i>et al.</i> 2018/ Canada	2.5 Y (January 2015–June 2017)	Izaak Walton Killam Health Centre ED	RS	158	<16 Y	53.8:46.2 (1.16:1)	Children with bites of the scalp, face, or neck	
21 McHeik, JN <i>et al.</i> 2000/ France	10 Y (1985–1995)		RS	100		59:41 (1.44:1)	E906.0 of ICD/9/CM	
22 Mitchell RB <i>et al.</i> 2003/USA	6 Y (January 1995–December 2000)	University of New Mexico Health Sciences Center	RS	44	1 – 12.1 Y, Mean 5.2±2.9 Y	61.3:38.7 (1.58:1)	Dog bite injuries sustained to head and neck.	
23 Monroy A <i>et al.</i> 2009 / USA	9 Y (1999–2007)	Tertiary care children's Hospital	RS	84	0 – 19 Y Mean 6.19±4.01 Y Median 4.07	46:38		

**Table I.** (continued).

Author/Country	Duration of study	Source	Design	Number of patients	Age	Gender	Case definition	Age Classification
24Reisner IR <i>et al.</i> 2011/USA	2 Y 3 Mo (December 2006–February 2009)	ED of the Level 1 trauma centre at the Children’s Hospital of Philadelphia	CS	203	3 Mo – 17 Y, Mean 7.2 Y, Median 6.5 Y	55.2:44.8 (1.23:1)	<17 years presenting for dog bite injuries	
25Schalamon J <i>et al.</i> 2005/ Austria	5 Y (1994–2003)	Department of Pediatric Surgery at the Medical University of Graz (Level 1 trauma center)	RS	341	8 D – 16 Y Mean 5.9 Y	174:167 (1.04:1)	Individuals younger than 17 years and sought medical attention after a dog bite	
26Speirs J <i>et al.</i> 2015/ Texas/ USA	6 Y (2005–2011)	Level one trauma centre	RS	116	<19 Y		<19 yrs old with a dog bite injuries	
27Sribnick EA <i>et al.</i> 2016/ USA	106 Mo (February 2000–December2009)	State – mandated trauma database (Georgia Central Trauma Registry)	RS	236	Mean 5.83 Y	132:104 (1.27:1)	Patients less than 18 years of age who were seen in the Emergency Department for a documented acute injury due to a dog bite.	
28Van As AB <i>et al.</i> 2010/ South Africa	13. 5 Y (March 1991– November 2004)	The Child Accident Prevention Foundation of South Africa (CAPFSA) trauma registry.	RS	596	2.5 Mo to 13.4 Y 5.1±2.9 Y	404:192 (2.1:1)		
29Wu PS <i>et al.</i> / USA	5 Y (January 2003– December 2008)	Urban tertiary care hospital	RS	87	9 Mo – 17 Y Mean 6.82 Y	41:46(0.89:1)	Patient 18 years or younger who sustained a facial dog bite injury and was treated by a single pediatric surgery practice at an urban, tertiary care hospital. Dog bites to the face of all severities	

\*Y= Year, Mo= Month, Wk= Week, D= Days, ED= Emergency department RS= Retrospective, PS= Prospective, CS= Cross-sectional.

**Table II.** Characteristics of animals included in studies.

Author	Most common breed identified (* 3 Most common in descending order)	Familiarity of Dog	Provocation by child	Most common time of year
1 Abraham JT <i>et al.</i> 2019/ USA	Pit bulls, Labrador	Pet 41.4% Non pet 58.6%	Recorded in 74 out of 102 cases P – 63.2%	Spring (March to May 31.4%) and Winter (December to February 29.4%) December 14.7% Summer 36%
2 Akhtar N <i>et al.</i> 2006/ UK	Alsatian, Japanese Akita, Rottweiler	F – 66% Pet 75%	P – 3 cases	Summer 36%
3 Alizadeh K <i>et al.</i> 2017/ USA	56 cases that had an identified dog breed, Pit bulls, German Shepherd, Husky, Small terriers	–	–	–
4 Avner RJ <i>et al.</i> 1991/ USA	Mixed breeds, German shepherd, Pit bull	K – 77%	P – 46%	65% in spring and summer months (April to September)
5 Bernardo LM <i>et al.</i> 1998/ USA	Recorded in 17% cases – German Shepherd, Rottweiler, Great Dane	–	Documented in 27(15%) cases only. P – 10, NP – 17	August (15%) June (13%)
6 Bernardo LM <i>et al.</i> 2000/ USA	Pit bull, German shepherd, Rottweiler	Parent <i>n</i> = 55 (27%) or a neighbor <i>n</i> = 57(28%) unrecorded in 49(24%)	P – 86+10 NP – 17+14	Summer (June – August) – 40%
7 Bernardo LM <i>et al.</i> 2002/ USA	Pitbull, German shepherd, Mixed breed/ mutt	Dog's owner parent <i>n</i> – 134 (34.7%) or neighbor <i>n</i> – 94 (24.4%).	P – 191 (49.5%) NP – 66 (17%)	May to Aug – 182 (47.2%)
8 Chen HH <i>et al.</i> 2013/ USA	Mixed breed, Labrador retriever, Rottweiler	K – 90% (family pet (51.2%) or through a neighbor (14.7%), friend (12.7%), or relative (9.5%)) Un – 5%	P – 164 (31%) NP – 144 (27%) Not documented/ witnessed 229 (43%)	–
9 Chiam SC <i>et al.</i> 2014/ Australia	Bull Terrier group, Jack Russell Terriers	F – 78% NF – 11.6% Undocumented 10.5%	P – 67.5% NP – 32.5%	NM
10 Daniels DM <i>et al.</i> 2009/ USA	Pit Bulls, German Shepherd, Great Dane	Child's caregiver (Family or baby sitter) 45(37%) Friend/ Neighbor – 19 Stray dog – 4	Undocumented 75% NP – 5+3+2 P – 13+5	Summer & spring (63%) Peak July(12.6%)
11 Dwyer JP <i>et al.</i> 2007/ South Africa	Recorded in 1% of cases Pit Bull Terrier, German Shepherd	–	–	546(29%) occurred in summer months of November and January
12 Eppley BL <i>et al.</i> 2013/ USA	Chow, Pit Bull, German Shepherd	Family – 49.4% Relative – 25.3% Neighbour – 19.5% Un – 5.7%	P – 59.7% NP – 19.5 % Observed 16 % Not observed 4.6%	–
13 Fien J <i>et al.</i> 2018/ California/ USA	–	–	–	–
14 Garvey EM <i>et al.</i> 2014/ USA	Pit Bull, Labrador, German shepherd	Families or extended families 53% Neighbor 21% Family friend 12% Stray 8% Un 6%	–	July and November
15 Greenhalgh C <i>et al.</i> 1991 Australia	German shepherd, Kelpie, Doberman	Ownership established in 110(69%) K – 65(59%)	P – 39% NP – 61%	–

**Table II.** (continued).

Author	Most common breed identified (* 3 Most common in descending order)	Familiarity of Dog	Provocation by child	Most common time of year
16 Kasbekar AV <i>et al.</i> 2013/ UK	Terrier group, Husky, Rottweiler	Family dog – 30(27%), Relative, friend or neighbour – 78(71%) K – 98% of which 55% were family pet		
17 Kaye AE <i>et al.</i> 2009/ USA	Pit bull terriers, Rottweilers, Mixed breeds	F – 68.8%	–	June and July – 24.1%
18 Kahn A <i>et al.</i> 2003 / Belgium	German Shepherds, Rottweilers, Labradors	F – 71	P – 86%	July and August
19 Lang, ME <i>et al.</i> 2005 /Canada	Rottweiler, German Shepherd, Husky	K – 73.9% Stray/ Stranger – 10.1% Not documented – 16%	–	June
20 McGuire C <i>et al.</i> 2018/ Canada	Pit bulls, Labrador retrievers, German shepherds	Family pet – 53.2% K – 29.7% Un – 14.6% Missing 2.5%	NP – 46.8% P – 26.6% Not documented – 26.6%	June – 13.3% and July – 16.5%
21 McHeik, JN <i>et al.</i> 2000/ France	–	–	–	–
22 Mitchell RB <i>et al.</i> 2003/ USA	Rottweiler – 13.6%, Chow – 11.4%, Pitbull – 9.0%	K – 79.4% Un – 20.6%		
23 Monroy A <i>et al.</i> 2009 / USA	Pitbulls	F – 27%	–	Summer – 38%
24 Reisner IR <i>et al.</i> 2011/USA	Mixed breed, Pit bull, Rottweiler	K – 72% Relative, Neighbour, Friend – 54% Family – 35% Stranger – 9%	Not clearly mentioned	
25 Schalamon J <i>et al.</i> 2005/ Austria	Crossbreed, German Shepherd, Labrador retriever	F – 73% NF – 15% Un – 12%	P – 75%	Summer (August)
26 Speirs J <i>et al.</i> 2015/ Texas/ USA	–	–	–	–
27 Sribnick EA <i>et al.</i> 2016/ USA	Pitbull, Rottweiler, Labrador	F – 75% Family – 44.5% Neighbor – 27.1% Friend – 4.2%	–	No correlation found
28 Van As AB <i>et al.</i> 2010/ South Africa	–	–	–	Summer of December and February
29 Wu PS <i>et al.</i> / USA	–	–	–	–

\*F=Familiar, NF= Non-familiar, K= Known, Un= Unknown, P=Provoked, NP=Non-Provoked.

neck region, the area frequently involved was cheek region and lip/mouth. The type of wounds afflicted range from minor soft tissue scratches to life threatening injuries including severe nerve and vascular or bony destruction. Laceration wound was the most frequent soft tissue injury.

#### Risk of bias and methodological quality appraisal

The articles included in this review were observational studies, which may have led to publication bias. There may be

geography-based bias, with most of the studies in the literature presenting data from western countries; thus not providing an accurate representation of global pediatric injuries inflicted by animals. In addition, bias may be caused by the articles that were excluded based on unavailability or non-English language.

The methodological quality appraisal of included studies using an adapted version of the NIH Scale for case series [50] and JBI prevalence critical appraisal tool revealed that most of the studies were of moderate quality (Tab. IV) [51].

**Table III.** Injury pattern and characteristics.

Author	Area	Type of injury
1 Abraham JT <i>et al.</i> 2019/ USA	Head and neck region – 92.1%, Extremities – 15.7 %, Trunk – 4.9 %, Multi – region – 12 patients	Major in 74 children Minor in 28 children
2 Akhtar N <i>et al.</i> 2006/ UK	Face – 59% (Middle third was most commonly affected), UL – 20%, LL – 6%, Scalp – 7%	Laceration – 75%, Puncture – 20%, Avulsion – 2.8%, Fracture – 1.4%, Tendon injury – 0.7%
3 Alizadeh K <i>et al.</i> 2017/ USA	Head/neck region – 59.2%, Upper & lower extremities – 30.5%	
4 Avner RJ <i>et al.</i> 1991/ USA	Face & scalp – 44, Trunk – 11, Extremity – 113	Lacerations – 38%, Abrasions – 33%, Puncture wounds – 29%
5 Bernardo LM <i>et al.</i> 1998/ USA	Skull/ head – 41, Face – 176, Neck – 13, Chest – 7, Back – 14, Shoulder/ Upper arm/ upper limb – 25, Elbow/ forearm/wrist/hand fingers – 32, Hip/ thigh – 13, Knee – 26, Leg – 12, Spine – 1, Buttocks/genitals – 3, Multiple sites/ unspecified – 77	Fractures – 26, Dislocations – 11, Cerebral lacerations/ contusions/ intracranial injury – 3, Pneumothorax/hemothorax – 3, Open wounds – 330, Vessel injury – 6. Amputation of fingers and arm – 3, Superficial injury – 25, Contusion – 13, Nerve injury – 8, Lacerations of eye – 12 Open wounds were most common type of injury
6 Bernardo LM <i>et al.</i> 2000/ USA	Total injuries – 511, Facial – 221, (cheek – <b>69</b> and lip/mouth – <b>66</b> )	Laceration – 57%, Puncture – 18% Abrasion/ scrapes – 16%
7 Bernardo LM <i>et al.</i> 2002/ USA	Total injuries – 886 Face – 61% UL – 19% LL – 9%	Laceration – 55% Puncture – 24% Abrasion – 13%
8 Chen HH <i>et al.</i> 2013/ USA	–	–
9 Chiam SC <i>et al.</i> 2014/ Australia	Head& Neck – 70.8%, UL – 18.4%, LL – 9.4%, others – 1.4%	–
10 Daniels DM <i>et al.</i> 2009/ USA	Head or neck (642), Trunk (90), Upper limb (342), lower limb (245)	–
11 Dwyer JP <i>et al.</i> 2007/ South Africa	Head, Neck or Face 633(31%), Trunk 132 (7%), Shoulder, arm or hand 344(17%), Perineum or buttock 133(7%), Leg or foot 779(39%)	Minor (Lacerations, Abrasions) 1718 (85%) Significant 303(15%)
12 Eppley BL <i>et al.</i> 2013/ USA	Head & Neck	Puncture – 15%, Avulsion – 25%, Combination – 90%
13 Fien J <i>et al.</i> 2018/ California/ USA	Head 852, Face 3594 (54%), Neck 216, Thorax 207, Abdomen 226, Spine 23, Upper extremity 1031, Lower extremity 512, Unspecified 1251	AIS classification: Minor(1) – 6287 (79.6%), Moderate(2) – 1122, Serious(3) – 383, Severe(4) – 99, Critical(5) – 10, Maximum(6) – 1, Not assigned – 10
14 Garvey EM <i>et al.</i> 2014/ USA	External (skin) 231 (81.9)Face 16 (5.65) Extremities/Pelvis 16 (5.65)Head/neck 13 (4.6)Abdomen 5 (1.8)Chest 1 (0.4)	AIS classification: Minor(1) – 198 (70.2) Moderate(2) – 73 (25.9)Serious (3) – 6 (2.1)Severe (4) – 4 (1.4)Critical (5) – 1 (0.4)Unsurvivable (6) – 0 (0)
15 Greenhalgh C <i>et al.</i> 1991 Australia	Face 91 bites (57%), Lower leg 11, Upper leg 9, Forearm 7, Hand 6, Back 5, Finger 5, Wrist 4, Abdomen 4, Elbow 2, Knee 2, Chest 2, Foot 2, Ankle 2	
16 Kasbekar AV <i>et al.</i> 2013/ UK	Lip 46%, Ear 23%, Cheek 15%, Eye/ undereye 5%, Nose 5%	
17 Kaye AE <i>et al.</i> 2009/ USA	Face 29.8%, UL+LL 53.9%, trunk 4.7%	NM
18 Kahn A <i>et al.</i> 2003 / Belgium	Face and head (46) Arms & hands (28)	Severe (Puncture & Lacerations) 80 Minor (Scratches & Bruises) 20
19 Lang, ME <i>et al.</i> 2005 /Canada	Face 58.5%, Extremity 35.5%, Head 1.4%, Buttock 1.4%, neck 0.7%	Mild 46%, Moderate 28.9%, Severe 25.1%

**Table III.** (continued).

Author	Area	Type of injury
20 McGuire C <i>et al.</i> 2018/ Canada	Face (42.9%), hands (12.6%) and scalp (12%) Arms (11%), Legs(11%) Neck (3.7%) Trunk (2.6%) Genitals (1.6%), Feet (1.6%) Buttocks (1.2%)	Lackmann's Type I (91.1%), Type II (3.2%), Type III (5.1%), Type IVa 0.6%), Type IV b no cases
21 McHeik, JN <i>et al.</i> 2000/ France	Cheek, 35 wounds (24.3%); Lip, 25 wounds (18.5%); Orbit, 24 wounds (16.4%); Forehead, 21 wounds (15%); Chin, 11 wounds (7.8%); Nose, 10 wounds (7.3%); Ear, 9 wounds (6.4%); and Scalp, 6 wounds (4.3%)	Stage 1 (simple wound without lacerations or muscular injury) 59%; Stage 2, (multiple injury with tissue lacerations and muscular injury) 35%; Stage 3 (substance loss) 6%
22 Mitchell RB <i>et al.</i> 2003/USA	Head and neck only	Scalp Laceration 57%
23 Monroy A <i>et al.</i> 2009 / USA	Cheek 34%, Lips 21%, Nose 8%, Ears 8%	Laceration complex – 45%, Laceration Linear – 32%, Avulsion – 18%, Puncture – 4%
24 Reisner IR <i>et al.</i> 2011/USA	Face/head 52.5%, Arm/hand 32.3%, Leg/Foot 20.6%, Other 7.0%	Injury Severity score ISS1 85.4% ISS2 9.1% ISS3 2.5% ISS4 3%
25 Schalamon J <i>et al.</i> 2005/ Austria	Face 50%, UL – 28% LL – 18%, trunk – 4%	Deep wounds – 85% Scratches/ Minor Lacerations – 15%
26 Speirs J <i>et al.</i> 2015/ Texas/ USA	Upper extremity 26(22.4%), Lower extremity 41(35.3%), Face/axial trunk 54 (46.6%)	Data mentioned only for upper extremity injuries Excoriation 15.38%, Laceration 57.69%, Puncture wound 30.77%
27 Sribnick EA <i>et al.</i> 2016/ USA	Head 73.7%, Other – 26.3%	–
28 Van As AB <i>et al.</i> 2010/ South Africa	Scalp 72 (11), Skull 13 (2), Brain – closed injury 2 (0), Eye(s) 42 (7), Nose 19 (3), Facial bones 9 (1), Mouth/oropharynx 64 (10), Mandible 4 (1), Ear 39 (6), Face (other) 353 (56), Neck 15 (2)	Laceration superficial – 64%, Laceration complicated – 15%, Abrasion – 13%, Close tissue 4%, Vascular – 0, Muscle tendon – 0, Others 3%
29 Wu PS <i>et al.</i> / USA	–	–

## Discussion

A systematic review is the mainstay of evidence-based practice, commonly used for formulation of prevention and treatment guidelines and policies [52–56]. It objectively evaluates all available scientific evidence to answer a research query; and identify the sectors where evidence is deficient [54,57]. The present systematic review evaluated the scientific literature for risk factors of animal bite injuries in children and adolescents.

Animal aggression may be a result of interaction of several factors [58]. The study of individual factors, interrelationship between victim, animals and their environment is very complex [59], several confounding factors such as perception, risk taking and health care seeking behavior of an individual may be affected by past experiences, education and culture. A good quality research requires reliable and reproducible measurement of both the outcome and variables of the study [59].

There are many barriers in measuring outcomes as the number of reported injuries is low in comparison to actual incidence of animal bite injuries.

Young children below 5 years and male child seem more vulnerable to be attacked because of their underdeveloped motor skills [22,24,27–30,33,40,43,46]. Face especially lips, nose and cheeks, also referred to as 'central target area' is more prone, may be because of comparatively smaller body and larger head size [3,5,6,9,11,60–71]. Some investigators found higher prevalence of animal bite injuries in older children [25,31,32,37]. Evidence shows that risk of biting to both household and non-household members increases if a dog lives in a house with children or teenagers [59]. This area requires further research. Daniels *et al.* (2009) [31] and Thompson (1997) [62] found that death in younger children was result of damage to vital structures and the child's fragile skull [31,62]. In addition, younger children were more susceptible to sustain deep wounds rather than superficial scratches or lacerations

**Table IV.** Methodological quality appraisal of included studies.

	Abraham	Akhtar	Alizadeh	Avner	Bernardo 1998	Bernardo 2000	Bernardo 2002	Chen 2013	Chiam	Daniels	Dwyer	Eppley					
1	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y					
2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y					
3	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y					
4	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y					
5	Y	N	N	N	Y	Y	N	N	N	N	N	N					
6	Y	N	N	N	N	Y	Y	N	N	Y	Y	N					
7	N	N	N	N	N	N	N	N	N	N	N	N					
Total Score	6	3	3	4	5	5	4	4	4	5	3	4					
	Fien	Garvey	Greenhalgh	Kasbekar	Kaye	Kahn	Lang	Mcguire	Mcheik	Mitchell	Monroy	Reisner	Schalamon	Speirs	Sribnick	Van As	Wu
1	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3	Y	N	N	Y	N	Y	N	N	N	N	N	Y	Y	Y	N	N	Y
4	N	Y	N	N	Y	Y	Y	Y	N	N	Y	N	Y	N	Y	N	N
5	Y	Y	N	N	Y	Y	Y	Y	N	N	N	Y	N	N	N	N	N
6	Y	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y
7	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Total	5	4	3	3	4	4	6	5	3	2	3	5	5	4	5	2	4

Quality Rating Criteria: Good: 6–7, Fair: 4–5, Poor: 1–3.

**Table V.** Proposed Singhal-Sikka Classification of Animal bite injuries.

Grade 1	Licking or touching by the animal without any breach in skin continuity
Grade 2	Superficial skin injuries like scratches, abrasions, lacerations
Grade 3	Wound extending from skin to fascia, muscle or cartilage
Grade 4	Wound with tissue necrosis or tissue loss
Grade 5	Neural or vascular injury/ bone involvement /Organ defect/ Amputation

[4,13,31]. Extremities; either the hands or lower limbs were more commonly bitten in older children [72–78]. Single bite wound was most frequently reported rather than multiple wounds which occurred in cases of severe mauling [4,79].

The upper age limit for inclusion in the study as pediatric population was not uniform in all the studies. Some included patients up to 15 years, whereas in some studies patients with age 17, 18 and 19 were included. This might have led to bias. Moreover, the categorization of the victims according to the age was variable, as some authors have categorized on the basis of age range and some have used the terminologies infant, pre-school, grade school and teenagers.

In order to report the injuries inflicted in different areas of body, few authors have divided the body parts as head & neck, upper and lower extremities and trunk/torso/chest whereas some have further subdivided head & neck into face, scalp, eye and neck. This led to inconsistencies while drawing conclusions from the data.

All the included studies in present systematic review reported dogs as the offending animals. No observational study reported any epidemiological data related to other animals. Also, the data pertaining to the unreported bite incidents were not apprehended. Discrepancies in health care seeking behavior and access to healthcare facilities are well recognized and affected by a number of factors, like severity of injury and risks posed, health beliefs and understanding [80–84]. Ignorance regarding appropriate treatment, its completion, vaccine was also implicated in the outcome.

No study included in present systematic review could establish high quality evidence regarding risk factors for animal aggression and none compared the risk across different groups. To establish a variable as a risk factor, a control or a comparator group is needed [59,85]. Comparison must be needed to isolate animals showing aggression from animals with no aggressive behaviour [86]. Also, comparison between characteristics of victims and non-affected population has to be included. None of the studies reaching the final review, examining the demographics of the target of aggression had a comparator group.

Pitbulls, Rottweilers, German shepherds, Bull terriers, Labradors and Dobermans were ranked as breeds with higher risk of attack [11,15,39,62,63,69]. Some breeds were considered to be more aggressive, indeed many breed specific legislations have been enacted [87–89]. However, the relationship between dog breed and aggression may be

confounded by several factors [59]. Even the experienced personnel may misidentify certain breeds, particularly cross breeds, leading to behavioral and expectational implications [90]. The breeds bull terrier, American Staffordshire bull terrier (also known as American pit bull terrier), and Staffordshire bull terrier are collectively referred to as “Pitbull” [91–93]. Misleading information perpetuated by media regarding dog breed also creates confusion [63]. Very few hospitalized cases reported or identified breed of the dog inflicting the injury [31,94–98]. Cognitive biases regarding a particular breed of dog causing serious injury may result in those recipients being more likely to attend for treatment [99].

Various authors have used variable terminologies like known/ unknown, familiar/ unfamiliar and pet/ non-pet to establish the relationship between the victim and the biting animal which created disparities while summarizing the data. Hence, uniformity in data during compilation of results could not be obtained. The events preceding the animal bite injuries which were considered as provoked incidents were not uniformly explained and demand a universally accepted definition. After reviewing all the articles, we propose, factors such as playing, teasing and feeding should be considered under the term “Provocation”. There is seasonal variation across different sub-continent with summer being the months of June, July and August in some parts of world while in others they occur during November, December and January. This could lead to bias in the registry database.

A lot of incongruity was observed in documentation of type and severity of injuries. The authors have used variable terminologies such as minor/major, mild/moderate/severe, laceration/abrasion/contusion/avulsion. Certain authors have used Injury severity score (ISS) and few used Lackmann’s classification [48,49]. These classifications did not address the full spectrum of animal attack injuries. There is a need of a globally accepted classification system that will help to make consistent decisions regarding their management also. So, we are hereby proposing a new classification-“Singhal-Sikka Classification of Animal bite injuries” (Tab. V).

There is a need for development and maintenance of an online database for reporting animal inflicted injuries in all the countries of the world. Standardized methods for reporting animal bite are required. Similarly, standardized methods for measuring and reporting animals particularly dog populations are required. The patient registry database should follow a universally accepted animal bite injury reporting form to

### ANIMAL BITE INJURIES REPORTING FORM

Reported by: \_\_\_\_\_ Date: \_\_\_\_\_

**Details of the Victim**

<b>Name</b>		<b>Age</b>		<b>Gender</b>	<input type="checkbox"/> MALE <input type="checkbox"/> FEMALE
<b>Address</b>		<b>Country</b>		<b>Locality</b>	<input type="checkbox"/> Urban <input type="checkbox"/> Rural
<b>Family Characteristics</b>	<input type="checkbox"/> Joint Family <input type="checkbox"/> Nuclear family <input type="checkbox"/> Single parent				
<b>Have the victim or the caregiver ever received education on prevention of animal bite injuries</b>				<input type="checkbox"/> YES <input type="checkbox"/> NO	

**Details of biting animal**

<b>Species</b>	<input type="checkbox"/> Dog <input type="checkbox"/> Cat <input type="checkbox"/> Monkey <input type="checkbox"/> Others <input style="width: 50px;" type="text"/>				
<b>Gender of biting Animal</b>	<input type="checkbox"/> MALE <input type="checkbox"/> FEMALE		<b>Breed of the Animal</b>	<b>Color of the Animal</b>	
	<input type="checkbox"/> Not Known				
<b>Ownership of animal</b>	<input type="checkbox"/> Pet <input type="checkbox"/> Stray <input type="checkbox"/> Wild <input type="checkbox"/> Not Known				
<b>Vaccination status</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> Not Known				
<b>Neuter Status</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> Not Known				
<b>Current Location of the animal</b>	<input type="checkbox"/> Alive and in Quarantine <input type="checkbox"/> Waiting to be tested <input type="checkbox"/> Euthanized <input type="checkbox"/> Unknown				

**Circumstances of the injury**

<b>Date of Incident</b>	/ /	<b>Time of Incident</b>	
<b>Location of incident</b>	<input type="checkbox"/> Own property <input type="checkbox"/> Neighbor/ Relative's property		
	<input type="checkbox"/> Stranger's property <input type="checkbox"/> Street or Public property		
<b>Familiarity of the victim with the biting animal</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> Not Known		
<b>Relationship of the owner of the biting animal(if pet) and the Victim</b>	<input type="checkbox"/> Self <input type="checkbox"/> Parent <input type="checkbox"/> Relative <input type="checkbox"/> Neighbor		
	<input type="checkbox"/> Friend <input type="checkbox"/> No relation <input type="checkbox"/> Not reported <input type="checkbox"/> Other <input style="width: 50px;" type="text"/>		
<b>Behavior of animal leading to the incident</b>	<input type="checkbox"/> Provoked (Playing, Teasing, Feeding) <input type="checkbox"/> Unprovoked		
	<input type="checkbox"/> Sick <input type="checkbox"/> Unknown <input type="checkbox"/> Other <input style="width: 50px;" type="text"/>		
<b>Time lag between the injury and presentation to the emergency services</b>			

**Characteristics of the injury**

<b>Number of wounds</b>	<input type="checkbox"/> Single <input type="checkbox"/> Multiple
<b>Anatomical site(s) involved</b>	<input type="checkbox"/> Head and Neck <input type="checkbox"/> Upper Limb <input type="checkbox"/> Lower Limb <input type="checkbox"/> Torso
<b>Type of tissue(s) affected</b>	<input type="checkbox"/> Skin <input type="checkbox"/> Muscle <input type="checkbox"/> Tendon <input type="checkbox"/> Nerve <input type="checkbox"/> Vascular <input type="checkbox"/> Bone
<b>Classification of Severity of Animal bite injuries</b>	<input type="checkbox"/> Grade I <input type="checkbox"/> Grade II <input type="checkbox"/> Grade III <input type="checkbox"/> Grade IV <input type="checkbox"/> Grade V

**Management**

<b>Has the patient washed wound(s) before coming to hospital?</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO    If yes, how long after exposure <input type="text"/> Agent(s) used <input type="text"/>
<b>Type of facility visited</b>	<input type="checkbox"/> Physician <input type="checkbox"/> Hospital Emergency <input type="checkbox"/> Others <input type="text"/>
<b>Wound(s) Flushed at hospital</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO    If Yes, Agent Used <input type="text"/>
<b>Suturing</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO
<b>Tetanus Prophylaxis given</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO
<b>Anti Rabies post exposure prophylaxis vaccine</b>	Recommended <input type="checkbox"/> YES <input type="checkbox"/> NO    Given <input type="checkbox"/> YES <input type="checkbox"/> NO
<b>Antibiotic therapy</b>	If given which one <input type="checkbox"/> RIG (immunoglobulin) <input type="checkbox"/> Rabies vaccine
	<input type="checkbox"/> YES <input type="checkbox"/> NO    If Yes, Agent Used <input type="text"/> Dose <input type="text"/> Frequency <input type="text"/> Duration <input type="text"/>
<b>Any other treatment Provided</b>	<input type="text"/>
<b>Hospitalization</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO    If Yes, Average duration of stay <input type="text"/>
<b>Wound infection</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO
<b>Permanent scarring (If any)</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO    If Yes, location <input type="text"/>
<b>Permanent disability (If any)</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO
<b>Death</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO
<b>Follow up</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO    If Yes, after how long <input type="text"/>
<b>Psychological counselling</b>	<input type="checkbox"/> YES <input type="checkbox"/> NO

document an incident of animal attack. An animal bite injury reporting form for attending physician ([Checklist 1](#)) and a checklist for the authors while writing a paper on animal bite injuries ([Checklist 2](#)) for accurate compilation is hereby proposed in this article.

## Checklist for the authors while writing a paper on animal bite injuries

### Details of victims

#### Frequency

#### Age range and Mean age

#### Sex ratio

#### Locality: Urban/ Rural

**Family characteristics:** Joint Family/ Nuclear family/ Single parent

#### Case definition

#### Non case definition

### Details of biting animal(s)

#### Species: Dog/ Cat/Monkey/Others

#### Sex ratio of biting animal: Male/ Female/ Unknown

#### Breed of the animal

#### Ownership of animal: Pet/ Stray/ Wild/Unknown

#### Vaccination status of animal: Yes/No/Not known

#### Neuter status: Yes/No/Not known

**Current Location of the animal:** Alive and in Quarantine/ Waiting to be tested/ Euthanized/ Unknown  
Circumstances of the injury

### Location of incident

#### Familiarity of the victim with the biting animal:

Familiar/ Nonfamiliar/ Unknown

#### Owner of the animal: Self/ Parent/ Relative/ Neighbor/

Friend/ No relation/ Not reported/ Other

**Behavior of animal leading to the incident:** Provoked/ unprovoked/Sick/Unknown/Other

#### Most common time of year

#### Most common time of day

**Time lag between the injury and presentation to the emergency services**

### Characteristics of the injury

#### Number of wounds: Single/Multiple

**Anatomical site(s) involved:** Head and Neck, Upper Limb, Lower Limb, Torso

**Type of tissue(s) affected:** Skin/ Muscle/ Tendon/ Nerve/ Vascular/ Bone

**Severity of animal bite injuries:** Grade I/ Grade II/ Grade III/ Grade IV/ Grade V

### Management:

#### Self-toileting of the wound

#### Agents used for self-toileting of wound

#### Wound flushed at the hospital

#### Agent used for wound flushing

#### Suturing

#### Tetanus vaccine

#### Rabies vaccine

### **Antibiotic therapy**

### **Dose, Frequency, Duration**

### **Hospitalization**

### **Average stay**

### **Scarring**

### **Permanent disability**

### **Fatalities**

### **Follow up**

### **Psychological counselling**

**Have the victim or the caregiver ever received education on prevention of animal bite injuries**

## Design priorities in future research

Future research regarding animal bite injuries should follow good methodological standards that will help to provide strong evidence for development of preventive strategies. Studies comparing victims with a control or comparator group should be undertaken. Importance of educational interventions need to be supported and should be area of future research. Educational intervention regarding expected behavior of children in presence of animals and adequate supervision by parents/caregivers should be emphasized. These studies can focus on public awareness about such injuries and importance of timely intervention. Longitudinal prospective studies to establish relationship between behavior of animals and their confounders like their temperament and training may reduce the risk of animal biting trait. Reliable methods for accurate identification of dog breed should be established like an atlas, including photographs as well as size of particular breed need to be developed and validated internationally. Observational studies should follow multivariable analysis to control the effect of confounders. Studies should also identify barriers in implementation of preventive strategies like neutering, avoiding high risk breeds of pets and supervision in household with young children. A Standardized Checklist as proposed in this article for reporting animal inflicted injuries should be followed and validated internationally.

## Why this paper is important?

Children are the most frequent victims of animal bite injuries. These injuries have a deep impact on social and psychological development of children.

Pediatric dentists can play an active role in early diagnosis, initial management and timely referral for proper treatment.

This paper provides an insight how pediatric dentists can impart anticipatory guidance to the patients and their families regarding risk factors of animal bite injuries and the behavioral response in case of an encounter.

## Author contributions

R.S. and N.S. conceived the ideas; R.S. and N.S. collected the data; R.S. and N.S. analysed the data; and R.S., N.S. and R. N. led the writing.

## Conflicts of interest

The authors declare that they have no conflicts of interest in relation to this article.

## Informed consent

As it was a systematic review involving data from previously published scientific literature, informed consent from subjects was not required.

## Ethical committee approval

Since the study involved retrospective collection of data of patients who had already been managed and their identity shall not be disclosed at any point of time, the ethical approval was not obtained.

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