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2 Mental Disorder as a Risk Factor for Dog Bites and Post-bite Cellulitis

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1 **Abstract**

2 **Objectives:**

3 Patients with mental disorders are at an increased risk for sustaining traumatic injury.
4 No study has evaluated the association between mental disorders and the injury of dog
5 bite. We conducted case-control studies to investigate whether people with mental
6 disorders are at elevated risks of dog bite and post-bite cellulitis.

7 **Methods:**

8 Using insurance data of 2000-2007, we compared 4,660 patients with dog bites and
9 18,640 controls without the events for the association with **mental disorders** and other
10 covariates. Among those with dog bites, a nested case-control study was performed to
11 compare 286 patients with post-bite cellulites and rest of 4374 patients for factors
12 associated with the infection.

13 **Results:**

14 Young children, the older adults, and people with low socioeconomic status were at
15 an elevated risk of sustaining the dog bite. In separate logistic regression models
16 adjusting for socio-demographic variables, the results showed that patients with
17 concomitant psychotic and non-psychotic mental disorders were associated with
18 increased risks of dog bites (adjusted odds ratio [OR]: =1.51, 95% confidence interval
19 [CI]: 1.32-1.74) and of post-bite cellulitis (OR = 2.13, 95% CI 1.46-3.10).

20 **Conclusions:**

21 Individuals with mental disorders are likely at an elevated risk for serious dog bites
22 and post-bite cellulitis.

23 **Key words:**

24 Mental disorder, dog bites, cellulitis, socio-economic status, Taiwan
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26

1 **Introduction**

2 Background

3 Recent studies have shown that mental disorders are common in individuals who
4 sustain traumatic injuries.^{31,36} Trauma victims with underlying mental disorders are
5 more likely to have higher rates of mortality and morbidity as well as to incur longer
6 hospital stays and higher hospital costs.^{12,14,36} However, few studies have
7 investigated the importance of mental disorders in commonly encountered other
8 injuries, such as dog bites.^{11,26,28} Animal bites, particularly dog bites, in humans are an
9 important health problem but are often neglected.^{21,27} In the United States, dog
10 bite-related injuries affect 1.5% of the population annually, with an incidence of 13.0
11 bites per 10,000 persons.^{19,34} In Asia, a Bangkok study found that dog bites accounted
12 for around 5.3% emergency room injuries [Bhanganada, 1993 #70]. And the
13 incidence of dog bites is 25.7/1000 population per year in India.[Agarwal, 2004 #91]

14 **Importance**

15 Serious dog bites can result in severe physiological and psychological
16 complications, including post-bite cellulitis, facial disfigurement, neurovascular
17 injuries, musculoskeletal injuries, post-traumatic stress disorder, and even death.^{1,8,28}
18 Thus, the high incidence of dog bite injuries and potential complications justify the
19 need to improve preventive measures and public policy strategies.

20 Several studies have demonstrated that male gender, young age, residence in rural
21 areas, and summer months are associated with a higher incidence of dog
22 bite.^{2,4,6,9,24,29,30,32,34,35} To the best of our knowledge, no study, however, has evaluated
23 the influence of underlying mental disorders on the occurrence of dog bites and
24 post-bite infections. In addition, most descriptive statistics of dog bite-related injuries
25 have been derived from household surveys, hospital-based studies, school-based

1 surveys, and police reports. These studies also have been limited by small sample
2 sizes, representing only specific populations such as children.^{7,11,27,35} Thus, it is
3 necessary to conduct a population-based investigation of dog bite injuries to prevent
4 and manage these injuries and their sequelae.

5 **Objectives**

6 We hypothesized that mental disorders could be an important factor in association
7 with dog bites. This study used the population-based universal insurance claims data
8 to evaluate association between underlying mental disorders and dog bite using a
9 case-control design. We also further conducted, in addition, a nested case-control
10 study to identify whether mental disorders also has a role of post-bite cellulitis.

11

12 **Methods and Materials**

13 **Study design**

14 This study was a retrospective, case-control design using insurance claims data
15 for 1,000,000 insured people randomly selected from the entire 23 million population
16 covered by the National Health Insurance program in Taiwan. We obtained the
17 database from the National Health Research Institutes. The Taiwan Department of
18 Health integrated 13 insurance systems into a universal insurance system in 1995,
19 with more than 96% of the population covered by the end of 1996.¹⁰ The patient
20 information that was recorded in the claims data included personal characteristics and
21 all medical services received from 1996 to 2007. The patient identification numbers
22 were scrambled to safeguard patient privacy and confidentiality for linking data files.
23 This study was thus exempt from ethic approval. In addition to claims data of
24 outpatient and inpatient services, we have retrieved information on patients' date of

1 birth, sex, occupation, and income inferred from their insurance fees, also using
2 scrambled identification..

3 **Selection of study subjects**

4 All diagnoses were coded using the International Classification of Disease, Ninth
5 Revision, Clinical Modification (ICD-9-CM). From the claims data, we identified
6 4660 patients diagnosed with dog bite (ICD-9-CM E906.0) in 2000-2007 as cases.
7 Not all dog bite victims seek care at the clinics, cases diagnosed in this study were
8 more likely “serious” dog bites. In order to achieve greater statistical power and
9 characterize the victims, for each dog-bite victim, four controls without the history of
10 dog bite were randomly selected from the same index year. **Random selection of**
11 **controls allows distinguish differences between the victims and the general insured**
12 **individuals.** Particularly, we also would like to differentiate whether
13 sociodemographic factors were significant covariates associated with dog bites.

14 In the nested case-control design for investigating factors associated with
15 post-bite cellulites, we selected patients with the diagnosis of cellulites from the
16 patients experienced dog bite in 2000-2007 as cases of post-bite cellulites. All rest of
17 patients with dog bite **but not the diagnoses of cellulites** were selected as controls.

18 **Measures**

19 Sociodemographic variables used in this study included sex, age, occupation,
20 urbanization level and income. The age of a case was defined when the event of dog
21 bite occurred, while the age of a control was taken when the control was selected.
22 Blue-collar workers were defined as those with occupations characterized by longer
23 work hours, such as farmers, fishermen, vendors, and industrial laborers. White-collar
24 workers were defined as those with occupations characterized by longer indoor work
25 hours, such as civil services and institution workers, enterprise, business and

1 industrial administration personnel, etc. Other occupations included mainly retired,
2 unemployed, and low income populations. The risk of dog bite may have an urban
3 and rural variation. We calculated population density of each township and city
4 district for the area each study subject resided. All areas were stratified into 4
5 urbanization levels by quartiles. Areas with population densities in the upper two
6 quartiles were the high urbanization area, those in the second lower quartile were the
7 moderately urbanized area, and those in lowest quartile the low urbanized.
8 Interactions between humans and dogs may be different in urban and rural
9 environments. Income was inferred from monthly insurance fees registered with the
10 National Health Insurance program; US \$919.00 was taken as the threshold for higher
11 vs. lower income (1 USD was about 32 Taiwan NTD).

12 We categorized mental disorders into two types: pure psychosis (type I)
13 [ICD-9-CM 290.XX-299.XX, in which X refers to any numeric code ranging from 0
14 to 9] and pure non-psychotic mental disorders (type II) [ICD-9-CM 300.XX-319.XX].
15 The combination of both groups was defined as type III. Post-bite cellulitis was
16 defined as a de novo diagnosis of cellulitis (ICD-9-CM 681.X and 682.X) within one
17 month after sustaining a dog bite.

18 **Data analysis**

19 We compared the sociodemographic and mental disorder status between cases
20 with dog bites and controls. Specific-types of psychosis (ICD-9-CM 290-299,
21 300-308, 309 and 311, 310 and 312-319) were extracted separately from cases and
22 controls. **Multilevel** logistic regression analysis was used to estimate odds ratios (OR)
23 and 95% confidence intervals (CI) of dog bite associated with the 3 types of mental
24 disorders controlling for the sociodemographic variables, including sex, age,
25 occupation, urbanization and income. The OR associated with each specific mental

1 disorder was also estimated using **multilevel** logistic regression analysis controlling
2 for the same sociodemographic variables. The further nested case-control analysis
3 compared mental disorder status between the dog bite victims with vs. without
4 post-bite cellulites. We also used **multilevel** logistic regression analysis to estimate the
5 OR of post-bite cellulites in association with mental disorders controlling for the
6 sociodemographic variables. All analyses were performed with the statistical package
7 SAS for Windows (Version 9.1, SAS Institute Inc., Carey, NC). A P value < 0.05 was
8 taken to represent statistical significance. All tests were two-tailed.

9

10 **Results**

11 Of the 4,660 cases sustained a probably serious dog bite and 18,640 controls, cases
12 were more prevalent to mental disorders than controls (27.2% vs. 22.5%) (Table 1).
13 Those with both psychotic and non-psychotic mental disorders were associated with
14 an adjusted OR of **1.51 (95% CI = 1.32-1.74)**. Males were at higher risk than females
15 to have been bitten. Compared with the 10-29-year age group, children < 10 years
16 were at the highest risk of the injury (**OR = 1.52; 95% CI = 1.35-1.71**), followed by
17 adults 50-69 years old (**OR = 1.32; 95% CI = 1.19-1.46**) and those \geq 70 years old (**OR**
18 **= 1.23; 95% CI = 1.08-1.41**).

19 Table 2 presents the associations between each specific type of mental disorder
20 and dog bite. Patients with underlying anxiety, dissociative, and somatoform disorders
21 were at higher risk of dog bites with an adjusted OR of **1.63 (95% CI = 1.50-1.78)**.
22 Significant risk of dog bite was also observed in patients with alcohol and drug
23 dependence or nondependent abuse of drugs (**OR = 1.33; 95% CI = 1.09-1.63**) and in
24 patients with other special symptoms, not elsewhere classified mental disorders (**OR =**
25 **1.20; 95% CI = 1.07-1.35**).

1 Among all victims, 6.1% (n = 286) had the post-bite cellulitis (Table 3). Compared
2 to dog-bite victims without cellulitis, those with cellulitis were older and more likely
3 to have underlying mental disorders. Risk of infection was the highest for patients
4 with a combination of psychotic and non-psychotic mental disorders (OR = 2.13; 95%
5 CI = 1.46-3.10). Further analysis revealed that patients with schizophrenia had an OR
6 of 2.65 (95% CI = 1.10-6.38) for post-bite cellulitis (data not shown).

7

8 Discussion

9 This study found that people with the underlying combination of psychotic and
10 non-psychotic mental disorders are at an increased risk for dog bite injuries and
11 post-bite cellulitis. In addition, anxiety, dissociative, and somatoform disorders
12 (ICD9-CM: 300) were independent risk factors for dog bite injuries.

13 The association between underlying mental disorders and dog bites has not been
14 fully investigated in previous studies, although attention deficit hyperactivity disorder
15 in children was found to be associated with increased risk for dog bites.²⁶ We
16 observed in patients with pure psychotic mental disorders a lower risk (OR = 0.68,
17 95% C.I.: 0.46-1.00), compared to those without mental disorders. In contrast, those
18 with non-psychotic mental disorders had a 17% higher risk. Clinically, with the
19 exception of episodic mood disorder, most patients with psychotic diseases are
20 characterized by “loss of contact with reality”. Patients with pure psychotic mental
21 disorders may have less opportunities to be in close contact with dogs, they may be
22 thus at lower risk of dog bites. In contrast, patients with non-psychotic mental
23 disorders might keep dogs as pets in order to comfort their moods, particularly
24 patients with anxiety, dissociative, and somatoform disorders. As a result, patients

1 with non-psychotic mental disorders tended to have more exposure to dogs and, hence,
2 at a higher risk of dog bite.

3 Why are patients diagnosed with both psychotic and non-psychotic mental
4 disorders had a 52% increased risk of dog bite in the present study? The greater odds
5 for these patients may originate from the combined effect of episodic mood disorders
6 and anxiety, dissociative, and somatoform disorders, the major components of
7 psychotic and non-psychotic type III mental disorders. However, this hypothesis
8 deserve proved by further investigation. To the best of our knowledge, no previous
9 study has ever identified mental disorders as a risk factor for dog bites.

10 The present study also showed dog bites are sociodemographic status related. Most
11 studies have shown that the incidence of dog bites is the highest in children,
12 particularly those aged 5 to 9 years and 15 to 24 years.^{29,34,35} In our investigation,
13 children less than 10 years old were also at the highest risk for serious dog bites. In
14 addition, the risk of dog bites also seemed to increase with patient's age. Children and
15 the elderly tend to have more contact with dogs, but less ability to physically control
16 dogs or less have a commending presence, thereby increasing the incidence of dog
17 bites.

18 It has been reported that the incidence of dog bites is higher in more rural
19 areas.^{19,22} We also found that blue-collar workers, and people of retired, unemployed
20 or lower incomes were at a higher risk of dog bite. We speculate that the longer period
21 of outdoor work for blue-collar workers is associated with more interactions with
22 dogs.^{3,23} Unemployed persons and low income people in this study are more likely
23 retired senior residents and are less able to control dogs.

24 Broad use of antibiotics and adequate management of bite wounds may reduce
25 infectious complications of dog-bite wounds to less than 5%.^{5,20,25} Most previous

1 studies on dog bite-related infections focused only on tetanus immunization,
2 evaluation for rabies infection, and possible microorganisms in the infected wounds.
3 These studies rarely discussed the epidemiological profiles of victims who suffer
4 infectious complications after the episodes.^{1,6,33} Patients with combined psychotic and
5 non-psychotic mental disorders in this study were more susceptible to infectious
6 complications after dog bites. As we mentioned earlier, episodic mood disorders were
7 the major component of psychotic type III mental disorders. We suspect that patients
8 with underlying episodic mood disorders may be overly optimistic while in an episode
9 of mania and thus may ignore the importance of managing dog-bite wounds.
10 Consequently, these individuals may suffer infectious complications after being bitten.
11 Thus, in order to decrease post-bite cellulitis, health care providers should advise
12 patients to visit clinics for wound management.

13 **Limitations**

14 This study **is** benefited from a large sample, but it is limited by the data provided
15 by insurance claims. The controls selected in this study are essentially similar to
16 clinic-based or hospital-based controls. Therefore, various limitations may arise.
17 **However, these limitations are not fatal to the study.** Patients who suffer minor dog
18 bites may care for their injury themselves without visiting any clinics; the occurrence
19 of total dog bites is thus underestimated. This study was conducted to investigate
20 more likely more events of serious dog bites. Similarly, not all patients with a mental
21 illness seek medical treatment. Those who seek treatment are more likely patients
22 with severer or more unmanageable symptoms. The second limitation is that the age
23 distribution of controls representing the age of general population, while the victims
24 are skewed to young children and older ages. However, the logistic regression
25 analysis showed the risk of post bite infection increased with age. Third, information

1 on human-dog interactions, such as whether the victims are familiar with the dogs that
2 bit them, the scene of the dog-bite incident, and any behaviors that might have
3 provoked the dogs to bite, was not available.^{3,13,22} Studies about the circumstances
4 surrounding serious dog-bite injuries are needed to fully understand injury disparities
5 and to implement prevention programs. In addition, data were also unavailable on the
6 age, sex, body size, and breed of the biting dogs in this study. Several studies have
7 suggested that young, male, large and “dangerous breeds” of dogs are associated with
8 serious dog bite incidence.^{1,7,18,29} An in-depth study into the breeds and characteristics
9 of dogs may generate suggestions for preventing dog bites. Finally, Taiwan has a
10 large, free-roaming dog population, comprising 12% of the island’s total dog
11 population in 2007.¹⁵ These dogs may be dangerous troublemakers.¹⁷ However, we
12 cannot determine the importance of stray dogs in dog-bite incidents in Taiwan based
13 on the findings of this study.

14 **Conclusion**

15 Mental disorders are independent risk factors for both dog bites and post-bite
16 cellulitis. Anxiety, dissociative, and somatoform disorders are more likely associated
17 with higher odds for serious dog bites.

18 **Conflict of interest statement**

19 None of the authors have any financial or personal relationships that could
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Table 1. Comparisons of sociodemographic factors and mental disorders between patients with dog bites and controls (case: control = 1:4)

	Dog bite						Multilevel OR (95% CI) ^a	
	No		Yes		Total			
	n	(%)	n	(%)	n	(%)	OR	(95% CI) ^a
Sex								
Female	9,522	(51.1)	2,224	(47.7)	11,746	(50.4)	1.00	(Reference)
Male	9,118	(48.9)	2,436	(52.3)	11,554	(49.6)	1.17	(1.09-1.25)
Age, years								
<10	1,712	(9.2)	556	(11.9)	2,268	(9.7)	1.52	(1.35-1.71)
10-29	5,473	(29.4)	1,150	(24.7)	6,623	(28.4)	1.00	(Reference)
30-49	6,273	(33.7)	1,372	(29.4)	7,645	(32.8)	1.05	(0.96-1.15)
50-69	3,704	(19.9)	1,119	(24.0)	4,823	(20.7)	1.32	(1.19-1.46)
≥70	1,478	(7.9)	463	(9.9)	1,941	(8.3)	1.23	(1.08-1.41)
Occupation								
White collar	9,773	(52.4)	2,109	(45.3)	11,882	(51.0)	1.00	(Reference)
Blue collar	5,828	(31.3)	1,737	(37.3)	7,565	(32.5)	1.20	(1.10-1.30)
Others ^b	3,039	(16.3)	814	(17.5)	3,853	(16.5)	1.13	(1.02-1.25)
Urbanization								
Low	2,285	(12.3)	699	(15.0)	2,984	(12.8)	1.18	(0.98-1.41)
Moderate	3,550	(19.1)	983	(21.1)	4,533	(19.5)	1.16	(0.96-1.39)
High	12,805	(68.7)	2,977	(63.9)	15,782	(67.7)	1.00	(Reference)
Income (US dollars)								
< 919	15,296	(82.1)	3,965	(85.1)	19,261	(82.7)	1.11	(1.00-1.23)
≥ 919	3,344	(17.9)	695	(14.9)	4,039	(17.3)	1.00	(Reference)
Mental disorders								
None	14,442	(77.5)	3,393	(72.8)	17,835	(76.6)	1.00	(Reference)
Type1(psychosis)	178	(1.0)	30	(0.6)	208	(0.9)	0.70	(0.47-1.04)
Type2 (neurosis)	3,140	(16.8)	904	(19.4)	4,044	(17.4)	1.16	(1.06-1.26)
Type3(combined)	880	(4.7)	333	(7.2)	1,213	(5.2)	1.51	(1.32-1.74)

^aOR (95% CI): odds ratio and 95% confidence interval measured by multivariable logistic regression models, adjusting for all other variables except the target variable;

^bretired, unemployed and low income.

Table 2. Odds ratios and 95% confidence intervals of dog bite associated with specific types of mental disorder controlling for socio-demographic variables

Type of psychosis	(ICD-9-CM code)	Dog bites				Multilevel OR (95% CI) ^a	
		No		Yes			
		n	%	n	%		
Dementia	(290)	220	(1.18)	82	(1.76)	1.04	(0.78-1.39)
Alcohol or Drug-induced mental disorder	(291, 292)	76	(0.41)	24	(0.52)	0.76	(0.47-1.26)
Mental disorder, classified elsewhere	(293, 294)	165	(0.89)	61	(1.31)	1.05	(0.76-1.46)
Schizophrenic disorder	(295)	139	(0.75)	48	(1.03)	1.00	(0.69-1.45)
Episodic mood disorder	(296)	532	(2.85)	215	(4.61)	1.16	(0.96-1.39)
Delusion disorder	(297)	27	(0.14)	12	(0.26)	1.30	(0.62-2.75)
Other non-organic psychosis	(298)	123	(0.66)	43	(0.92)	0.93	(0.63-1.37)
Pervasive developmental disorders	(299)	22	(0.12)	5	(0.11)	0.74	(0.25-2.17)
Anxiety, dissociative, and somatoform disorders	(300)	3,467	(18.6)	1,321	(28.4)	1.63	(1.50-1.78)
Personality disorder	(301)	55	(0.30)	21	(0.45)	0.95	(0.55-1.64)
Sexual and gender identify disorders	(302)	87	(0.47)	36	(0.77)	1.24	(0.82-1.87)
Alcohol and drug dependence, nondependent abuse of drug	(303-305)	420	(2.25)	165	(3.54)	1.33	(1.09-1.63)
Physiological malfunction arising from mental factors	(306)	716	(3.84)	260	(5.58)	1.11	(0.95-1.30)
Other special symptoms or syndromes, not elsewhere classified	(307)	1,443	(7.74)	539	(11.6)	1.20	(1.07-1.35)
Acute reaction to stress	(308)	138	(0.74)	45	(0.97)	0.96	(0.67-1.38)
Adjustment reaction, depressive disorder	(309, 311)	452	(2.24)	175	(3.76)	1.14	(0.93-1.38)
Specified non-psychotic mental disorders due to brain damage	(310)	115	(0.62)	45	(0.97)	1.25	(0.87-1.80)
Disturbance of conduct	(312)	102	(0.55)	26	(0.56)	1.01	(0.64-1.59)
Disturbance of emotions specific to childhood and adolescence	(313)	44	(0.24)	9	(0.19)	0.61	(0.28-1.34)
Hyperkinetic syndrome of childhood	(314)	132	(0.71)	45	(0.97)	1.33	(0.90-1.96)
Specific delays in development	(315)	154	(0.83)	41	(0.88)	0.86	(0.58-1.27)
Psychotic factors associated with disease	(316)	42	(0.23)	19	(0.41)	1.26	(0.70-2.28)
Mental retardation	(317-319)	92	(0.49)	25	(0.54)	1.00	(0.62-1.63)

^aOR (95% CI): odds ratio and 95% confidence interval.

Table 3. Odds ratios and 95% confidence intervals of post-bite cellulitis after dog bites associated with mental disorders controlling for socio-demographic variables

	Post-bite Cellulitis					
	No N=4,374		Yes N=286		Multilevel	
	n	(%)	N	(%)	OR	(95% CI) ^a
Sex						
Female	2,074	(47.4)	150	(52.5)	1.00	(Reference)
Male	2,300	(52.6)	136	(47.5)	0.91	(0.71-1.95)
Age, years						
<10	533	(12.2)	23	(8.0)	1.00	(Reference)
10-29	1,094	(25.0)	56	(19.6)	1.18	(0.71-1.95)
30-49	1,291	(29.5)	81	(28.3)	1.41	(0.86-2.30)
50-69	1,029	(23.5)	90	(31.5)	1.78	(1.08-2.92)
≥70	427	(9.8)	36	(12.6)	1.52	(0.86-2.68)
Occupation						
White collar	2,005	(45.8)	104	(36.4)	1.00	(Reference)
Blue collar	1,610	(36.8)	127	(44.4)	1.27	(0.93-1.72)
Others ^b	759	(17.4)	55	(19.2)	1.18	(0.82-1.69)
Urbanization						
Low	650	(14.9)	49	(17.1)	1.16	(0.76-1.76)
Moderate	928	(21.2)	55	(19.2)	1.00	(Reference)
High	2,795	(63.9)	182	(63.6)	1.15	(0.82-1.62)
Income (NTD)						
<30,000	3,709	(84.8)	256	(89.5)	1.37	(0.89-2.12)
≥30,000	665	(15.2)	30	(10.5)	1.00	(Reference)
Mental disorders						
None	3,211	(73.4)	182	(63.6)	1.00	(Reference)
Type1 (psychoses)	28	(0.6)	2	(0.7)	1.19	(0.28-5.12)
Type2 (non-psychotic)	844	(19.3)	60	(21.0)	1.07	(0.77-1.47)
Type3 (combined)	291	(6.7)	42	(14.7)	2.13	(1.46-3.10)

^a OR (95% CI), odds ratio and 95% confidence interval measured by multivariable logistic regression models; adjusting for sex, age, occupation, urbanization and income.

^bretired, unemployed and low income.