

BMJ Open Characteristics and factors associated with post-exposure prophylaxis (PEP) treatment of dog and cat bites among left-behind children: a cross-sectional study in two cities of China

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ABSTRACT

Objective Animal injury is a significant cause of morbidity and mortality worldwide. Dog bites account for tens of millions of injuries annually and the highest risk is among children. However, children may not receive postexposure prophylaxis (PEP) treatment timely and appropriately after rabies exposure. This study aimed to investigate the characteristics and factors associated with PEP treatment of dog and cat bites among left-behind children.

Design A cross-sectional study using questionnaire was conducted in primary and high schools.

Setting Shenzhen and Shantou cities, Guangdong Province, China.

Participants A total of 9380 participants were included and 2236 of them were with a history of dog and cat bites.

Results 1188 (53.1%) boys and 1048 (46.9%) girls suffered from animal bites. Bitten in holidays was less likely to receive PEP treatment (OR 0.512, 95% CI 0.377 to 0.695) than those bitten in school days. Bitten while being with family (OR 1.418, 95% CI 1.040 to 1.934) and bitten at roadside (OR 1.842, 95% CI 1.297 to 2.171), bitten by unvaccinated animals (OR 1.745, 95% CI 1.246 to 2.443) tended to receive PEP treatment. Compared with unbroken skin, bleeding (OR 1.789, 95% CI 1.165 to 2.745) and laceration (OR 3.834, 95% CI 2.310 to 6.366) were showed as treatment prompting factors.

Conclusions Bitten in holidays was found as a risk factor of receiving PEP treatment of animal bites. Certain measures should be taken to raise left-behind children's awareness of receiving PEP treatment timely and appropriately after dog and cat bites.

INTRODUCTION

Animal bites are common worldwide, which remains a serious public health problem. In the USA, 200 per 100 000 persons are estimated to suffer from animal bites each year.¹ In Germany, the incidence of bites is 30 000–50 000 injuries per year.² Rabies is preventable yet it is responsible for roughly 59 000 deaths per year.³ A study estimates that globally canine rabies causes ~59 000 human deaths, over 3.7 million disability-adjusted

Strengths and limitations of this study

- Our study focused on left-behind children which was a vulnerable group.
- Our study was the first of its type to investigate the characteristics and factors associated with post-exposure prophylaxis treatment of dog and cat bites among left-behind children in Shenzhen and Shantou cities, China.
- Response bias may be present, and limit generalise to represent the overall population of China.

life years and US\$ 8.6 billion economic losses annually.⁴ Reports in the USA show that >350 000 people are treated for bites in emergency departments each year, a significant number of whom are hospitalised, require long-term drug treatment and undergo surgical procedures.^{5 6} Infections are the most common complications after a bite and the treatment of bite wounds is usually inappropriate and delayed; thus, the risk of acute infection and sequelae has increased.⁷ Timely post-exposure prophylaxis (PEP) treatment is necessary in order to reduce the risk of infections.

Dog bites account for tens of millions of injuries annually and the highest risk is among children.⁸ In China, many parents work outside and leave their children at home. Since the end of November 2016, the number of left-behind children under the age of 16 years was 9.02 million.⁹ Studies reveal that left-behind children suffered more mental health problems and psychological well-being neglect.^{10 11} Interaction with dogs could enhance people's physical and psychological health, promote a social support network between dog owners¹² and create greater self-esteem, promote more exercise and reduce loneliness.¹³ Pet ownerships are

most frequently observed in families with children, which may play an important role in animal injuries.

Given the unique social and cultural background of China, better understanding and identifying the factors associated with PEP treatment of dog and cat bites are important in left-behind children. Shenzhen (a well-developed city) and Shantou (a developing city) are two different-sized cities and their economies differ from each other. Up to now, no research has been conducted to investigate the characteristics and factors associated with PEP treatment in animal bites related injuries in the two cities. Our study, therefore, aims to investigate and explore the characteristics and factors associated with PEP treatment of dog and cat bites in left-behind children in two cities of China.

METHODS

Study setting and its features

Shenzhen and Shantou are two different-sized cities and their economies differ from each other. The two cities were chosen as study locations for the following reasons: on the one hand, their gross domestic products and populations vary evidently, which might play a significant impact on PEP treatment of dog and cat bites; on the other hand, Shenzhen, as one of the top four megacities and the first special economic zone in southern China, is a well-developed city and is adjacent to Hong Kong, with its population of 11.91 million; conversely, Shantou, as one of the seven special economic zones in eastern China, is

a developing city with its population of 5.58 million.¹⁴ In addition, Shenzhen is an economically developed area, and the government in Shenzhen attaches great importance to education. What is more, in terms of owning a dog, there are written rules on dog raising management made by Chinese government policies that are similar in both Shenzhen and Shantou cities.¹⁵ First, residents of both cities are required to register and have their dogs vaccinated against rabies by an authorised agency, otherwise they are fined and even their dogs will be confiscated. Second, if a dog hurts someone, the dog owner should immediately send the victim to a hospital for diagnosis and receiving PEP treatment, pay the medical expenses and bear the corresponding civil liability according to law. More information about the two cities is shown in table 1.

Study design and data source

In April 2015, a cross-sectional study was conducted on all dog and cat bite cases among left-behind children (aged 6–19 years) residing in two cities (Shenzhen and Shantou) of Guangdong province, southern China. A multistage random sampling method was used to ensure the reliability and representativeness of the data collection. First, 7 schools (including 3 primary schools, 2 junior high schools and 2 senior high schools) in Shenzhen and 10 schools (including 3 primary schools, 4 junior high schools and 3 senior high schools) in Shantou were selected randomly. Second, of all the selected schools, students in grades 1–11 were invited to fill in a self-designed questionnaire that included personal information (age, gender,

Table 1 Characteristics of the study population in a sample of 9380 in Shenzhen and Shantou cities, China and city statistic information

Characteristics	Total (n=9380)			Shenzhen (n=4967)			Shantou (n=4413)		
	n (%)	No of bitten	Prevalence	n (%)	No of bitten	Prevalence	n (%)	No of bitten	Prevalence
Gender									
Boy	4739 (50.5)	1188	0.25	2681 (54.0)	728	0.27	2058 (46.6)	460	0.22
Girl	4641 (49.5)	1048	0.23	2286 (46.0)	562	0.25	2355 (53.4)	486	0.21
Age (years)									
6~	1876 (20.0)	294	0.16	1272 (25.6)	217	0.17	604 (13.7)	77	0.13
10~	2053 (21.9)	612	0.30	1349 (27.2)	458	0.34	704 (16.0)	154	0.22
13~	2898 (30.9)	792	0.27	1387 (27.9)	427	0.31	1511 (34.2)	365	0.24
16–19	2553 (27.2)	538	0.21	959 (19.3)	188	0.20	1594 (36.1)	350	0.22
Grade									
Primary school	3812 (40.6)	886	0.23	2437 (49.1)	639	0.26	1375 (31.2)	247	0.18
Middle school	2672 (28.5)	776	0.29	1238 (24.9)	424	0.34	1434 (32.5)	352	0.25
High school	2896 (30.9)	574	0.20	1292 (26.0)	227	0.18	1604 (36.3)	347	0.22
Population (million)				11.91			5.58		
City statistics*				Area (km ²)			2199.04		
				GDP (billion ¥)			208.097		

*2017 Statistical yearbook.¹⁴

GDP, gross domestic products.

Table 2 Recommended PEP for rabies infection

Category of exposure to suspect rabid animal	Post-exposure measures
Category I—touching or feeding animals, licks on intact skin (ie, no exposure)	None
Category II—nibbling of uncovered skin, minor scratches or abrasions without bleeding	Immediate vaccination and local treatment of the wound
Category III—single or multiple transdermal bites or scratches, licks on broken skin; contamination of mucous membrane with saliva from licks, exposures to bats.	Immediate vaccination and administration of rabies immunoglobulin; local treatment of the wound

PEP, post-exposure prophylaxis.

personality, grade, parents' education, average monthly income and others) and animal injuries experiences (injured part, place where the injury happened, severity of wound, vaccination status of involved animal, PEP treatment and others). They completed their questionnaires with the help of trained investigators in the classroom. All questionnaires were collected in the classroom and were checked immediately to assure its accuracy and completeness. Before the launch of a formal investigation, our preliminary investigation showed a good reliability and correlation coefficient between 0.786 and 0.851 ($p < 0.01$). Written informed consent forms were got from students' parents in advance.

Definition

Left-behind children were defined as those who stay in their hometowns while one or both parents work away from home for at least 6 months.¹⁶ In our study, the type of involved animals only meant dogs and cats. In addition, PEP was the abbreviation of post-exposure prophylaxis. For the purpose of our study, receiving timely PEP was defined as the initiation of prevention and treatment measures of category II and III exposure to suspect rabid animal ≤ 24 hours after animal bites.¹⁷ The recommended PEP depends on the category of exposure to suspected or confirmed rabid animals (table 2).¹⁸

Statistical analyses

Data were analysed by SPSS V.19.0 software. Descriptive analysis was applied to describe the characteristics of the two cities. In addition, differences between age, gender, personality, grade, parents' education, average monthly income, city, ownership of involved animal, vaccination status of involved animal, severity of wound, injured body part, companionship, place where the injury happened and PEP treatment were also analysed. All variables in our study were categorical variables. χ^2 test was used as a univariable analysis to test the associations of factors with PEP treatment of dog and cat bites in the two cities. Once the variables were identified, a binary logistic regression analyses, using forward stepwise regression with the criteria of $p < 0.05$ for entry and $p < 0.10$ for removal, was performed to control the potential confounding factors so as to assess which independent variables may explain the likelihood of a victim receiving PEP treatment. PEP

treatment, a binary variable, was considered as the dependent variable in the binary logistic regression model. OR and 95% CI were used to evaluate the associations between the factors and PEP treatment. A two-tailed $p < 0.05$ was adopted to indicate statistical significance.

Patient and public involvement

No patients or public were involved in the recruitment to or conduct of the study. The results of this study were not disseminated to the study participants but have informed the management department of involved schools.

RESULTS

Demographic and injury characteristics of the study population, as well as the number of bitten children by animal in Shenzhen and Shantou, were shown in tables 1 and 3, respectively. The study population included 9380 participants from the two cities, of which 2236 left-behind children (1290 in Shenzhen and 946 in Shantou) aged 6–19 years were included in all analyses, with a history of animal bites. The sample contained 1188 boys (53.1%) and 1048 (46.9%) girls, and the boy to girl gender ratio was 1.13 in the injury population. The median age of victims was 16 in Shenzhen compared with 14 in Shantou. In Shenzhen, most injuries occurred in primary school (49.5%, $n=639$), while in Shantou middle school had the large proportions (37.2%, $n=352$).

The result of univariable analysis about PEP treatment of animal bites was presented in table 3. There were significant differences in the PEP treatment among certain age groups, monthly income, city, vaccination status of involved animal, severity of wound, injury time, injured part, place, ownership and companionship. There were no significances in gender, personality and parents' education level.

After using multivariate logistic regression analysis (shown in table 4), we found that injury time was a risk factor of receiving PEP treatment of animal bites among left-behind children. Among the victims, those bitten in holidays were less likely to receive PEP treatment (OR 0.512, 95% CI 0.377 to 0.695) than those bitten in school days. Children who were with their family members tended to receive PEP treatment after an animal bite,

Table 3 Univariable analysis about PEP treatment of animal bites among left-behind children (n=2236) (Y=treatment, N=no treatment)

Variables	PEP treatment		χ^2	P value
	Y (n/%)	N (n/%)		
Gender				
Boy	182 (15.8)	969 (84.2)	0.012	0.913
Girl	160 (16.0)	841 (84.0)		
Age (years)				
6~	38 (13.8)	238 (86.2)	9.652	0.022
10~	91 (15.3)	504 (84.7)		
13~	109 (14.2)	656 (85.8)		
16~19	104 (20.2)	412 (79.8)		
Personality				
Introversion	59 (18.2)	265 (81.8)	4.403	0.111
Normal	170 (14.4)	1013 (85.6)		
Extroversion	103 (17.4)	488 (82.6)		
Father's education level				
Primary school or less	51 (16.9)	250 (83.1)	4.006	0.261
Middle school	144 (16.1)	751 (83.9)		
High school	101 (17.4)	481 (82.6)		
University or above	34 (12.2)	245 (87.8)		
Mother's education level				
Primary school or less	93 (17.4)	443 (82.6)	1.360	0.715
Middle school	127 (15.3)	704 (84.7)		
High school	72 (15.8)	385 (84.2)		
University or above	32 (14.6)	187 (85.4)		
Monthly income*				
Low	233 (17.7)	1035 (82.3)	7.049	0.029
Average	71 (12.8)	483 (87.2)		
High	34 (15.1)	191 (84.9)		
City				
Shenzhen	164 (13.2)	1081 (86.8)	16.344	<0.001
Shantou	178 (19.6)	729 (80.4)		
Vaccination status of involved animal				
Yes	78 (12.0)	570 (88.0)	12.987	0.002
No	118 (19.4)	490 (80.6)		
Unknown	1421 (16.5)	721 (83.5)		
Severity of wound				
Skin unbroken	210 (17.9)	962 (82.1)	43.034	<0.001
Bleeding	53 (9.4)	513 (90.6)		
Laceration	20 (11.0)	162 (89.0)		
Other	54 (26.9)	147 (73.1)		
Injury time				
School days	87 (22.5)	299 (77.5)	15.333	<0.001
Holidays	239 (14.4)	1417 (85.6)		
Ownership				

Continued

Table 3 Continued

Variables	PEP treatment		χ^2	P value
	Y (n/%)	N (n/%)		
Family's	153 (19.5)	632 (80.5)	13.066	0.004
Other family's	124 (13.7)	784 (86.3)		
Stray	30 (12.5)	210 (87.5)		
Other	33 (16.0)	173 (84.0)		
Injured part				
Hand	192 (20.3)	753 (79.7)	29.992	<0.001
Lower limbs	88 (11.5)	679 (88.5)		
Head/neck	10 (10.5)	85 (89.5)		
Trunk	35 (12.4)	247 (8.6)		
Companionship				
Alone	190 (19.8)	770 (80.2)	21.191	<0.001
Family	91 (14.4)	541 (85.6)		
Others	60 (11.1)	481 (88.9)		
Place				
Own home	165 (20.8)	630 (79.2)	24.523	<0.001
Roadside	75 (12.4)	528 (87.6)		
Public place	27 (12.6)	187 (87.4)		
Animal's home	47 (12.5)	329 (87.5)		
Other	24 (16.8)	119 (83.2)		

Please note that there were different missing data in different variables but the ratio of missing values was <20% of the whole participants.

*Monthly income: low means <5000¥, average means 5000–10 000¥, high means >10 000¥.

PEP, postexposure prophylaxis.

compared with those being alone (OR 1.418, 95% CI 1.040 to 1.934). In addition, compared with those bitten at their own home, those bitten at roadside were inclined to receive PEP treatment (OR 1.842, 95% CI 1.297 to 2.171). Further, among severity of wound group, compared with skin unbroken, bleeding (OR 1.789, 95% CI 1.165 to 2.745), laceration (OR 3.834, 95% CI 2.310 to 6.366) and others (OR 2.752, 95% CI 1.436 to 5.276) were shown as treatment prompting or protecting factors. As for injured part, left-behind children tended to receive PEP treatment if they hurt their lower limbs (OR 1.777, 95% CI 1.304 to 2.423) and trunks (OR 1.691, 95% CI 1.092 to 2.619) by a dog or a cat, compared with hurt their hands. If left-behind children were bitten by unvaccinated animals, they would be likely to receive PEP treatment (OR 1.745, 95% CI 1.246 to 2.443).

DISCUSSION

To our knowledge, ~99% of human rabies cases are resulted from dog bites and, once the symptoms of rabies emerge, the disease is almost inevitably fatal.¹⁹ Animal bites are fatal causes of morbidity and mortality around the world, but it can be prevented by timely and appropriate PEP treatment.²⁰ It is needless to say that the quality

Table 4 Multivariate logistic regression analyses of PEP treatment of animal bites among left-behind children

Variables	OR (95% CI)	P value
Injured part		
Hand	1.000	
Lower limbs	1.777 (1.304 to 2.423)	<0.001
Head/neck	2.045 (0.985 to 4.246)	0.055
Trunk	1.691 (1.092 to 2.619)	0.019
Companionship		
Alone	1.000	
Family	1.418 (1.040 to 1.934)	0.027
Others	1.898 (1.328 to 2.716)	<0.001
Place		
Own home	1.000	
Roadside	1.842 (1.297 to 2.171)	0.001
Public place	1.439 (0.868 to 2.386)	0.158
Animal's home	1.221 (0.829 to 1.797)	0.313
Other	1.716 (0.936 to 3.145)	0.081
Injury time		
School days	1.000	
Holidays	0.512 (0.377 to 0.695)	<0.001
Severity of wound		
Skin unbroken	1.000	
Bleeding	1.789 (1.165 to 2.745)	0.008
Laceration	3.834 (2.310 to 6.366)	<0.001
Other	2.752 (1.436 to 5.276)	0.002
Vaccination status of involved animal		
Yes	1.000	
No	1.745 (1.246 to 2.443)	0.001
Unknown	0.902 (0.663 to 1.228)	0.514

Because the variables were not significant in the univariable analysis form or had a p value of >0.05, they were not included in multivariate logistic regression form.

OR <1 meant the variable is a risk factor of receiving PEP treatment, that was to say, left-behind children would be less likely to receive PEP treatment after exposure to an animal bite. PEP, post-exposure prophylaxis.

of the initial medical care received by the victims has a significant impact on the long-term function and quality of their lives.

Most studies conducted in different countries showed that most animal bites occurred in males^{21–24} which was in concordance with the results of the present study. That is to say, compared with girls, boys had a higher likelihood of being injured by animals, which could be explained by the fact that boys were more active, extroverted and adventurous than girls. Animal bite prevention should continue to target all children and their family, particularly in boys, and must also include parents to reduce the risk of bites for children.²⁵

Several researches conducted in different countries revealed that the majority of animal bites, particularly when dogs were involved, were suffered by children.^{6 23 26} More and more families keep dogs as pets. Pets were considered as having potential roles in children's social networks and were often ranked higher than certain kinds of human relationship, and they featured prominently as providers of comfort, esteem support and confidantes for a secret.²⁷ In our study, compared with school days, if children suffered from animal bites during holidays, they were not inclined to receive PEP treatment. As we know, during school days, the teachers would take the students exposure to animal bites to emergency department or outpatient clinic to receive PEP treatment. However, when not at school, left-behind children, brought up by grandparents or having poor economic status, bad relationship and low frequency of communication with parents, were prone to encounter more loneliness.¹⁰ Thus, without parents' supervision and care, they might tend to interact and play with animals, which increased the chance of animal bites injury. Children are more vulnerable to animal bites for they often provoke animals without recognising the emotions or behavioural signals of animals.^{28 29}

This indicates that teaching children how to appropriately interact with animals when they are alone would be a critical component of preventing this kind of animal bites. What is more, in another study,³⁰ dogs owned by the victim were more than twice as likely to be responsible for bites. Understanding which place may be most likely to pose the greatest risk for animal bites allows children to take preventive actions before severe bite incidents with tragic outcomes occur. Particularly, left-behind children are unable to obtain adequate and timely care due to personal or financial reasons, which makes them be more vulnerable to psychological problems or physical injuries in their long-term personal development.^{31 32} Our study showed that left-behind children were likely to receive PEP when with their family members or others. All above, the most practical and direct way is that children should keep their guardian informed in the initial stage after a bite and be sent to receive timely and appropriate PEP treatment. Raising left-behind children's awareness of receiving PEP treatment after exposure to animal bites is extremely urgent.

Severity of wound was an influential factor associated with PEP treatment. The result of the present study was consistent with other studies.^{22 24} As for injured part, our study showed that it was also a potential factor. Left-behind children would likely to receive PEP treatment when they got their lower limbs or trunk injured. This may possibly due to these body parts were severely injured. A bite can transmit unusual pathogens from the saliva into the wound. The risk of infection after bitten by animal is about 10%–20%, and 30%–60% of the infections are of mixed aerobic–anaerobic origin.² The size of wounds is critical because, particularly when it is >3 cm, the risk of infections significantly increases.³³ Another study²¹ found 35.0% reduction in the risk of delay PEP treatment

in the case of deep wounds. That was probably because participants who had deep wounds visited emergency department or outpatient clinic to seek for standard management and receive antirabies treatment as soon as possible. A bite that appears harmless on the surface may involve clinically significant tissue injury in the depths of the wound, thus, it is crucial to take proper PEP treatment in time.

The medical, psychological and socioeconomic consequences of rabies have an extensive impact on individuals, families and communities. Animal bite victims often underestimate the seriousness of smaller injuries. There is a potential rabies exposure from any scratch or bite wounded by an animal that may be infected through animal's saliva. In fact, animal bites are preventable injuries. Pre-exposure rabies prophylaxis is safe and immunogenic.³⁴ The general management of bites is no difference from that usually recommended for wounds of any origin.⁷ For example, teaching children or their guardian to wash the site of bite vigorously with water and soap but the margins of puncture wounds should be excised and left open, whereas those of other wounds should be carefully excised and closed. Healthcare providers should be educated on the appropriate management of dog bites. Health authorities and policymakers should ensure rabies control within dog populations, ensure appropriate supplies of rabies vaccines for potential rabies exposure in people and develop data collection systems to further document the burden of this problem.

There are some limitations in our study. First, all collected information was based on self-reported questionnaires, therefore potential response bias may be present. Second, perhaps some students were not report their exposure to dogs or cats for fearing that they would be blamed or punished when their parents or teachers knew their real experiences. Consequently, we may underestimate the rate of dog or cat bites. Third, only two cities were as study settings in our study. Therefore, the results of the present research may not be generalised to represent the overall population of China. Despite these limitations, the current study demonstrated the characteristics and factors associated with PEP treatment of dog and cat bites among left-behind children in the cities of China. Initiating PEP treatment immediately after exposure to an animal bite is highly effective in preventing rabies. Certain measures should be taken to raise left-behind children's awareness of seeking care for PEP treatment such as going to emergency department or outpatient clinic for standard treatment after a bite.

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