

Should I Get Rabies Vaccines? Rethinking Rabies Vaccine Awareness Among Beijing's High Schoolers

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ABSTRACT

The author conducted a questionnaire survey among students in grades 9-12 in Beijing in March 2024 to understand their knowledge about rabies and rabies vaccines. Analyzing 421 valid questionnaires, this research made some important findings. First, about 60% of students have the experience of raising cats or dogs. Second, 25.7%, 11.4%, and 8.6% of the students or their family members were scratched or bitten by their own, neighbors' and unknown sources of cats or dogs, respectively. Third, while about 65% of victims choose to go to a hospital, one in six victims of scratches and bites from dogs or cats of unknown origin do not seek medical attention. Fourth, of 72 cases of scratches and bites from their own pets who had been regularly vaccinated, 46 chose to seek medical attention, and 38 (82.6%) of these cases were recommended to get vaccines and finally followed the doctor's advice. These results suggest that for rabies and rabies vaccines, not only do many students have the Type 1 Lack of Awareness (T1_LA), that is, they think they should not be vaccinated when they should be vaccinated, but also many students have the Type 2 Lack of Awareness (T2_LA), that is, they think they should be vaccinated when they should not be vaccinated. Hence, to effectively prevent rabies and the abuse of rabies vaccines, the whole society should not only strengthen the dissemination of relevant knowledge but also improve relevant public health policies.

Introduction

Stylized Facts About Rabies and Rabies Vaccine

Rabies is a deadly disease caused by a Mononegaviruses RNA virus that is mainly carried and transmitted by cats or dogs. Humans who don't receive treatment in time and start showing explicit symptoms are shown to have approximately 100% mortality. Post-exposure prophylaxis (PEP) of rabies includes immediate wound cleaning, receiving human rabies vaccines, and human rabies immune globulin (HRIG), with a 10-day observation period. If timely and correct treatments are taken, PEP is highly effective for rabies patients who receive it immediately after exposure with a survival rate above 99% (Ahmad et al., 2022).

In the past years, the world has been paying high attention to rabies and has taken a series of disease-controlling actions. In 2018, the World Health Organization (WHO, 2018) launched a global campaign "Zero by 30", aiming to achieve zero human deaths from dog-mediated rabies by 2030.

Rabies in China

Being greatly affected, China has already put great effort into rabies control. The government has employed surveillance, epidemiological analysis, strategic planning, etc. (Feng et al., 2020; Cai et al., 2021; Chen et al., 2021). With these efforts, the rabies incidence rate has exhibited a downward sloping trend, and only 157 rabies cases were reported in China in 2015 (Zhang et al., 2023). However, the problem remains serious for practical reasons.

Rabies Exposure Rate

With China's rapid economic growth and demographic changes, more and more families are keeping pets, resulting in a drastic increase in the number of pet dogs and cats over time. According to *China Pet Industry White Paper 2023-2024 (Consumption Report)*, in 2023, there will be approximately 120 million pet dogs and cats in total, leading to an increase in stray pets at the same time. These stray animals became potential carriers of rabies. Due to frequent interactions between stray animals and domestic dogs and cats, the likelihood of rabies-infected animals passing the disease to the household increases.

Canine Rabies Vaccination

Research has shown that, since 1949, dog-mediated transmission is a major source of infection for humans, specifically, 99% of human rabies cases are transmitted by dogs (Hu et al., 2009; Shen et al., 2023). For domestic dogs, dog owners are legally required to have official identification, rabies vaccination, and other implemented dog ownership rules (Beijing Municipal Government, 2023). However, the government's less rigid control over implementing related policies according to a summary of animal rabies in China, provides a chance for people to exploit loopholes in laws to avoid getting an official ID (Tu et al., 2018). For unregistered and stray pets, in contrast with some health-care-developed countries, the Chinese government has relatively low control over their vaccination (Zhang et al., 2017).

The target of >75% canine rabies vaccination coverage hasn't been achieved by 2023 due to high vaccine costs, lack of awareness, and insufficient veterinary resources (Shen et al., 2023). The vaccination coverage rate in dogs is overall below 70% for dogs in China according to Shen et al, and it varies significantly ranging from around 0% to 90% according to Shen et al. and past research.

Human Vaccination

Accordingly, the need for human vaccination after exposure increases. In fact, in 2020, China became the highest human rabies vaccination country with the demand for PEP rising dramatically to 15 times higher than two decades ago (Shen et al., 2023).

Drawbacks of the Human Rabies Vaccine

Far from a perfect treatment, the Rabies vaccine has its drawbacks, including its potentially severe side effects on the human body and high cost.

According to the CDC and Children's Hospital in Philadelphia (CHOP), although it is not very likely to cause death, the human rabies vaccine is likely to cause severe side effects that could affect one, especially health conditions, including short-term sore arms, nausea, vomiting, and dizziness, and long-term immune diseases (CHOP, 2022).

Besides, as a Category 2 vaccine in China, recipients must pay the full price for the human rabies vaccine. Apart from multiple hospital visits, completing the five-shot course of PEP rabies vaccines entails costs ranging from 500 to 2500 RMB, varying between domestic and imported vaccine prices (Chen, 2023). Additionally, the cost of HRIG amounts to approximately 1,200 RMB for a 60-kilogram individual (Li, 2023). Considering 600 million people in China earn around 1000 RMB only per month (Li Keqiang, 2020), such costs can represent a substantial financial challenge for many individuals.

Considering these factors, people would be advised to avoid taking the rabies vaccine when proven there is no need. Therefore, people should be equipped with a correct understanding of the disease and vaccine and make thoughtful choices on vaccination based on their understanding of the topic and personal situation.

Related Research and Gaps in the Literature

Lack of Awareness

Lack of awareness of rabies and rabies vaccine remains a huge problem in China, especially severe in rural areas. According to a survey of three middle schools in rural Guangxi, only 12.01% understand the risk of people being exposed to rabies (Yang et al., 2022). Lack of awareness is attributed to a variety of factors, such as education level and experience of pet keeping and risk of rabies exposure in animal interactions.

According to the WHO Expert Consultation on Rabies (WHO, 2013), rabies exposure can be categorized into three levels:

- I. Touching or feeding animals; Licks on intact skin; Contact of intact skin with secretions or excretions of a rabid animal or human case.
- II. Nibbling of uncovered skin Minor scratches or abrasions without bleeding.
- III. Transdermal bit(es) or scratch(es), licks on broken skin; Contamination of mucous membrane with saliva (i.e. licks); Exposure to bats.

According to this categorization, and other information in the WHO guidebook (WHO, 2013), people at the II and III levels need to receive rabies vaccine for PEP immediately and apply the 10-day observation method. Additionally, people with the III exposing level need human rabies immune globulin (HRIG) immediately after wound cleansing. According to WHO, people who are bitten or hurt with skin damage by not their dog or cat are at risk of exposure to rabies, especially by dogs or cats with unknown health conditions. Due to the almost uniform fatality, these people require human vaccines. Meanwhile, there is no PEP needed for someone with exposure levels if a reliable case history is available. This provides an implication for this research that people bitten or hurt by vaccinated household dogs and cats, especially those vaccinated regularly, and with unobvious wounds, do not need to be vaccinated, if they are aware enough and the doctors are reliable.

Hence, the lack of awareness of rabies and rabies vaccines can be regarded as when people cannot correctly seek health care due to a lack of information or strong personal beliefs. It can be separated into two types, and in this research, we define them to be:

- Type 1 of Lack of Awareness (T1_LA): When they should receive vaccines, people mistakenly believe that no medical attention is necessary.
- Type 2 of Lack of Awareness (T2_LA): When they should not receive vaccines, people demand a vaccination incorrectly.

Most of the existing literature revolves around T1_LA, stressing the importance of receiving rabies vaccines after experiencing a risk of rabies exposure. However, T2_LA may be as or more common in China. Considering that rabies vaccine manufacturers can gain high profits by selling rabies vaccines, T2_LA could lead to a series of complex bad consequences. For example, there exists a disproportionately high human rabies vaccination rate in China so most vaccines might be taken by those who do not need them (Wang et al., 2019).

Hypothesis

Based on the above information, there are three basic hypotheses in this research.

1. H_1 : The assumptions of situations in China are validated, including high pet keeping, human-animal interaction, and human vaccination rates.
2. H_2 : Not only do many people have T1_LA, but also many, even more people have T2_LA in China.
3. H_3 : Relevant medical institutions are likely to misuse vaccines to take advantage of a widespread T2_LA in China.

Research Design and Methodology

Aim Population

The target population of this study was 9th to 12th graders in Beijing, China.

Beijing

Many rabies cases are reported from rural areas in China, and existing research analyzed potential contributing factors, for example, education level, financial support, and awareness. It is worth researching how people with relative higher education levels and other identified factors are involved in the decision-making within a well-developed city like Beijing.

The extremely high vaccination rate within China suggests that in more developed areas, not in rural areas where people are comparatively much less aware of getting vaccines, vaccination rates are higher for dogs and cats. Therefore, people in large cities are likely to over-vaccinate, which can only be explained by the fact that for them, the benefit outweighs the cost. Beijing, as one of the most educated and economically developed cities in China, is representative of these big cities, making it one of the favored areas where this research can be conducted.

High School Students

High schoolers are the best-fitting aim population for this research. Firstly, compared to adults, high schoolers are less careful when interacting with animals, raising the likelihood of adolescents' exposure to diseases such as rabies. Second, compared to younger children, high schoolers have independent thinking distinct from their parents. Studies, such as those conducted in Malawi, have shown that educational interventions significantly improve knowledge and attitudes towards rabies among younger students (Burdon Bailey et al., 2018). This suggests that similar educational approaches could be effective for different age groups, including high school students. Thirdly, they are also recipients of the latest education, making them ideal subjects for understanding the current rabies and rabies vaccine awareness in China. By studying high school students in Beijing, we can better understand their level of knowledge and awareness and guide future educational programs to prevent rabies.

Investigation Methods and Quality Control

Survey Design

The questionnaire is based on relevant literature and the purpose of this study. Survey design refers to the survey used by a study on rabies and rabies vaccine awareness at Jinan University (Zhou, Zhang, & Zhang, 2022). Since their study aimed to identify T1_LA within this study, our survey in this research adds questions serving our purpose. Questions added are either common questions in most rabies awareness-related research or according to related knowledge within WHO PEP guidelines (WHO, 2013). The survey consists of three parts: basic information of participants, awareness of rabies, and awareness of rabies vaccine.

Sample Acquiring

The survey was conducted from Feb 18 to Mar 10, 2024, using the "Tencent Questionnaire" platform, where each WeChat account could only fill out the questionnaire once.

During the survey process, questionnaire links were distributed mainly through WeChat groups managed by teachers and students at related schools, grades, and classes, aiming for a high response rate.

Sample Size

Power analysis was conducted before spreading the questionnaire. The required sample size is calculated to be 384 respondents, based on an estimated number of 9~12 graders in Beijing with 385,553, a marginal error of 5%, and a confidence level of 95%. There are 312,816 students in the aim population, with 113,888, 75,141, 62,428, and 61,359 students respectively for 9th to 12th graders in Beijing (Beijing Daily, 2023).

In total, 433 responses were collected. Among these, four responses were ruled out since they answered "No" for the first question asking whether they are 9~12 graders in Beijing. Besides, eight respondents chose the answer "scratched or bitten by their own pets" to Question 6, "Have you or your family members been scratched or bitten by

a dog or cat?". However, according to the answers to Question 5, "Do you have pets at home?", their pets were not cats or dogs. For caution, the following analysis is based on the remaining 421 samples after excluding them. Even so, the total of 421 valid responses exceeds the sample size required, therefore, making this study representative based on these data. For data analysis, the collected questionnaires were checked for logical consistency, and any with contradictory responses were discarded.

Statistical Analysis Methods

The electronic questionnaires were organized into a database using Excel. Statistical analysis is conducted using STATA16, including characteristic categorization, Ordinary Least Squares (OLS), and Logistic regression. The characteristic categorization method is applied to identify T1_LA and T2_LA among people who were bitten or scratched by cats or dogs. OLS supports this research by identifying variables that significantly affected the explained variables (awareness of rabies and rabies vaccines). Meanwhile, the use of logistic regression by setting the awareness of rabies and rabies vaccine as a binary variable—1 if above the median value and 0 otherwise—facilitates the examination of which variables enable survey respondents' awareness levels to surpass the median. This statistical design is in line with the study on Jinan University students (Zhou et al., 2022).

Results

Basic Information of the Respondents

The basic information about the 421 valid responses is presented in Table 1.

Among these samples, the gender distribution of the samples is 170 boys (40.4%); 226 girls (53.7%); and 25 students (5.9%) who are unwilling to disclose their gender. The grade distribution of the sample is 17 ninth graders (4.0%), 112 tenth graders (26.6%), 223 eleventh graders (53.0%), and 69 twelfth graders (16.4%).

The parents of the samples are generally highly educated. Among them, the number of samples in which at least one of the parents has a bachelor's degree is 390, accounting for 92.6%.

Statistical data indicate common pet ownership among the sample, with 250 respondents (59.4%) reporting experience in raising pets. Of these, 184 cases (43.7%) involved the raising of cats and/or dogs, including 68 individuals (16.2%) who had exclusively owned dogs, 74 (17.6%) who had exclusively owned cats, and 42 (10.0%) who had owned both cats and dogs. Additionally, 66 respondents (15.7%) reported owning other types of pets, with specific figures including 20 fish owners, 18 tortoise owners, 15 hamster owners, 11 rabbit owners, 4 lizard owners, 2 parrot owners, 2 guinea pig owners, 2 frog owners, and 1 owner each of a snake and a hedgehog.

Among all the samples, there were 192 cases where the respondents themselves or their family members had experienced being scratched or bitten by cats or dogs, accounting for 45.6% of the total sample. Among them, 108 cases (25.7%) were scratched or bitten by their own cats or dogs, and 48 cases (11.4%) were scratched or bitten by neighbor cats and dogs. It is worth noting that 36 cases (8.6%) reported that they and their family members had been scratched or bitten by cats and dogs of unknown origin.

Table 1. Basic Information of Survey Participants

	Quantity	Proportion (%)
Gender		
Male	170	40.4
Female	226	53.7
Unwilling to Disclose	25	5.9

Grade

9 th Grade	17	4.0
10 th Grade	112	26.6
11 th Grade	223	53.0
12 th Grade	69	16.4

Educational Status Of Parents, At Least One With A Bachelor's Degree

No	31	7.4
Yes	390	92.6

Experience Of Raising Cats Or Dogs

No	171	40.6
Yes	250	59.4
<i>Dog Only</i>	68	16.2
<i>Cat Only</i>	74	17.6
<i>Cats And Dogs</i>	42	10.0
<i>Other</i>	66	15.7

Experience Of Being Scratched Or Bitten By Cats Or Dogs

No	229	54.4
Yes	192	45.6
<i>Scratched Or Bitten By Your Own Cat Or Dog</i>	108	25.7
<i>Scratched Or Bitten By Neighbor's Cat Or Dog</i>	48	11.4
<i>Scratched Or Bitten By Cat Or Dog With Unknown Origin</i>	36	8.6

Students who reported that they or their family members had been scratched or bitten by cats or dogs, 125 cases, or about 65%, went to the hospital for treatment. In other words, among all 421 samples, the proportion of respondents who themselves or their family members were scratched or bitten by cats or dogs and sought medical treatment is as high as 29.7%.

These statistical results all show that: (1) In China, especially in big cities like Beijing, it is very common to keep pets such as cats and dogs, and there are also a large number of stray cats and dogs; (2) Residents are interacting with cats and dogs, including various unknown species. Indicating that the probability of being scratched and bitten by cats and dogs is very high; (3) The proportion of people who are scratched and bitten by cats and dogs and seek medical treatment is high. These findings align with previous research such as research shown from 2016 to 2021, the rabies clinic in Tongzhou District, Beijing received a total of 142,772 patients (Sun Yuanjie et al., 2023).

Treatment After Being Scratched and Bitten by A Cat or Dog

How the parties handle themselves after being scratched and bitten by a cat or dog can more truly show the respondent's level of knowledge about rabies and rabies vaccines. To this end, four questions were designed in the questionnaire, namely: "How bad was the bite and scratch?" (Question 9-1), "After being bitten and scratched, did you go to the doctor?" (Question 9 -2), "If you go to the doctor, does the doctor require rabies vaccination?" (Question 9-3), "Did you finally choose to be vaccinated?" (Question 9-4).

Because the scenarios of "being scratched and bitten by a cat or dog" are different, the meanings of various behaviors of the subjects under investigation will also be different. Therefore, we need to introduce it in four situations below.

Situation 1: Scratched And Bitten by A Cat or Dog of Unknown Origin

Observing data, two types of lack of awareness are demonstrated simultaneously under this situation.

For T1_LA, there were 36 cases in total under situation 1, of which 6 did not seek medical treatment, and are identified as T1_LA. Among the other 30 cases who chose to seek medical treatment, doctors recommended rabies vaccination in 26 cases, and all of them complied with the doctor's advice. Among these 36 cases, the proportion of T1_LA was $6/36=16.67\%$. Among the other 30 cases who chose to seek medical treatment, 26 cases (86.7%) were recommended to take the vaccine, and all of them complied with the doctor's advice. The result aligns with previous findings on general residents, children, and adults, additionally emphasizing its prevalence among Beijing high schoolers. This strengthens the results for the entire Beijing population. This highlights the need for ongoing educational efforts to raise awareness about rabies and the importance of vaccination post-exposure.

For T2_LA, among the four cases where doctors did not recommend rabies vaccination, two cases insisted on getting rabies vaccination. Considering the fatality of rabies, doctors will not state there is no necessity for PEP rabies vaccines unless they are confident that the patient is not at risk of exposure. Therefore, these two cases can be regarded as making T2_LA. Among these 36 cases, the proportion of T2_LA was $2/36=5.56\%$.

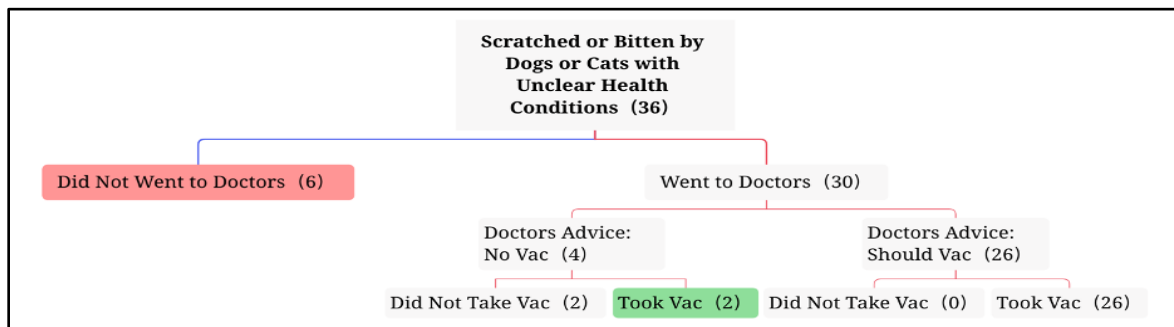


Figure 1-1. Choice Of Actions After Being Bitten by A Cat Or Dog Of Unknown Origin

Situation 2: Scratched And Bitten by Neighbor's Cat or Dog

Of the 48 cases in situation 2, 36 sought medical treatment. Of the 36 sought medical treatment, 30 cases (83.3%) were recommended by doctors to get vaccines, but only one case did not obey. Doctors recommended vaccination in 29 cases, but only one case did not follow the doctor's advice and did not get vaccinated. Notably, among the 6 cases where doctors did not recommend vaccination, 2 insisted on getting vaccinated.

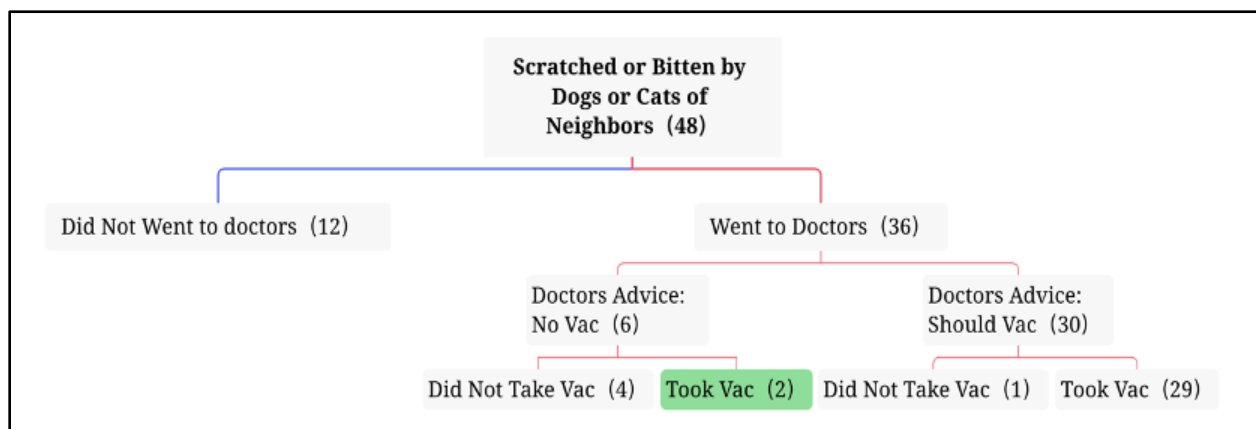


Figure 1-2. Situation of Being Bitten by a Neighbor's Cat or Dog

Situation 3: Scratched And Bitten by Your Own Cat or Dog (Not Regularly Vaccinated)

Among the 36 cases, 13 sought medical treatment, 11 cases (84.6%) of which were recommended by doctors to be vaccinated, and only one case did not obey. For the 23 cases that did not seek medical treatment, although they are at risk of T1_LA considering that family members know their cats and dogs relatively well, it is not appropriate to over-interpret them.

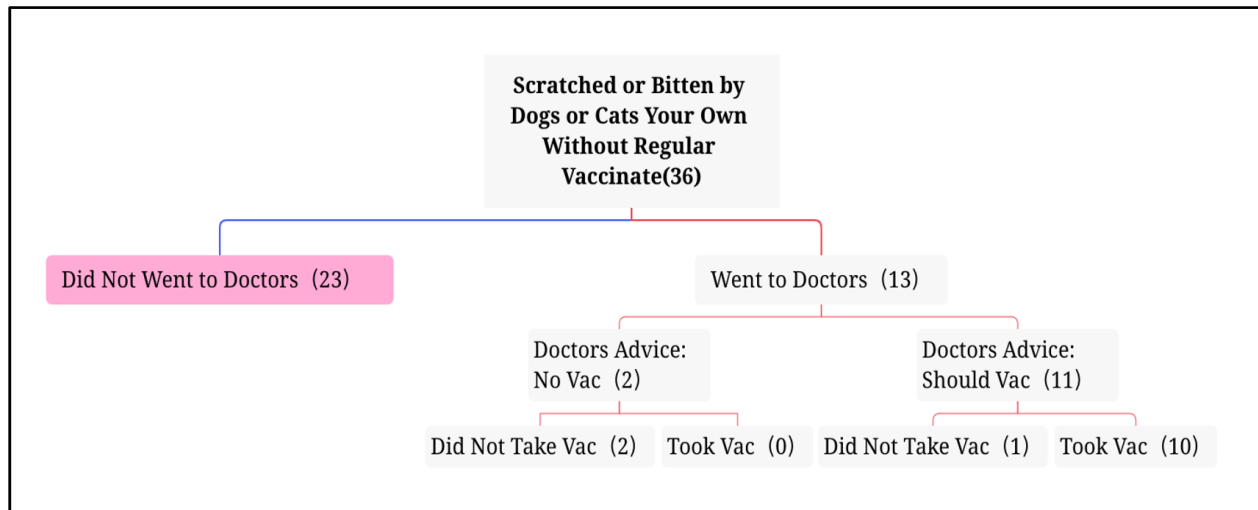


Figure 1-3. Situation Of Being Bitten By Your Own Cat Or Dog (Not Regularly Vaccinated)

Situation 4: Scratched And Bitten by Your Own Cat Or Dog (Regularly Vaccinated)

Among the 72 cases in this situation, 46 (63.9%) sought medical treatment, despite a near-zero risk from pets regularly vaccinated against rabies. Their action indicates caution but also a lack of understanding about their safety status. Among them, one case disobeyed the doctor's advice that no vaccine was needed and insisted on vaccination, so this case is T2_LA.

Notably, there are 38 cases (82.6%) advised by doctors to be vaccinated among the 46 cases who sought medical attention. Moreover, these 38 cases all followed the doctor's advice. In addition, another insisted on getting the vaccine, even though the doctor did not recommend it. Therefore, the 39 cases (54.2%) may have T2_LA within this situation.

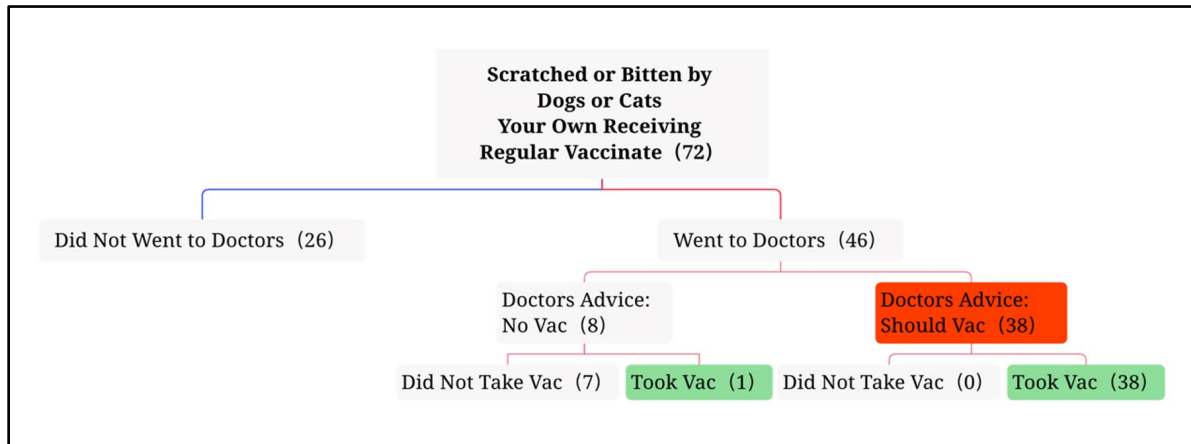


Figure 1-4. Situation Of Being Bitten By Your Own Cat Or Dog (Regularly Vaccinated)

In conclusion, the statistical analysis of the above four conditions implies that not only is T1_LA not rare in Beijing middle school students from grades 9-12, but also the proportion of students with T2_LA is very high.

Knowledge About Rabies and Rabies Vaccine

In the previous section, this research inferred to a certain extent the patients' knowledge of rabies and rabies vaccines through their medical treatment status. However, since most people have no experience of being scratched or bitten by cats or dogs and seeking medical treatment, it is necessary to design some questions to understand the respondents' level of knowledge of rabies and rabies vaccines.

Awareness of Rabies

In the questionnaire, 8 questions were designed to test the awareness of rabies (see Table 2).

The first question is about the main source of rabies infection of rabies. Among the 421 samples, only 260 samples chose the correct answer, namely "cats and dogs", accounting for 61.8%. At the same time, 142 cases chose "dog", 5 cases chose "cat", and 14 cases chose "other". This means that among the 421 samples, 156 (=142+14) students, or 37.1% of the students, did not know that "cats" are also the main source of infection of rabies.

Table 2. Awareness of Rabies

Question		Correct sponse quency	Re- Fre- Awareness rate (%)
Question 10-1	<i>The main sources of infection are (dogs and cats)</i>	260	61.8
Question 10-2	<i>Transmitted through wounds in the skin and mucous membranes</i>	399	94.8
Question 10-3	<i>Diseases that are generally susceptible to the population</i>	248	58.9
Question 10-4	<i>The pathogen is a virus</i>	331	78.6
Question 10-5	<i>Typical symptoms are fear of wind and water</i>	361	85.8
Question 10-6	<i>The incubation period is usually 1-3 months</i>	277	65.8
Question 10-7	<i>The mortality rate of rabies is close to 100%</i>	363	86.2
Question 10-8	<i>After exposure, the wound should be washed immediately with soap and water and then vaccinated</i>	372	88.4

What is even more surprising is that although 94.8% of students knew that rabies is transmitted through wounds in the skin and mucous membranes, only 58.9% of students knew that rabies is a disease that the population is generally susceptible to. At the same time, the students under investigation knew that “the pathogen of rabies is a virus” (Question 10-4), “Typical symptoms are fear of wind and water” (Question 10-5), and “The incubation period is usually 1-3 months” (Question 10 -6), the proportions of "the fatality rate is close to 100%" (question 10-7) are 78.6%, 85.8 %, 65.8 % and 86.2 respectively. In addition, 88.4% of the respondents knew that after being bitten or scratched by a cat or dog, they should immediately wash the wound with soap and water and then get vaccinated.

The above statistical results imply that a considerable proportion of students have T1_LA.

Knowledge About Rabies Vaccine

Regarding the awareness of rabies vaccine, this questionnaire set 12 questions (Table 3).

Table 3. Knowledge about rabies vaccine

Question		Correct sponse quency	Re- Fre- Awareness Rate (%)
Question 11-1	Anyone who is scratched or bitten by a cat or dog needs to be vaccinated	247	58.7
Question 11-2	Only scratches or bites from cats or dogs of unknown health need to be vaccinated	231	54.9
Question 11-3	If your skin is scratched by a cat or dog but no obvious bleeding occurs, you need to be vaccinated	266	63.2
Question 11-4	Vaccination is required if the skin is broken by being licked by a cat or dog	337	80.1
Question 11-5	It is best to get a rabies vaccine within 24 hours after being scratched or bitten by a cat or dog.	413	98.1
Question 11-6	Vaccination is by intramuscular injection	369	87.7

Question 11-7	The vaccination site is the upper arm	377	90.0
Question 11-8	If you are bitten and scratched again after vaccination, if it is more than 6 months since the last time, you need to be fully vaccinated again	370	87.9
Question 11-9	In addition to vaccination, patients with severe trauma also need to use passive immune preparations according to the situation.	405	96.2
Questions 11-10	The vaccine injection method is: two injections on the 1st day, one injection on the 8th and 22nd days, a total of four injections	279	66.3
Questions 11-11	The vaccine injection method is: one injection each on the 1st, 4th, 8th, 15th, and 29th day, a total of five injections	294	69.8
Questions 11-12	Rabies vaccine is not 100% effective	354	84.1

In order to understand the T1_LA of the survey respondents, the questionnaire was designed with two questions: “If the skin is scratched by a cat or dog but no obvious bleeding occurs, vaccination is required” (Question 11-3); “When the skin is scratched by a cat, Or dogs need to be vaccinated for licking” (Question 11-4). For the two questions, although 266 (63.2%) and 337 (80.1%) respondents respectively chose the correct answer “YES”, there were also 155 (37.8%) and 84 (19.9%) respondents chose the wrong answer “NO”, respectively.

For T2_LA, the questionnaire designed questions: “Anyone who is scratched or bitten by a cat or dog needs to be vaccinated” (Question 11-1); “Only if you are scratched or bitten by a cat or dog with unknown health status Injuries require vaccination” (Question 11-2). For question 11-1, 247 (58.7%) respondents chose the correct answer “NO”, but 174 (41.3%) chose the wrong answer. For question 11-2, 231 (54.9%) respondents chose the correct answer “YES”, but 190 (45.1%) chose the wrong answer.

The above results imply a considerable proportion of students in grades 9-12 in Beijing lack a correct understanding of rabies and rabies vaccines, especially T2_LA in general subjects. This is also a very important factor leading to the abuse of rabies vaccines in China.

Inter-Group Comparison of Knowledge About Rabies and Rabies Vaccine

Table 4 compares the differences in the awareness of rabies and rabies vaccines among the respondents in each group based on the different characteristics of the respondents.

Regarding the awareness of rabies, respondents who have experience in raising dogs or cats and who regularly vaccinate their pets have a higher awareness rate. The difference is statistically significant, which shows that respondents with experience in raising pets tend to take the initiative to learn about rabies.

Regarding the awareness of rabies vaccine, the differences between the groups are mainly reflected in the groups of different grades and parents’ education status. Respondents in higher grades and those with better parents’ education have a higher awareness rate of rabies vaccine. At the same time, there was no significant difference between the groups in terms of whether they had experience of raising pets or whether they had experience of being bitten or scratched.

Table 4. Comparison Of Knowledge About Rabies And Rabies Vaccine Between Groups

	Rabies		Rabies Vaccine	
	Awareness Rate	P value	Awareness Rate	P value
Gender				
Male	78.2 %		77.1 %	
Female	77.6 %	0.706	76.9 %	0.887

Private	72.5%	0.116	70.3%	0.029**
Grade				
Grade 9	74.3 %		68.6 %	
Grade 10	76.9 %	0.590	75.7 %	0.069*
Grade 11	78.6 %	0.276	77.3 %	0.009***
Grade 12	75.9 %	0.756	77.5 %	0.027**
Parent Education Level				
No bachelor's degree or above	77.8 %		72.0 %	
At least one person with a bachelor's degree or above	77.5 %	0.917	76.9 %	0.047**
Pet Raising Experience				
None	75.5 %		77.3 %	
Have a dog or cat	79.3 %	0.034**	75.8 %	0.296
Have other pets	77.8 %	0.345	76.9 %	0.828
Pets Vaccinated Regularly				
No	77.1 %		75.4 %	
Yes	80.5 %	0.086*	76.8 %	0.411
Experience Of Being Bitten Or Scratched				
None	76.6 %		77.2 %	
Have	78.6 %	0.230	75.9 %	0.310

Note. *Significant at the 90% confidence level ($p < 0.1$); **Significant at the 95% confidence level ($p < 0.05$); ***Significant at the 99% confidence level ($p < 0.01$)

Regression Analysis of Awareness Rate of Rabies and Rabies Vaccine and Characteristics of Survey Respondents

Furthermore, to be more precise, OLS and Logit regression methods were used to examine the impact of the above characteristics on the respondents' awareness of relevant knowledge.

The regression results of OLS are shown in Columns (1)-(2) of Table 5. The explained variables are rabies and rabies vaccine awareness rates, respectively. The regression results show that the experience of raising a pet (cat or dog) will significantly increase the respondent's awareness rate of rabies. Respondents who are in higher grades and whose parents have better education have higher awareness rates of rabies vaccines. (3)-(4) of Table 5 uses the Logistic regression method. The explained variables are whether the rabies awareness rate and the rabies vaccine awareness rate are higher than the median level. If they are higher than the median awareness rate of all survey respondents, the value is 1, otherwise it is 0.

Table 5. Regression Between Rabies and Rabies Vaccine Awareness Rates and Survey Respondent Characteristics

OLS	Logit Regression
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Explained variable	Rabies Awareness Rate	Rabies Vaccine Awareness Rate	Rabies Awareness Rate: Is It Above The Median	Rabies Vaccine Awareness Rate: Is It Above The Median
	(1)	(2)	(3)	(4)
Gender - Female	-0.0101 (0.0172)	0.0038 (0.0136)	-0.2524 (0.2314)	-0.0340 (0.2260)
Gender - Not disclosed	-0.0597*	-0.0605**	-0.3552	-0.6520
Grade-10th	(0.0356) 0.0208 (0.0432)	(0.0281) 0.0701** (0.0341)	(0.4670) 0.5507 (0.3861)	(0.4384) 0.4209 (0.3731)
Grade-11th	0.0403 (0.0418)	0.0875*** (0.0331)	0.5762* (0.3378)	0.7139** (0.3310)
Grade-12th	0.0143 (0.0451)	0.0880** (0.0357)	0.3222 (0.3933)	0.7037* (0.3950)
Parental Education Status	-0.0021 (0.0310)	0.0541** (0.0245)	0.3573 (0.3249)	0.3939 (0.3178)
Keep A Pet Cat Or Dog	0.0356* (0.0196)	-0.0118 (0.0155)	0.0582 (0.2653)	-0.0536 (0.2626)
Pet Raising - Others	0.0237 (0.0241)	-0.0031 (0.0191)	0.2306 (0.3295)	-0.3563 (0.3097)
Whether Bitten	0.0079 (0.0183)	-0.0052 (0.0144)	0.5104** (0.2507)	0.0589 (0.2410)
Observations	421	421	421	421

Note. * Significant at the 90% confidence level ($p < 0.1$); ** Significant at the 95% confidence level ($p < 0.05$); *** Significant at the 99% confidence level ($p < 0.01$)

The regression results show that respondents in the second grade of high school (11th grade) are more likely to have higher than average awareness rates of rabies and rabies vaccines. At the same time, the experience of being bitten or scratched will also increase the respondents' awareness of rabies.

However, the imperative finding is that the experience of both pet keeping and being bitten or scratched does not affect people's awareness level. With a relatively low awareness level among the general population, indicating a possible deficiency in the educational processes. If they receive adequate education associated with the administration of the rabies vaccine, individuals who own pets, as well as those who have previously been scratched by cats or dogs, ought to possess a more comprehensive understanding.

Inter-Group Comparison of Knowledge About Rabies and Rabies Vaccine Regarding Sources of Knowledge

There is no statistically significant difference in rabies awareness based on the method of access to knowledge. All methods contribute to a relatively similar level of awareness, which implies that a diversified approach to public education may be necessary in the future.

Table 6. Comparing Effects on Awareness Among Different Types of Access to Relevant Knowledge

	Rabies		Rabies Vaccine	
	Awareness Rate	P value	Awareness Rate	P value
Access To Relevant Knowledge				
School	78.4 %		75.4 %	
Family	76.4 %	0.601	75.2 %	0.952
Hospital And Community Public-ity	76.6 %	0.654	76.2 %	0.788
Website, Tv, Radio	77.7 %	0.862	78.9 %	0.208
Books, Publications	78.7 %	0.938	75.9 %	0.841
Other	73.4 %	0.501	68.2 %	0.270

Discussion

Through the analysis of these questionnaires, two phenomena deserve special attention.

First, regardless of the situation of a scratch or bite, once people go to the doctor, they have a very high probability of being advised to get vaccinated. Specifically, the rate the doctor suggested to take the rabies vaccine in situation 1~3 is accordingly 86.7%, 83.3%, and 84.6%. What was particularly surprising was that in situation 4, where people were scratched or bitten by regularly vaccinated housekept dogs or cats, 38 people, 82.6% among those who went to hospitals, were advised to take the rabies vaccine. According to WHO, those 38 people do not need PEP treatment, and the vaccine for PEP treatment might have severe side effects or complications. However, all of them followed the doctor's advice to take the vaccine.

Second, students or their family members who had been scratched or bitten by dogs or cats did not have better knowledge of rabies vaccines than the rest of the population, although their knowledge of rabies was significantly better.

These phenomena suggest that a considerable number of relevant medical institutions and doctors do not give scientific medical advice to patients who are bitten by cats and dogs when they seek medical treatment. According to some public information, the gross profit of rabies vaccines is usually above 90%. For example, Chengdu Kanghua Biological Products Co., LTD., predominantly producing the Human Diploid Cell Rabies Vaccine (HDCV), achieves a gross profit rate exceeding 95% (Shenzhen Tongshunhua Information Technology Co., Ltd., 2024). Therefore, it is reasonable to speculate that the relevant medical institutions and doctors not only failed to impart the correct knowledge to the patients but also used the patients' T2_LA to strongly recommend the rabies vaccine. This should be an important reason for the abuse of the rabies vaccine in China. Now, it is extremely disturbing that China occupies over 80% of the global rabies vaccine market share! (Business World Magazine,2023, June 19).

Policy Recommendations

This paper identifies four key areas to address the PEP rabies vaccination issue in China: stray dog management, public policy, public education, and medical system regulation.

Stray Dog Management

First, responsible pet ownership is crucial to prevent abandonment. This can be achieved by contract signing with kennels or other organizations before pet-keeping. The contract should inform potential owners about the costs and

care required for pets, helping them assess their ability to provide necessary care. These contracts should also require owners to commit to regular vaccinations for their pets. Additionally, the general public should be cautious around animals with unknown health status.

Public Policy

Second, public policy should effectively balance impact and financial support to enhance efficiency. A low vaccination rate among canines and other animals often leads to higher rates of rabies prevalence. Animal vaccination is the most cost-effective method for preventing rabies spread, as demonstrated in many developed countries like the United States and Europe, where comprehensive pet healthcare systems often include free or subsidized animal vaccines. Consequently, future Chinese policies should prioritize increasing vaccination coverage among domestic and stray dogs and cats.

Public Education

Third, proper education is needed for a broader population in China to address the general lack of awareness about rabies and PEP vaccines. T1_LA and T2_LA account for a similar proportion of the population, yet T2_LA has been less emphasized in past studies. While rabies still causes deaths, the focus has traditionally been on T1_LA due to its immediate impact on reducing T1_LA and advocating PEP vaccinations. This approach may lead those who recognize the importance of vaccination post-bite but with a non-complete understanding of PEP to overreact. Thus, while rabies education is critical, it must comprehensively cover both benefits and drawbacks, defining "risk" exposure and related concepts. The goal is to enable individuals to independently assess their risk of rabies exposure and the necessity for vaccination, rather than relying solely on medical advice. Nonetheless, caution is essential; individuals should seek medical attention under potentially unsafe conditions.

Medical System Regulation

Lastly, the Chinese medical system may need reform to ensure more professional patient care. Professionally, a stricter assessment system is needed that includes practical evaluations reflecting health providers' knowledge of the latest treatments based on research and WHO guidelines. Additionally, to reduce doctors' incentives for administering PEP rabies vaccines driven by manufacturer relationships, the government should regulate vaccine pricing. This could include government-led bulk purchases of vaccines to minimize potential collusion between manufacturers and hospitals, or providing subsidies for PEP recipients to lower the profits manufacturers can earn.

Limitations

There are several limitations in this study. First, the questions in the questionnaire should be richer and more comprehensive. Family income and side effects experienced were not included in the questions. Consequently, this study did not explore how the costs and side effects of PEP rabies vaccines affect decision-making, nor whether individuals were aware of these drawbacks before vaccination. Secondly, there is a lack of investigation and research on the relationship between doctors, the China CDC, and rabies vaccine manufacturers, and further, there is a lack of in-depth theoretical and empirical research on how to encourage and prevent vaccine abuse in China. Future research can be conducted on investigating the optimal methods of increasing pet keepers' responsibility.

Conclusion

This research seeks to investigate the awareness level of Beijing high schoolers (grade 9~12) on rabies and rabies vaccines and to identify the related societal problems regarding two types of lack of awareness and vaccine abuse.

This research identified three basic phenomena among high school students, who reflect on society, based on social phenomena identified from previous studies. First, there exists a lack of awareness of rabies and rabies vaccine among high school students. Second, lack of awareness can be separated into two types, the well-identified Type 1 Lack of Awareness (T1_LA) some people are not aware of the lethality of rabies and the importance of vaccination, or the newly identified not well-studied Type 2 Lack of Awareness (T2_LA) that some people are overreacting after being bite and blindly wanting to be vaccinated ignoring the fact of no risk and potentially severe side effects of rabies vaccine. Both T1_LA and T2_LA exist within the population. Third, rabies vaccine abuse occurs, and it might result from interest involvement within hospitals or companies.

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References

- Ahmad, N., Nawi, A. M., Jamhari, M. N., Nurumal, S. R., Mansor, J., Zamzuri, M. I. A., Yin, T. L., & Hassan, M. R. (2022). Post-exposure prophylactic vaccination against rabies: A systematic review. *Iranian Journal of Public Health*, 51(5), 967–977. <https://doi.org/10.18502/ijph.v51i5.9412>
- Beijing Daily. (2023, April 3). 今年北京各学段毕业年级人数上升！小升初增近1.3万人 [This year, the number of students in graduation grades in Beijing has increased! Nearly 13,000 more students in elementary to junior high transition]. Retrieved from https://news.cnr.cn/native/gd/20230403/t20230403_526204536.shtml
- Beijing Municipal Government. (2023, October 18). 狗狗也要有“身份证”！还有这些养犬规定要知晓—— [Dogs also need "ID cards"! And these dog-keeping regulations need to be known]. https://www.beijing.gov.cn/fuwu/bmfw/sy/jrts/202310/t20231018_3281072.html
- Burdon Bailey, J. L., Gamble, L., Gibson, A. D., deC Bronsvort, B. M., Handel, I. G., Mellanby, R. J., & Mazeri, S. (2018). A rabies lesson improves rabies knowledge amongst primary school children in Zomba, Malawi. *PLoS Neglected Tropical Diseases*, 12(3), Article e0006293. <https://doi.org/10.1371/journal.pntd.0006293>
- Business World Magazine. (2023, June 19). 占据全球超80%的份额 · 这可能是中国最混乱的 暴利生意 [Occupying over 80% of the global market share, this may be China's most chaotic lucrative business]. Retrieved June 19, 2023, from <https://mp.weixin.qq.com/s/ZgQZfgxJGiM975J4OtWMqA>
- Cai, L., Wang, L., Guan, X., Wang, L., Hu, X., Wu, Y., Tong, Y., & Wang, P. (2021). Epidemiological analysis of rabies in Central China from 2013 to 2018. *Infection and Drug Resistance*, 2021(14), 2753–2762. <https://doi.org/10.2147/IDR.S314881>
- Centers for Disease Control and Prevention. (2020, July 29). Rabies around the world.

<https://www.cdc.gov/rabies/location/world/index.html>

Centers for Disease Control and Prevention. (2022, June 2). Rabies vaccine: What you need to know.

<https://www.cdc.gov/vaccines/hcp/vis/vis-statements/rabies.html>

Chen, Q., Ma, X., Rainey, J. J., Li, Y., Mu, D., Tao, X., ... & Petersen, B. (2021). Findings from the initial Stepwise Approach to Rabies Elimination (SARE) Assessment in China, 2019. *PLoS Neglected Tropical Diseases*, 15 (3), e0009274. <https://doi.org/10.1371/journal.pntd.0009274>

Chen, X. B. (2023). 打一针狂犬疫苗多少钱? [How much does a rabies vaccination cost?]. Wuhan University Renmin Hospital. Retrieved April 23, 2024, from https://m.baidu.com/bh/m/detail/ar_170356402982084719

Children's Hospital of Philadelphia (CHOP). (2022). Rabies vaccine [Reviewed by Paul A. Offit]. Retrieved April 15, 2024, from <https://www.chop.edu/centers-programs/vaccine-education-center/vaccine-details/rabies-vaccine>

Feng, Y., Wang, Y., Xu, W., Tu, Z., Liu, T., Huo, M., Liu, Y., Gong, W., Zeng, Z., Wang, W., Wei, Y., & Tu, C. (2020). Animal rabies surveillance, China, 2004–2018. *Emerging Infectious Diseases*, 26(12). <https://doi.org/10.3201/eid2612.200303>

Hu, R., Tang, Q., Tang, J., & Fooks, A. R. (2009). Rabies in China: An update. *Vector-Borne and Zoonotic Diseases*, 9(1). <https://doi.org/10.1089/vbz.2008.0046>

Li, K. (2020). Premier Li Keqiang meets the press: Full transcript of questions and answers. The Third Session of the 13th National People's Congress Press Conference. Retrieved May 29, 2020, from https://english.www.gov.cn/premier/news/202005/29/content_WS5ed058d2c6d0b3f0e9498f21.html

Li, T. (2023). 狂犬病人免疫球蛋白多少钱一针? [How much does human rabies immunoglobulin cost per dose?]. Capital Medical University Affiliated Beijing YouAn Hospital. Retrieved April 23, 2024, from https://m.baidu.com/bh/m/detail/ar_2231081589197850327

Pethaddop Research. (2023). China's Pet Industry White Paper 2023-2024 (Consumption Report).HiPet Link Co., Ltd. <https://www.hipetlink.com/China-s-Pet-Industry-White-Paper-2023-2024-id65302307.html>

Quiambao, B. P., Dy-Tioco, H. Z., Dizon, R. M., Crisostomo, M. E., & Teuwen, D. E. (2009). Rabies post-exposure prophylaxis with purified equine rabies immunoglobulin: One-year follow-up of patients with laboratory-confirmed category III rabies exposure in the Philippines. *Vaccine*, 27(51), 7162-7166. <https://doi.org/10.1016/j.vaccine.2009.09.036>

Shen, T., Welburn, S.C., Sun, L., et al. (2023). Progress towards dog-mediated rabies elimination in PR China: A scoping review. *Infectious Diseases of Poverty*, 12(1), 30. <https://doi.org/10.1186/s40249-023-01082-3>

Shenzhen Tongshunhua Information Technology Co., Ltd. (2024). Hithink RoyalFlush: Kanghua Biological 2024 Q1 Report [Data file] [Mobile application software]. Retrieved from <https://board.10jqka.com.cn/gateway/visual>

/searchResult?Client_userid=Ht8ML&back_source=hyperlink&share_hxapp=isc&fontzoom=no#code=300841&type=2024-first&source=tssy

- Sun, Y., Shi, J., Cui, T., Zhang, J., Liu, Y., & Zhao, C. (2023). Analysis of outpatient visits to rabies vaccination clinics in Tongzhou District of Beijing from 2016 to 2021. *Medical Animal Control*, 39(5). <https://doi.org/10.7629/yxdwzfz202305010>
- Tu, C., Feng, Y., & Wang, Y. (2018). Animal rabies in the People's Republic of China. *Revue Scientifique et Technique (International Office of Epizootics)*, 37(2), 519-528. <https://doi.org/10.20506/rst.37.2.2820>
- Wang, D. L., Zhang, X. F., Jin, H., Cheng, X. Q., Duan, C. X., Wang, X. C., Bao, C. J., Zhou, M. H., & Ahmad, T. (2019). Post-exposure prophylaxis vaccination rate and risk factors of human rabies in mainland China: a meta-analysis. *Epidemiology and Infection*, 147, e64. <https://doi.org/10.1017/S0950268818003175>
- World Health Organization. (2013). Post-exposure rabies prophylaxis (PEP) guidelines. https://www.who.int/docs/default-source/searo/india/health-topic-pdf/b5010.pdf?sfvrsn=619e77a3_2
- World Health Organization. (2018). Zero by 30: The global strategic plan to end human deaths from dog-mediated rabies by 2030. <https://www.who.int/publications-detail-%20redirect/9789241513838>
- Yang, C., Zhang, S., Meng, X. Y., Deng, X. C., Jiang, H., He, J. Z., Zhang, Y. Y., Wu, J., & Xie, R. Q. (2022). Health risk perception and prevention awareness related rabies among rural middle schools in Guangxi Province. *Chinese Center for Health Education*, 38, 44–47.
- Zhang, J. Y., Zhang, B., Zhang, S. F., Zhang, F., Li, N., Liu, Y., & Hu, R. L. (2017). Dog- transmitted rabies in Beijing, China. *Biomedical and Environmental Sciences*, 30(7), 526-529. <https://doi.org/10.3967/bes2017.069>
- Zhang, N., Song, C., Tao, X., & Zhu, W. (2023). Epidemiologic features of human rabies in China from 2015-2021. *Zoonoses*. <https://doi.org/10.15212/ZOONOSSES-2023-0012>
- Zhou, C., Zhang, L., & Zhang, W. (2022). Analysis of Cognitive Status of Rabies and Rabies Vaccines Among Students in Jinan University. *Journal of Jinan University (Natural Science & Medicine Edition)*, 43(6), 666-672. DOI: 10.11778/j.jdxb.20220162