Chula Med J Vol. 64 No. 1 January - March 2020;29-37 DOI : 10.14456/clmj.2020.4

Original article

Incidences and characteristics of monkey-related injuries among locals and tourists in Mueng District, Lopburi Province, 2013 - 2017

Anothai Juttuporn[a], Sarunya Hengpraprom[b*], Thanapoom Rattananupong[b]

[a]*Program in Health Research and Management, Department of Preventive and Social Medicine, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand*
[b]*Department of Preventive and Social Medicine, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand*

Background: Conflicts between monkeys and humans are increasing, mainly because of urbanization and deforestation. Mueng district of Lopburi Province is one of the greatest conflict areas in Thailand, where public health concerns of zoonoses transmission from monkey - bites and scratches are high. Currently, there is no epidemiological research of monkey-related injuries in Thailand.
Objectives: The purposes of this study were to determine the incidence of monkey-related injuries and investigate the trends and characteristics of the injured cases in Mueng District, Lopburi Province, in 2013 - 2017.
Methods: A cross - sectional analytical study was conducted to compare monkey-related injuries and investigate the incidences between locals, Thai, and foreign tourists by collecting secondary data from medical records in 3 hospitals in the study area. The cumulative incidences were used to calculate relative risk between the tourists and the locals. The characteristics of the injury cases are presented by frequency and percentage.
Results: Yearly incidences of locals, Thais, and foreign tourists were in the ranges of 9.16 - 18.33, 190.16 - 379.13, and 254.07 – 736.91 per 100,000 population, respectively. The trend of injury was remarkably higher in foreign tourists. Recently, in 2016 - 2017, Thai and foreign tourists had relative risks of injury estimated as 20 and 40 times compared to that of the locals, respectively. Time, place and circumstance of injury, and wound site suggested monkey provisioning with food as the main risk factor of monkey-related injuries.
Conclusion: The incidences of monkey-related injuries was highest in foreign tourists, followed by Thai tourists. Preventive measures should primarily focus on the tourists, such as training on safety behaviors with monkey, promoting pre- and post-exposure prophylaxis, and providing safeguards, warning signs, and first aids stations at monkey provisioning sites.

Keywords: Epidemiology, incidence, monkey - bites, Lopburi Province, Thailand, long-tailed macaque.

A new concern about emerging infectious diseases (EID) has been continuously rising globally. Most EID are zoonotic disease, and most of zoonotic diseases come from wildlife.[1] In Thailand, one of the most common urban wildlife is free-ranging monkeys, so called the long-tailed macaque *(Macaca fascicularis)*.[2] Because they are not within the possession or control of humans, they are considered wildlife. This situation promotes infectious agents to cross-species transmission between humans and monkeys.[3, 4] Monkey-bites can pose a risk of zoonoses from the herpes B virus, rabies virus, simian retroviruses, *Clostridium tetani*, and various groups of bacteria inside the monkey oral cavity.[5 - 7] Although there is no case reported of herpes B virus and rabies virus transmission from monkeys in Thailand, the severity of infection from both viruses is very high.[6, 8] Simian retroviruses have potential to develop new emerging infectious diseases in human. An example, simian immunodeficiency virus (SIV), was one species of simian retroviruses that was transmitted to humans and mutated to become the human immunodeficiency virus (HIV).[3] *Clostridium*

***Correspondence to: Sarunya Hengpraprom**, Department of Preventive and Social Medicine, Faculty of Medicine, Chulalongkorn University, Bangkok10330, Thailand.
E-mail: hengprs@gmail.com
Received: February 12, 2019
Revised: March 8, 2019
Accepted: May 3, 2019

tetani can be found in the feces of monkeys and have a potential risk to infect humans via bite and scratch.[9] Monkey - bites can pose a risk of bacterial soft tissue infection that require broad-spectrum antibiotic prophylaxis, similar to human bites,[6] and the risk of zoonoses mentioned above is not uncommon, because among mammal bites in Thailand, monkey - bites rank the third following those from dogs and cats.[6, 10]

There are many conflicts between monkeys and humans throughout Thailand, such as bite, scratch, robbing, and vandalism from monkey. Lopburi Province is one of the most critical areas, especially in the old town of Lopburi Province, where the locals live with monkeys and tourists travel for monkey tourism and food provisioning; thus, interaction between humans and monkeys is very high in this area.[2, 11, 12]

Currently, there is no research on the epidemiology of monkey bites in Thailand. So far, this is the first study that uses epidemiological methods to assess the risk to locals, Thai tourists, and foreign tourists of monkey - bites. To compare the risks among the 3 study groups, we use cumulative incidence as an outcome. Further, monkey bites trend and characteristics of the bite cases will be explored. Results from the study will benefit the public health sector and local governments in Lopburi Province, helping them to prioritize and plan preventive measures for monkey - bites, and being an original study to be applied in other areas that also have urban wildlife conflicts.

Materials and methods

A cross-sectional study was conducted to compare monkey-bites between locals, Thai, and foreign tourists. This study collected numbers of monkey - bite cases during 2013 - 2017 from 3 hospitals in Mueng District, Lopburi Province: King Narai Hospital (government tertiary hospital), Anandamahidol Hospital (military tertiary hospital), and the Royal Thai Air Force Wing 2 Hospital (military secondary hospital). We used the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) to search for the monkey-bite cases by the ICD-10 codes "W55" (Contact with other mammals), and "W54" (Contact with dogs). Most monkey-bite cases were recorded as W55, but we included W54 to cover monkey - bite cases that were mistakenly recorded with the dog bite code. Then medical records of W55 and W54 cases were explored to differentiate other animal bite cases from monkey - bite cases. Further, data of monkey - bite cases were collected from the rabies exposure cases report system, provided by the Department of Disease Control, to sync with hospital medical records for completeness of data. Exclusion criteria for case selection included: 1) medical records that were not available; 2) data did not indicate monkey as a cause of injury; and 3) injuries that occurred in Lopburi Zoo. The last criterion was proposed because the characteristics and circumstances of captive monkeys in the zoo were completely different from those of free-ranging monkeys in most parts of Lopburi Province.

The population at risk in each study group was defined by address and race. The locals were people who live in the Mueng District, Lopburi Province. The numbers of mid-year local population during 2013 - 2017 were provided by the Bureau of Registration Administration. Thai tourists were any Thai people whose addresses were outside Mueng District, Lopburi Province. Foreign tourist were any non-Thai people that have address outside Mueng District, Lopburi Province. The numbers of Thai and foreign tourists during 2013 - 2017 were provided by the 4th regional office of the Department of Fine Arts, Lopburi Province. Each month, the 4th regional office collected the number of visitors from 5 governed tourist landmarks: Phra Prang Sam Yot, King Narai's Palace, Wat Phra Si Rattana Mahathat, Vichayen House, and Yen Hall. We calculated the median number of visitors in each year to estimate mid-year tourist population.

The cumulative incidence is calculated from the number of bite cases divided by the mid-year population in each of the study groups. Then incidences were compared among Thai and foreign tourists and locals using locals as a reference group to calculate relative risk with a 95% confidence interval. The bite trend was presented by line graph. The characteristics of bite cases are presented by frequency and percentage. The characteristics consist of 3 parts: 1) personal history, 2) injury history, and 3) treatment history. The proportions of each characteristic factor were compared among the 3 study groups by Fisher's exact test at the significant level of 0.05. SPSS version 22.0 (IBM Corp. 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.) was used to analyze the statistics.

Results

Numbers of bite cases and numbers of population at risk

Data collection from ICD-10 and medical records in 3 hospitals showed 493 monkey - bite cases from 2013 - 2017. After exclusion of 9 bite cases that occurred in the Lopburi Zoo, 484 cases were included in our study. Classifying by race and address: 185 cases were locals; 179 cases were Thai tourists; 120 cases were foreign tourists, and only 2 of 484 cases could be synchronized with data from the rabies exposure cases report system (Figure 1). The number of cases ranged from 62 - 146 per year. Mid-year local populations ranged from 250,829 - 251,282. Mid-year Thai and foreign tourist populations ranged from 12,076 – 16,337 per year and 5,416 – 7,073 per year, respectively. The number of visitors was available in 2014 - 2017 but was missing in 2013. Thus, in 2013, cumulative incidences of Thai and foreign tourists could not be calculated (Table 1).

Cumulative incidences

Cumulative incidence of locals, Thai, and foreign tourists ranged from of 9.16 - 18.33, 190.16 – 379.13, and 254.07 – 736.91 per 100 000 population, respectively. The incidence of tourists was clearly higher than that of the locals; however, foreign tourists had the highest incidences in almost every year (Figure 2). Results from the relative risk calculation showed that in 2016 – 2017 Thai and foreign tourists were 20 and 40 times more likely to get injured compared to the locals, respectively (Table 1).

Monkey - bite trends

The incidences of locals and Thai tourists decreased from 2014 through 2015, whereas the incidence of foreign tourists slightly increased. After 2015, the incidences of locals and Thai tourists rebound to equal the incidences in 2014, whereas the incidence of foreign tourist was remarkably increased, 2 - 3 times compared to 2014 – 2015 (Figure 2).

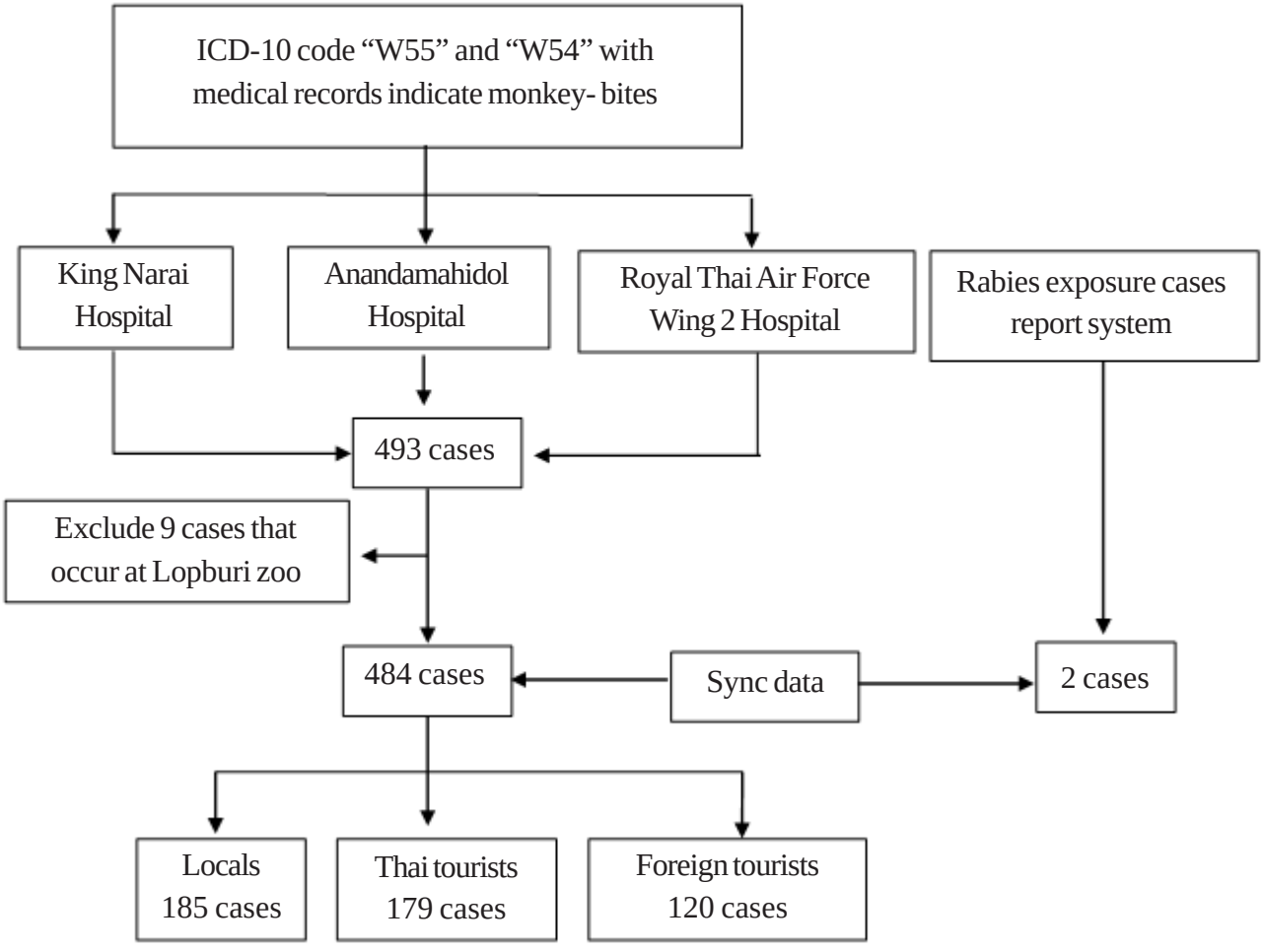

Figure 1. Diagram showing source of study population.

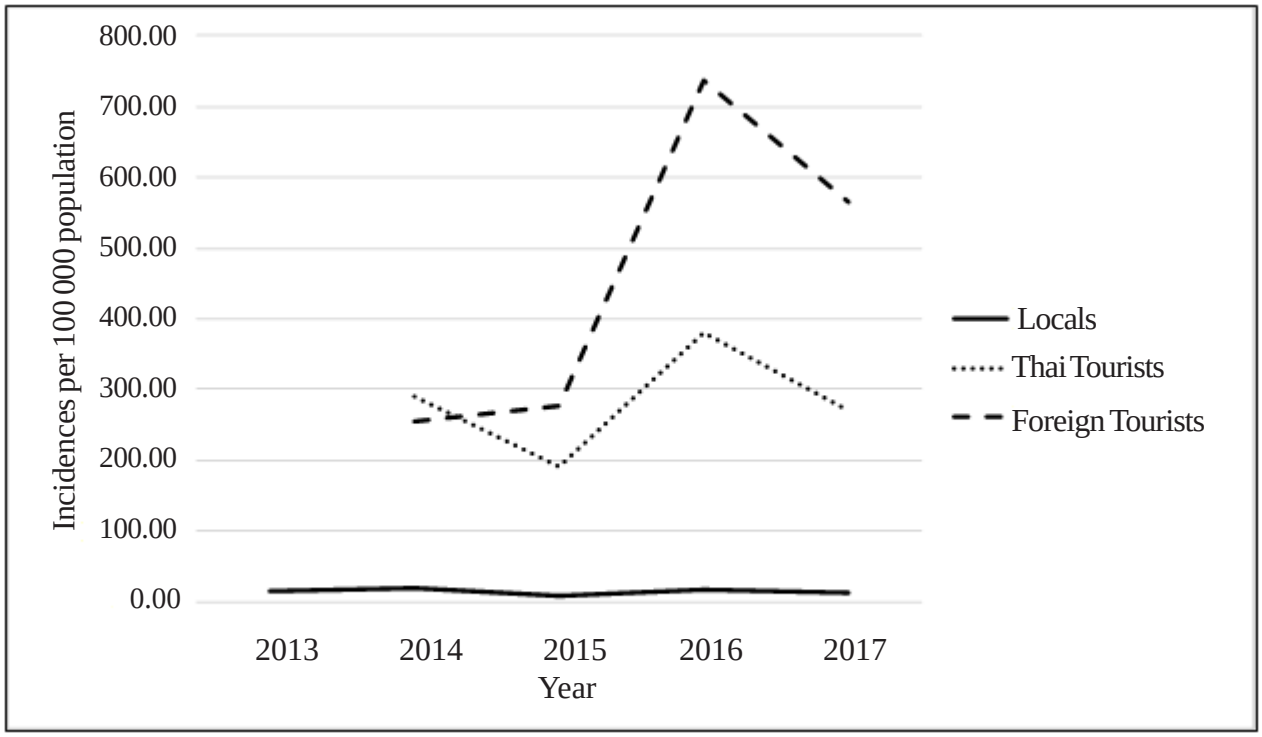

Figure 2. Cumulative incidences and trend separated by each study group.

Table 1. Cumulative incidence and relative risk analysis.

Year	Study group	Number of injured cases	Number of mid-year population at risk	Cumulative incidence (per 100 000 population)	Relative risk (95% CI)
2013					
	Locals	37	251,282	14.72	-
	Thai tourists	15	-	-	
	Foreign tourists	10	-	-	
2014					
	Locals	46	250,914	18.33	Ref.
	Thai tourists	35	12,076	289.83	15.81 (9.89, 25.08)
	Foreign tourists	14	5,510	254.07	13.86 (7.04, 25.66)
2015					
	Locals	23	251,194	9.16	Ref.
	Thai tourists	25	13,147	190.16	20.77 (11.31, 38.29)
	Foreign tourists	15	5,416	276.95	30.25 (14.68, 60.52)
2016					
	Locals	45	250,977	17.93	Ref.
	Thai tourists	60	15,826	379.13	21.14 (14.13, 31.85)
	Foreign tourists	41	5,564	736.91	41.10 (26.25, 64.19)
2017					
	Locals	34	250,829	13.56	Ref.
	Thai tourists	44	16,337	269.33	19.87 (12.41, 32.05)
	Foreign tourists	40	7,073	565.50	41.72 (25.75, 67.95)

Characteristics of monkey - bite cases

The characteristics of monkey - bite cases consisted of 3 parts: 1) personal history; 2) injury history; and 3) treatment history. There were missing data in some variables, especially in the injury history part. Among the 484 cases collected into the study, missing data were highest in the place of injury (97.5%) and circumstance of injury (97.1%), followed by level of education (72.3%), and time of injury (25.4%). However, the missing data were only minor in other variables (0 – 15.1%).

Personal history (Table 2)

Most of the bite cases are female (60.5%), and adult (ages 20 - 59 years, 77.7%), but locals have a higher proportion of child, adolescent and elder cases (ages 1 - 19 and 60 - 89) than tourists (35.7% vs. 10.8 - 16.2%). About one-third of all cases were students or collegians. Foreign tourists have the highest proportion of educations of bachelor's degree or higher (78.3%), followed by Thai tourists (50.0%), and the locals (19.5%).

The top 10 nationalities of foreign tourists were: French (15.8%), American (10.0%), Canadian (9.2%), German (9.2%), British (6.7%), Chinese (5.8%), Dutch (5.8%), Italian (5.0%), Polish (5.0%), and Czechoslovak (4.2%). Moreover, the combined proportions of French, Dutch, and Italian tourists increased from 0% in 2015 to 34.2% in 2016, and 35% in 2017.

Injury history (Table 3)

Most of cases were injured during the day (6.01 am – 6.00 pm, 84.5%), especially in the evening (2 pm – 6 pm, 42.7%). However, the locals tended to get injured during the night through morning (6 pm – 10 am) more than tourists (37.8% vs. 24 - 25%). About two - third of the locals and tourists got injured at the monkey provisioning sites, such as San Phra Kan Shrine (50.0%), and Phra Prang Sam Yot (16.7%). Moreover, the locals were also bitten at school areas, Sra Kaew Circle, and Erawan Crossing. Half of provoked circumstances were activities that involved the handling of food or belongings. Food provisioning accounted for one - third of them (Table 5). Although, it should noted that the data of most places and circumstances of injuries were missing from hospital medical records.

About two-third of cases were injured on the upper extremities. About 60% of the wounds were bleeding (WHO category 3); 40 % were abrasions without bleeding (WHO category 2), and there was only one case were the skin was still intact (WHO category 1).

Table 2. Personal-history characteristics of monkey bite cases.

Personal history	Locals (percent) n = 185	Thai tourists (percent) n = 179	Foreign tourists (percent) n = 120	Total (percent) n = 484	*P* - value[a]
Gender					
Male	58 (31.4)	78 (43.6)	55 (45.8)	191 (39.5)	0.015*
Female	127 (68.6)	101 (56.4)	65 (54.2)	293 (60.5)	
Age (years)					
1 - 19	49 (26.5)	23 (12.8)	12 (10.0)	84 (17.4)	< 0.001*
20 - 59	119 (64.3)	150 (83.8)	107 (89.2)	376 (77.7)	
60 - 89	17 (9.2)	6 (3.4)	1 (0.8)	24 (5.0)	
Occupation					
Housewife/unemployed	26 (14.9)	25 (15.4)	13 (17.3)	64 (15.6)	0.001*
Public and private employee	65 (37.4)	75 (45.7)	12 (16.0)	151 (36.7)	
Student/Collegian	57 (32.8)	46 (28.4)	32 (42.7)	135 (32.8)	
Other	26 (14.9)	17 (10.5)	18 (24.0)	61 (14.8)	
Education					
Primary school	8 (19.5)	4 (5.7)	2 (8.7)	14 (10.4)	< 0.001*
Secondary school/ diploma/certificate	25 (61.0)	31 (44.3)	3 (13.0)	59 (44.0)	
Bachelor or higher	8 (19.5)	35 (50.0)	18 (78.3)	61 (45.5)	

*$P < 0.05$, [a]Fisher's exact.

Table 3. Injury-history characteristics of monkey - bite cases.

Injury history	Locals (percent) n = 185	Thai tourists (percent) n = 179	Foreign tourists (percent) n = 120	Total (percent) n = 484	*P* - value[a]
Time of injury					
6.01 - 10.00 a.m.	27 (20.0)	18 (12.7)	8 (9.5)	53 (14.7)	0.006*
10.01 a.m. - 2.00 p.m.	40 (29.6)	31 (21.8)	30 (35.7)	101 (28.0)	
2.01 - 6.00 p.m.	44 (32.6)	77 (54.2)	33 (39.3)	154 (42.7)	
6.01 p.m. - 6.00 a.m.	24 (17.8)	16 (11.3)	13 (15.5)	53 (14.7)	
Place of injury					
San Phra Kan Shrine	3 (50.0)	3 (60.0)	0 (0.0)	6 (50.0)	0.437
Phra Prang Sam Yot	0 (0.0)	1 (20.0)	1 (100.0)	2 (16.7)	
School area	1 (16.7)	1 (20.0)	0 (0.0)	2 (16.7)	
Sra Kaew Circle/Erawan Crossing	2 (33.3)	0 (0.0)	0 (0.0)	2 (16.7)	
Wound site					
Head and neck	11 (6.0)	12 (6.8)	9 (7.6)	32 (6.7)	0.09
Upper extremities	114 (62.3)	125 (70.6)	90 (75.6)	329 (68.7)	
Trunk	19 (10.4)	15 (8.5)	4 (3.4)	38 (7.9)	
Lower extremities	39 (21.3)	25 (14.1)	16 (13.4)	80 (16.7)	
Wound severity					
WHO category 1	1 (0.6)	0 (0.0)	0 (0.0)	1 (0.2)	0.892
WHO category 2	72 (42.4)	67 (39.6)	47 (40.5)	186 (40.9)	
WHO category 3	97 (57.1)	102 (60.4)	69 (59.5)	268 (58.9)	

*$P < 0.05$, [a]Fisher's exact.

Treatment history (Table 4)

About three quarters of the cases arrived at the hospital within 6 hours from the time of injury. However, the proportion of cases that arrived later than 6 hours were higher in the locals and Thai tourists compared to foreign tourists (29.5%, 22.7% vs. 13.8%). When the cases arrived at the hospital, 98.7% received wound cleansing; 97.5% received a rabies vaccination; 61.9% received a tetanus vaccination; and 92.1% received prophylactic antibiotics.

Table 4. Treatment-history characteristics of monkey bite cases.

Treatment history	Locals (percent) n = 185	Thai tourists (percent) n = 179	Foreign tourists (percent) n = 120	Total (percent) n = 484	*P* - value[a]
Time from injury to hospital arrival (hours)					
≤ 6	120 (70.6)	130 (77.4)	81 (86.2)	331 (76.6)	0.012*
7 - 24	38 (22.4)	28 (16.7)	13 (13.8)	79 (18.3)	
> 24	12 (7.1)	10 (6.0)	0 (0.0)	22 (5.1)	
Wound cleaning					
Received	166 (98.8)	166 (98.8)	109 (98.2)	441 (98.7)	0.774
Not received	2 (1.2)	2 (1.2)	2 (1.8)	6 (1.3)	
Rabies vaccination					
Received vaccine	108 (61.0)	84 (48.0)	53 (44.2)	245 (51.9)	0.025*
Received vaccine and immunoglobulin	66 (37.3)	87 (49.7)	62 (51.7)	215 (45.6)	
Not received	3 (1.7)	4 (2.3)	5 (4.2)	12 (2.5)	
Tetanus vaccination					
Received	117 (66.5)	111 (65.7)	58 (49.6)	286 (61.9)	0.007*
Not received	59 (33.5)	58 (34.3)	59 (50.4)	176 (38.1)	
Antibiotics prophylaxis					
Broad-spectrum	83 (50.9)	93 (56.7)	65 (56.5)	241 (54.5)	0.751
Narrow-spectrum	64 (39.3)	60 (36.6)	42 (36.5)	166 (37.6)	
Not received	16 (9.8)	11 (6.7)	8 (7.0)	35 (7.9)	

*$P < 0.05$, [a]Fisher's exact.

Table 5. Provoked circumstances of monkey - bite cases.

Provoked circumstances	Cases (percent)
Providing food directly to monkey	4 (33.3)
Being snatched by monkey	2 (16.7)
Being climbed or jumped up by monkey	2 (16.7)
Helping injured monkey from electrical shock	2 (16.7)
Teasing monkey	1 (8.3)
Helping child from monkey aggression	1 (8.3)

There are some differences in the proportion of vaccination between each study groups, the proportion of Thai and foreign tourists that received a rabies vaccination along with rabies immunoglobulin was higher than locals (49.7%, 51.7% vs. 37.3%), but the proportions of locals and Thai tourists that received tetanus vaccinations were higher than foreign tourists (66.5%, 65.7% vs. 49.6%).

Discussion

The cumulative incidences of monkey-bites in locals was less than the estimated cumulative incidence of dog bites in the Thai population per 100 000 population.[13] This was corresponds with a former report that monkey - bites were ranked after dog and cat bites.[6, 10] There was an exception in Thai and foreign tourists, because their monkey-bite incidences exceeded the estimated dog bites incidences. To compare this finding with relative risks, shown in Table 1, we conclude that tourists clearly have a higher risk than the locals, and particularly for tourist populations, foreign tourists have a higher risk than Thais. These correspond with qualitative research in both Thailand and other countries.[11, 12, 14]

In Lopburi Province, the locals tend to have more safety precautions than tourists, and they avoid direct contact with monkeys. The locals protect themselves by using tools to frighten monkeys away, but tourists do not.[11, 12] Compared to Thai tourists, foreign tourists have more risky close contact behaviors with monkeys.[11, 12] Moreover, foreign tourists, especially from Europe, tend to wear clothing that has large areas of skin exposure. This can increase the risk of injury when being bitten or scratched by a monkey.[14]

The incidences of the local and Thai tourists decreased from 2014 through 2015, because in mid-2014 a large number of monkeys were suddenly captured from Mueng District and translocated to other districts.[15, 16] On the contrary, the incidences of foreign tourists have never decreased, and the incidences after 2015 were remarkably 2 - 3 times higher compared to those of 2014 – 2015. We assume that increasing proportions of French, Dutch, and Italian tourists from 2015 – 2017 may contribute to the rising trend among foreign tourists, but this assumption requireds further research to confirm.

Most monkey - bite cases are females, probably because females tend to touch monkeys or be frightened by monkeys more than males.[17] Another assumption is females are more likely to have serious wounds than male, because they are more likely to be bitten by adult monkeys than juvenile monkeys.[17] Thus, a female who has a more serious wound is more likely to go to hospital.

Adults were prone to monkey bites, this corresponds with research in Bali, Indonesia[17, 18] but the locals have a greater proportion of child, adolescent, and elderly cases than the tourists, probably because most of tourists are in adulthood, and for a local child, adolescent, and elder, they are more vulnerable than local adults. Moreover, local cases have lower levels of education, probably because they are lower class, and have an outdoor job during which they are more likely to be exposed to monkeys, or they lived in an area of monkey habitat. Therefore, they got injured during the night time through to morning more than the tourists.

Most injuries occurred during the day, it was the time that monkeys were provisioned with food.[19] Injuries also took place at monkey provisioning sites, while humans were involved in food provisioning. Moreover, wounds were most commonly found on the upper extremities, this corresponds with a study in Bali that showed offering food to monkeys directly with bare hands was associated with upper extremity injuries. [18] These findings correspond with former researches that specify food provisioning as an important risk factor of monkey - bites. [17 - 19]

Nearly 60% of injuries caused bleeding wounds (WHO category 3), this corresponds with research in Bali[18] In our study there is only one case that was categorized as WHO category 1. Thus, most of the minor bite cases in all groups may not have come to hospitals, and this may have led to a marked underestimation of monkey - bite cases collected from hospital medical records. This corresponds with many studies that show only 11.7% – 66.8% of cases will go to a hospital or medical clinic after an animal-bite injury.[10, 18, 20]

Arriving at the hospital, most cases received wound cleaning, vaccination, and prophylactic antibiotics. Although one-third of all bite cases did not receive a tetanus vaccination, they already had completed a tetanus vaccination within the past 5 years, and thus they were not required to have a tetanus booster. Foreign tourists received fewer tetanus vaccines, but more rabies immunoglobulin treatments compared to the other groups. This probably suggested that most of them already got tetanus pre-exposure prophylaxis, but a smaller proportion of them got rabies pre-exposure prophylaxis. This correspond with other researches in Thailand that showed only 2.2 - 11.6 % of foreign travelers had completed their rabies pre-exposure prophylaxis.[10, 20]

Risk of bacterial wound infection is considered to increase, if the time from injury to wound management is delayed for more than 6 - 12 hours.[21] As for rabies, initiation of post-exposure prophylaxis after 24 - 48 hours since injury is considered delayed.[22, 23] In our study 23.4% of the cases arrived at the hospital more than 6 hours from the time of injury, and 5.1% of the cases arrived at the hospital more than 24 hours from the time of injury, therefore the risk of bacterial wound infections and rabies infections may be increased in these cases. Moreover, the risk of bacterial wound infection may be increased, because only half of the cases received broad-spectrum antibiotics that can cover various type of bacteria inside the monkey oral cavity.

Healthcare workers are unfamiliar with the herpes B virus from monkey bites.[6] Only one case in this study received Acyclovir, an antiviral medication, for the prevention of herpes B virus infection. The concern of herpes B virus is now increasing since US Centers for Disease Control and Prevention launched a medical guideline for the herpes B virus, and it is continually being updated.[6, 8]

Conclusion

Monkey-related injury in Lopburi Pronince is common, especially in tourists, because of their risky behaviors. Preventive policy for tourists should focus on safety behaviors when confronted with monkeys, appropriated clothing patterns, first aids, and pre- and post-exposure prophylaxis. The risk among tourists should be promoted on websites, social networks, brochures, and warning signs. From the varieties of foreign tourists, language used for communication should include at least English, French, German, Italian, and Chinese. Food provisioning is the main risk factor of the injury, therefore all monkey - provision sites, both official and unofficial, should set up safeguards, warning signs, and first aid stations. Trainings and education programs, about the prevention and management of monkey-related injuries, should involve stakeholders in monkey tourism, animal health-care workers, and human health-care workers. We recommend animal health-care workers publish surveillance information of monkey infectious diseases that will be beneficial to human health care workers and the public. As for human health care workers, they should establish guidelines for caring for monkey - bite injuries, including appropriate antibiotic prophylaxis and antiviral prophylaxis for the herpes B virus. Moreover, tracking systems for tourists should use electronic questionnaires to follow up the completeness of post-exposure prophylaxis. Although tourists are riskier than locals, we suggest concerns for vulnerable groups of locals including children, adolescents, elders, outdoor workers, and lower-class.

Acknowledgments

We would like to express appreciation to Professor. Dr. Suchinda Malaivijitnond, Dr. Saowapak Hinjoy, Dr. Juthamas Supanam, Dr. Visit Arsaithamkul, and Col. Kathawoot Deepreecha, for giving great advice and coordinating with related agencies. We would also like to show our gratitude to staff of King Narai Hospital, Anandamahidol Hospital, and the Royal Thai Air Force Wing 2 Hospital for assisting in data collection.

Conflict of interest

The authors, hereby, declare no conflict of interest.

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