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Potential risk of viral transmission from flying foxes to domestic animals and humans on the southern coast of West Java, Indonesia

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ABSTRACT. Flying foxes have been considered to be involved in the transmission of serious infectious diseases to humans. Using questionnaires, we aimed to determine the direct and/or indirect contacts of flying foxes in an Indonesian nature conservation area with domestic animals and humans living in the surrounding area. We surveyed 150 residents of 10 villages in West Java. Villages were classified into 3 groups: inside and/or within 1 km from the outer border of the conservation area and 1–5 km or 5–10 km away from the reserve's outer border. Data were collected by direct interview using a structured questionnaire consisting of the respondent characteristics (age, sex and occupation); histories of contacts between flying foxes and humans, dogs and other domestic animals; and knowledge about infectious diseases, mainly rabies, in flying foxes. We found that flying foxes from the nature conservation area often enter residential areas at night to look for food, especially during the fruit season. In these residential areas, flying foxes had direct contacts with humans and a few contacts with domestic animals, especially dogs. People who encounter flying foxes seldom used personal protective equipment, such as leather gloves, goggles and caps. The residents living around the conservation area mostly had poor knowledge about flying foxes and disease transmission. This situation shows that the population in this region is at a quite high risk for contracting infectious diseases from flying foxes.

KEY WORDS: flying fox, Indonesia, questionnaire, rabies, zoonoses

The occurrence of emerging viral zoonoses worldwide, such as Nipah, Hendra, Menangle virus, SARS, Marburg, Ebola and lyssavirus diseases, is known to be associated with bats [3, 26, 29]. Flying foxes (genus *Pteropus)* is one of the largest bats in Old World fruit bats (family *Pteropodidae*). These bats have been confirmed to play important roles in viral infectious diseases related to lyssavirus [8], Hendra virus [6] and Nipah virus (NiV) [4]. Flying foxes are abundant in tropical, subtropical and temperate regions of Asia, Australia and islands of Africa.

Spillover of bat-borne zoonoses to domestic animals and humans has been caused by closer relationships between bats, domestic animals and humans [13]. Natural disasters, such as drought, floods and strong typhoons directly affect the roosting sites of flying foxes, resulting in shortages of their food supply and changes in the physical distance between bats and other animals, including humans. The development of land by humans has also influenced the distance between bats and human communities. Direct contacts between flying foxs and humans are suspected to have transmitted viruses to humans in Ebola cases in the Congo [15]. Domestic animals have played a role as intermediate hosts in cases of Nipah (pigs) and Hendra (horse) viruses in Malaysia and Australia, respectively [5].

The district of Garut is an area of central Indonesia with numerous dairy cattle and sheep farms. People in Garut keeps dogs

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Fig. 1. Map of West Java Province, Indonesia (green). Red area shows Leuweung Sancang Nature Reserve (bottom right). Inset map shows the location of West Java in Indonesia.

to hunt wild boars or as guard dogs, such that the population of dogs in Garut is comparatively high in Indonesia. A huge nature conservation area, Leuweung Sancang (2,157 hectares), is located on the south coast of Garut District [17], as shown in Fig. 1.

Inside the conserved area, many large trees serve as roosting sites for thousands of flying foxes during the daytime. At night, flying foxes from the reserve roam throughout the area in search of food, including in residential zones surrounding the conservation area. Direct and/or indirect contacts between flying foxes, domestic animals and humans in these residential areas potentiate the transmission of viruses from flying foxes to other animals [29]. Direct contacts refer to physical touch between a flying fox and another animals, whereas indirect contact is mediated via physical contact with the urine, feces or body fluids of flying foxes.

Rabies among both humans and animals remains problematic in Garut District. During 2005–2012 in West Java, there were 4,027 cases of people being bitten by a dog, with 15 deaths; of these, six deaths were in the district of Garut [11]. Until now, the previous cases of human rabies had been thought to be associated with dogs, even though flying foxes in Indonesia might carry other lyssaviruses, which cause disease that closely resemble paralytic rabies [12]. The aim of this study was to determine via survey, the contacts between flying foxes and domestic animals and human in residential areas around roosting sites and to assess potential viral transmission, especially rabies-related lyssaviruses, from flying foxes to domestic animals and/or humans around a nature conservation area in West Java, Indonesia.

MATERIALS AND METHODS

Area of research

We focused on the Leuweung Sancang Nature Conservation area in Cibalong subdistrict, Garut District, West Java Province, Indonesia. We obtained all necessary permissions to conduct the study from the Ministry of Environment and Forestry of Indonesia and local governments of West Java Province and Garut District. This nature conservation area is rich in wildlife, including more than 10,000 flying foxes [17]. To reveal the relationship among flying foxes, domestic animals and humans with respect to the transmission of pathogens, we administered a questionnaire to residents in and around the nature conservation area.

Participants

Participants were chosen from within a limited distance range from the nature conservation. Residents lived either in or within 1 km from the conservation (50 residents), from 1–5 km (50 residents) and from 5–10 km (50 residents) from the conservation. Initially, we attempted to choose participants randomly, regardless of sex. However, the questionnaire was finally administered mainly to men, because we found that female residents in the study area are not very interested in flying foxes and pay little attention to them. To fulfill our study objective, that is, to determine the contact between humans and animals, we decided to select men for the interviews, which were carried out one-on-one for about 30–60 min per person.

Respondents to the interviews were aged 15 years and older and were considered key informants of the villages where they resided. They included leaders in the community, at children's health centers, and of farmer and/or fishermen groups, as well as religious and youth leaders.

Table 1. The characteristics of respondents

No	Variables	R<1 km		R=1–5 km		R=5–10 km		Total	
		Total	%	Total	%	Total	%	Total	%
1	**Sex**								
	- Man	49	32.7	39	26.0	46	30.7	134	89.3
	- Women	1	0.7	11	7.3	4	2.7	16	10.7
2	**Age**								
	- <40 years	17	11.3	18	12.0	19	12.7	54	36.0
	- >40 years	33	22.0	32	21.3	31	20.7	96	64.0
3	**Education**								
	- Not school	3	2.0	5	3.3	3	2.0	11	7.3
	- Elementery school	28	18.7	22	14.7	32	21.3	82	54.7
	- Junior high school	13	8.7	13	8.7	6	4.0	32	21.3
	- Senior high school	6	4.0	8	5.3	9	6.0	23	15.3
	- University	0	0.0	2	1.3	0	0.0	2	1.3
4	**Work**								
	- State employee	0	0.0	4	2.7	9	6.0	13	8.7
	- Private employee	5	3.3	5	3.3	1	0.7	11	7.3
	- Entreprenuer	8	5.3	12	8.0	8	5.3	28	18.7
	- Farmer	22	14.7	21	14.0	28	18.7	71	47.3
	- Fisherman	14	9.3	0	0.0	1	0.7	15	10.0
	- Housewife	1	0.7	7	4.7	2	1.3	10	6.7
5	**Name of the villages**								
	- Karyamukti	10	6.7	0	0.0	0	0.0	10	6.7
	- Karyasari	0	0.0	14	9.3	0	0.0	14	9.3
	- Maroko	0	0.0	0	0.0	11	7.3	11	7.3
	- Mekarsari	0	0.0	0	0.0	24	16.0	24	16.0
	- Mekarwangi	0	0.0	24	16.0	0	0.0	24	16.0
	- Najaten	7	4.7	0	0.0	0	0.0	7	4.7
	- Sagara	21	14.0	0	0.0	7	4.7	28	18.7
	- Sancang	12	8.0	12	8.0	0	0.0	24	16.0
	- Simpang	0	0.0	0	0.0	8	5.3	8	5.3

Data collection

Data were collected through direct interviews using a structured questionnaire. The questionnaire mostly comprised closed, Likert scale type questions. The questions posed addressed six areas: respondent characteristics (age, sex and occupation); contacts between flying foxes and humans, dogs and other domesticated animals; experiences of infectious diseases after contact with flying foxes; and other aspects of knowledge, attitudes and practice (KAP) regarding rabies in flying foxes. KAP information was collected about rabies-related diseases including classical rabies, i.e., lyssavirus diseases themselves, natural reservoirs of lyssaviruses, their modes of transmission and prevention and treatment of lyssavirus diseases derived from flying foxes.

Statistical analysis

The maps used in this study were prepared using ArcGIS Version 10.2 (Environmental Systems Research Institute Inc., Redlands, CA, U.S.A.). Questionnaire data were analyzed using IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY, U.S.A.). Data were analyzed separately for the three ranges of distance from the nature conservation area. We used a scoring system to assess people's knowledge and attitude; incorrect answers were given 0 points; uncertain (unsure) answers, 1 point and correct answers, 2 points. Therefore, the maximum score for 15 questions was 30 and the minimum score was 0. Respondents' knowledge levels were categorized as poor for a score ≤15, fair (neutral) for a score of 16–23 and good for a score ≥24. Correlations between respondents' knowledge and residence area were analyzed by gamma correlation test.

RESULTS

Respondent profiles

The profiles of respondents living in areas located within a radius <1 km (a), 1–5 km (b) and 5–10 km (c) from the outer border of the nature conservation area are shown in Table 1. Area (a) mostly lies along the south coast of Java and contains fruit and vegetable farms and plantations. Area (b) is quite urbanized with little agricultural land and area (c) is a mountainous region covered with timber and rubber plantations. A total of 10 villages were chosen for this study, namely, Karyamukti, Najaten, Sagara, and Sancang in area (a); Karyasari, Mekarwangi and Sancang in area (b); and Maroko, Mekarsari and Sagara in area (c). The distribution of respondents in each area is shown in Fig. 2.

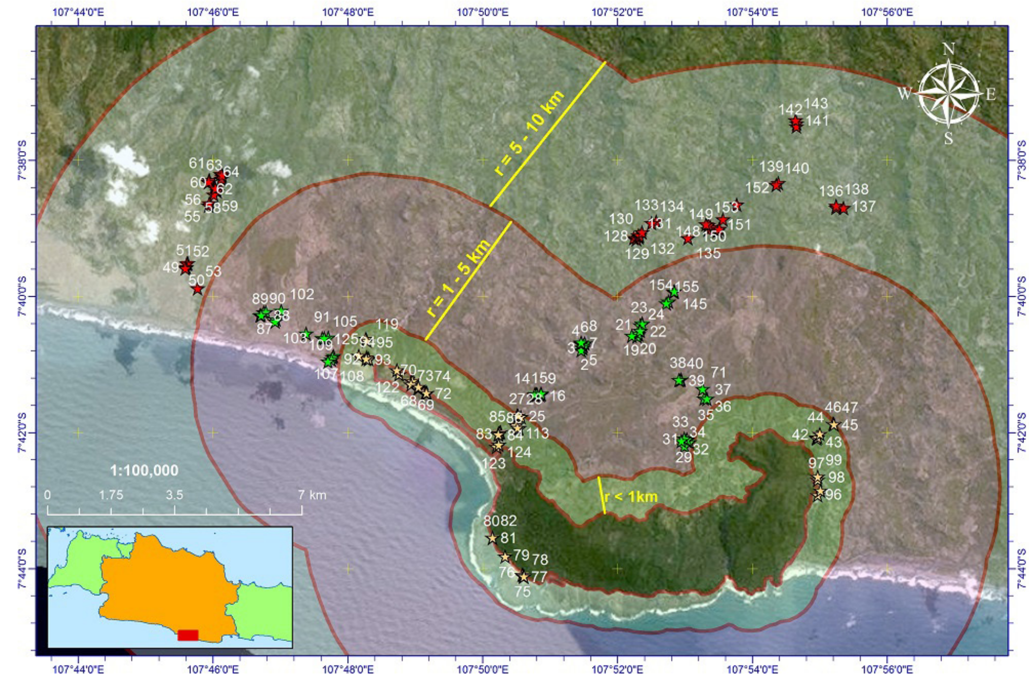

Fig. 2. Respondents' locations. Red lines show borders of areas within 0 km (conservation area), 1, 5 and 10 km from the nature conservation area of Leuweung Sancang. Stars indicate the geographical location of each respondent; these are color-coded by distance: yellow for respondents <1 km, green for those 1–5 km and red for those 5–10 km from the nature reserve. A sequential number is assigned to each respondent (white).

Respondent characteristics are shown in Table 1. The majority of respondents (89.3%) were men, as explained above. This is because men are more interested in flying foxes compared with women. Men more frequently go outside their houses at night and thus have more opportunity to encounter flying foxes. Most respondents were also over 40 years old. The educational attainment of more than half of respondents (54.7%) was elementary school level; residents of area (c) had the lowest educational levels. This is likely because access to schools is difficult owing to poor transportation.

Domestic animals in respondents' communities

The presence of domestic animals in the residential areas studied is shown in Table 2. All respondents (100%) said that they saw dogs roaming around their houses. Most of them (88.7%) said that they saw dogs very often (>5 dogs), nearly every night. Around 86.7% of respondents said they believed that these roaming dogs have owners, but the owners do not keep their dogs on a leash. In the more mountainous region of area (c), roaming dogs were more numerous and more frequently seen.

In Cibalong District, many cattle are found during the daytime on plantations along paved roads. These cattle are usually in small groups and guarded by herding dogs . Only 7.3% of respondents had cattle. A few respondents (5.3%) only owned 1–2 cattle. The people in this area also had other domestic animals at home, such as goats (13.3%), sheep (22.5%), chickens (80%) and cats (32.5%).

Flying foxes and other bats around residential areas

Flying foxes forage actively at night. During the nighttime, flying foxes often enter residential areas to look for food. Reported sightings of flying foxes in residential areas are shown in Table 3. All respondents (100%) claimed to have seen flying foxes at night. Nearly all respondents (94.0%) reported seeing flying foxes frequently. Most respondents (82.0%) also stated that flying foxes remain in the forest near their villages during the daytime. The majority of respondents (93.3%) said they had seen flying foxes in the trees surrounding residential areas at night and more than half (52%) had often seen flying foxes enter their residential area. There were few differences in these answers among areas (a), (b) and (c).

Nearly all respondents (98.7%) had fruit trees around their houses including mangoes, papayas, soursops, kapoks and/or coconuts. Flying foxes often got into their fruit trees (92.0% of respondents). The number of flying foxes entering the residential areas was more than 10 per night (the average of the three areas was 79.7%). Flying foxes seemed to enter residential zones more frequently during fruit seasons, according to 87.0% of respondents. Respondents said they do not like when flying foxes invade their fruits trees; however, most (86.2%) simply ignore them. In some communities, respondents claimed that flying foxes had been driven away (18.1%), caught (8.7%) or killed (11.6%).

Physical contacts between flying foxes and humans

Physical contacts between flying foxes and humans in the residential areas are shown in Table 4. Less than half (44.7%) of

Table 2. Domestic animals in communities of respondents

No	Variables	R<1 km		R=1–5 km		R=5–10 km		Total	
		Total	%	Total	%	Total	%	Total	%
1	**Dogs**								
1.1	See dogs around houses								
	- Yes	50	33.3	50	33.3	50	33.3	150	100.0
	- No	0	0.0	0	0.0	0	0.0	0	0.0
1.2	Frequency to see dogs								
	- Very rare	4	2.7	1	0.7	1	0.7	6	4.0
	- Sometimes	7	4.7	3	2.0	1	0.7	11	7.3
	- Often	39	26.0	46	30.7	48	32.0	133	88.7
1.3	The number of dogs around houses at night								
	- <5 dogs	21	14.0	12	8.0	3	2.0	36	24.0
	- >5 dogs	29	19.3	38	25.3	47	31.3	114	76.0
1.4	The types of dogs around residences								
	- Wild dogs	1	0.7	1	0.7	0	0.0	2	1.3
	- Community dogs	40	26.7	41	27.3	49	32.7	130	86.7
	- Unowned dogs	9	6.0	8	5.3	1	0.7	18	12.0
1.5	Have dogs								
	- Yes	3	2.0	6	4.0	10	6.7	19	12.7
	- No	47	31.3	44	29.3	40	26.7	131	87.3
1.6	The number of dogs at home								
	- 1 dog	3	2.0	5	3.3	6	4.0	14	9.3
	- 2 dogs	1	0.7	1	0.7	3	2.0	5	3.3
	- 5 dogs	0	0.0	0	0.0	1	0.7	1	0.7
2	**Cattles**								
2.1	Have cattles								
	- Yes	2	1.3	7	4.7	2	1.3	11	7.3
	- No	48	32.0	43	28.7	48	32.0	139	92.7
2.2	The number of cattle								
	- 1–2 cattle	2	1.3	4	2.7	2	1.3	8	5.3
	- >10 cattle	0	0.0	3	2.0	0	0.0	3	2.0
3	**Have other animals**								
3.1	Having goat	6	5.0	7	5.8	3	2.5	16	13.3
3.2	Having sheep	8	6.7	11	9.2	8	6.7	27	22.5
3.3	Having chicken	32	26.7	40	33.3	24	20.0	96	80.0
3.4	Having cat	12	10.0	19	15.8	8	6.7	39	32.5

respondents had frequent physical contact with flying foxes. Types of contact included hunting or holding (95.8%) and eating (34.7%) flying foxes. Only a few respondents (4.9%) used personal protective equipment (PPE) like leather gloves, glasse and/or hats to prevent being scratched or bitten when touching flying foxes. Fifty-eight percent of respondents did not touch flying foxes. Among the above 44.7% of respondents, the most frequently reported physical contact between humans and flying foxes was hunting or holding (96.6%), followed by cooking (83.9%), cutting (81.6%) and eating (78.2%). A few people (4.9%) who reported making frequent contact with flying foxes, used PPE when doing so.

Abnormal behavior of flying foxes

Abnormal behaviors of flying foxes observed by respondents are presented in Table 5. All respondents had never seen or heard of any incidents related to humans being attacked by flying foxes (0%). Nevertheless, 35.5% of them had seen or heard that flying foxes had fallen from a tree or died. These incidents were reported by many respondents (75.5%), but they are rare events. Flying foxes sometimes seemed to fall down to the sea or be electrocuted while hanging on electric wires in the residential area.

Cases of sudden deaths among humans in the community

The incidence of human sudden deaths is shown in Table 6. The incidence of sudden deaths among the population living around the roosting sites of flying foxes was confirmed by nearly half (42.0%) of respondents. However, most respondents (76.2%) stated that the incidence of human sudden death is very rare.

Cases of sudden deaths in infants were mentioned by more than a quarter (26.0%) of respondents. Nevertheless; the majority (84.6%) of respondents stated that the death rate in children was classified as very rare.

Table 3. Flying foxes and other bats around residential areas

No	Variables	R<1 km		R=1–5 km		R=5–10 km		Total	
		Total	%	Total	%	Total	%	Total	%
1	**Seen flying foxes**								
1.1	Seen flying foxes								
	- Yes	50	33.3	50	33.3	50	33.3	150	100.0
	- No	0	0.0	0	0.0	0	0.0	0	0.0
1.2	Frequency of seen flying foxes								
	- Very rare	2	1.3	3	2.0	0	0.0	5	3.3
	- Sometimes	1	0.7	3	2.0	0	0.0	4	2.7
	- Often	47	33.3	44	31.2	50	35.5	141	94.0
1.3	Place seen of flying foxes								
	- On the beach	12	8.0	11	7.3	14	9.3	37	24.7
	- On the tree in forests	42	28.0	40	26.7	41	27.3	123	82.0
	- On the tree around recidential areas	47	31.3	45	30.0	48	32.0	140	93.3
	- On the tree inside residential areas	30	20.0	25	16.7	23	15.3	78	52.0
2	**Flying foxes came into residential areas**								
2.1	Have fruit trees around houses								
	- Yes	50	33.3	49	32.7	49	32.7	148	98.7
	- No	0	0.0	1	0.7	1	1.7	2	1.3
2.2	Flying foxes come to the fruit trees								
	- Yes	47	31.3	44	29.3	47	31.3	138	92.0
	- No	3	2.0	6	4.0	3	2.0	12	8.0
2.3	Seasons of flying foxes come								
	- Throughout a year	6	4.3	6	4.3	4	2.9	16	11.6
	- At fruit seasons	40	29.0	38	27.5	42	30.4	120	87.0
2.4	Total number of flying foxes								
	- Little (<10 bats)	5	3.6	17	12.3	6	4.3	28	20.3
	- Many (>10 bats)	42	30.4	27	19.6	41	29.7	110	79.7
2.5	Actions for incoming flying foxes								
	- Left	43	31.2	37	26.8	39	28.3	119	86.2
	- Expelled	6	4.3	7	5.1	12	8.7	25	18.1
	- Catched	2	1.4	4	2.9	6	4.3	12	8.7
	- Killed	7	5.1	5	3.6	4	2.9	16	11.6

Physical contacts between flying foxes and domestic animals

Flying foxes that enter residential areas may have physical contact with domestic animals (Table 7). A few respondents (4.0%) claimed to have seen or heard that flying foxes encountered dogs. According to respondents, dogs sometimes hunt flying foxes at night (33.3%) and eat them (66.7%). Nevertheless, none of the respondents claimed to have seen flying foxes attack dogs or cattle in their areas.

Sudden deaths among domestic animals

More than a quarter of respondents (28.0%) had seen or heard of sudden death cases among dogs in their residential area (Table 8). A considerable number of respondents (34.0%) had witnessed or heard of sudden deaths among cattle, but 64.7% of them stated that these were very rare.

Knowledge among village residents about rabies

The level of respondents' knowledge of rabies is shown in Table 9. More than half of respondents (56.0%) had poor knowledge level about the disease. Respondents in area (a) tended to have lower knowledge than the other two areas. A small portion of the overall respondent population (8.7%) had good knowledge levels. Statistical analysis showed no correlation between respondents' residence location and level of knowledge about flying foxes and associated diseases (P=0.136, r=0186).

DISCUSSION

The educational attainment of more than half of the respondents in our study was elementary level. This might be associated with the age of most respondents (over 40 years). The educational level in area (c) seemed to be lower than the other two areas, which is probably because area (c) is a mountainous region with limited access to roads and schools.

Garut District is known as one of Indonesia's centers of livestock farming, mainly cattle and sheep. Most farms in the district use

Table 4. Physical contacts between flying foxes and humans

No	Variables	R<1 km		R=1–5 km		R=5–10 km		Total	
		Total	%	Total	%	Total	%	Total	%
1	**Contacts with flying foxes**								
1.1	Contacts with flying foxes frequently								
	- Yes	25	16.7	21	14.0	21	14.0	67	44.7
	- No	25	16.7	29	19.3	29	19.3	83	55.3
1.2	Type of contacts								
	- Expelling	6	8.3	6	8.3	4	5.6	16	22.2
	- Hold/capture/hunt	23	31.9	21	29.2	25	34.7	69	95.8
	- Cutting	3	4.2	9	12.5	8	11.1	20	27.8
	- Cooking	4	5.6	8	11.1	8	11.1	20	27.8
	- Eating	6	8.3	12	16.7	7	9.7	25	34.7
	- Selling	0	0.0	1	1.4	4	5.6	5	6.9
1.3	Used personal protective equipment (PPE) when contacted								
	- Yes	2	2.4	1	1.2	1	1.2	4	4.9
	- No	26	31.7	24	29.3	28	34.1	78	95.1
1.4	Kind of PPE used when contacted								
	- Helmets/hat	0	0.0	0	0.0	0	0.0	0	0.0
	- Mask	0	0.0	0	0.0	0	0.0	0	0.0
	- Glasses	0	0.0	0	0.0	0	0.0	0	0.0
	- Leather gloves	0	0.0	0	0.0	0	0.0	0	0.0
	- Boots	0	0.0	0	0.0	0	0.0	0	0.0
2	**Other people in community contacted with flying foxes**								
2.1	Other people in community contacted with flying foxes frequently								
	- Yes	25	16.7	27	18.0	35	23.3	87	58.0
	- No	25	16.7	23	15.3	15	10.0	63	42.0
2.2	Type of contacts								
	- Expelling	7	8.0	4	4.6	4	4.6	15	17.2
	- Hold/capture/hunt	25	28.7	27	31.0	32	36.9	84	96.6
	- Cutting of	20	23.0	22	25.3	29	33.3	71	81.6
	- Cooking	20	23.0	24	27.6	29	33.3	73	83.9
	- Eating	19	21.8	22	25.3	27	31.0	68	78.2
	- Selling	5	5.7	7	8.0	7	8.0	19	21.8
2.3	Used PPE when contacted								
	- Yes	0	0.0	0	0.0	0	0.0	0	0.0
	- No	25	28.7	27	31.0	35	40.2	87	100.0
3	**Injured by flying foxes**								
3.1	Have injured or scratches caused by flying foxes								
	- Yes	2	1.3	4	2.7	4	2.7	10	6.7
	- No	48	32.0	46	30.7	46	30.7	140	93.3
3.2	Frequency of being scratches by flying foxes								
	- Very rare	2	20.0	3	30.0	4	40.0	9	90.0
	- Sometimes	0	0.0	0	0.0	0	0.0	0	0.0
	- Often	0	0.0	1	25.0	0	0.0	1	10.0
3.3	To do with the injury								
	- Left	0	0.0	0	0.0	0	0.0	0	0.0
	- Wash with water	1	10.0	0	0.0	1	10.0	2	20.0
	- Wash with water and soap	1	10.0	1	10.0	1	10.0	3	30.0
	- Treated with iodine	0	0.0	1	10.0	2	20.0	3	30.0
	- Go to doctor/health center	0	0.0	1	25.0	0	0.0	1	10.0

the animal sharing system wherein farm owners entrust the management of their livestock to farmers through agreements. In turn, owners share the animal products, such as milk, meat or offspring. Many livestock animals in Garut are mainly grazed on rubber plantations along roads, because of a lack of land.

There are also many free-roaming dogs in Garut that are owned by residents for protection and hunting purposes. This is the conventional way of keeping dogs, similar to other areas of Indonesia. Data from Jakarta and the surrounding areas before 1990 indicated that 65.5 and 24.0% of dog owners in rural and urban areas, respectively, let their dogs roam freely outside their house [18]. These free-roaming dogs could be a source of pathogens like rabies that are transmitted to other animals, including humans.

Table 5. Abnormal behaviors of flying foxes

No	Variable	R<1 km		R=1–5 km		R=5–10 km		Total	
		Total	%	Total	%	Total	%	Total	%
1	**Attacked by flying foxes**								
1.1	Flying foxes attacked people								
	- Yes	0	0.0	0	0.0	0	0.0	0	0.0
	- No	50	33.3	50	33.3	50	33.3	150	100.0
2	**Flying foxes fallen down or dead**								
2.1	Heard or seen dead/fallen flying foxes								
	- Yes	14	9.3	21	14.0	18	12.0	53	35.5
	- No	36	24.0	29	19.3	32	21.3	97	64.7
2.2	Frequency of dead/fallen flying foxes								
	- Very rare	12	22.6	16	30.2	12	22.6	40	75.5
	- Sometimes	2	3.8	3	5.7	5	9.4	10	18.9
	- Often	0	0.0	2	3.8	1	1.9	3	5.7
2.3	Number of dead/fallen flying foxes								
	- Little (<10 flying foxes)	14	26.4	21	39.6	18	34.0	53	100.0
	- Many (>10 flying foxes)	0	0.0	0	0.0	0	0.0	0	0.0
2.4	Actions for dead/fallen flying foxes								
	- Left	12	22.6	18	34.0	16	30.2	46	86.8
	- Treated	0	0.0	1	1.9	0	0.0	1	1.9
	- Used as foods for other animals	1	1.9	0	0.0	0	0.0	1	1.9
	- Ate	0	0.0	1	1.9	2	3.8	3	5.7
	- Played by kids	0	0.0	0	0.0	1	0.0	1	1.9
2.5	Other animals contacted with dead flying foxes								
	- Yes	0	0.0	2	1.3	1	0.7	3	2.0
	- No	50	33.3	48	32.0	49	32.7	147	98.0
2.6	Kinds of animals contacted with dead flying foxes								
	- Cat	0	0.0	1	25.0	1	25.0	2	50.0
	- Rat	0	0.0	2	50.0	0	0.0	2	50.0
	- Dog	0	0.0	2	50.0	0	0.0	2	50.0
2.7	Actions for dead flying foxes								
	- Left	0	0.0	2	50.0	1	25.0	3	75.0
	- Buried	0	0.0	0	0.0	1	25.0	1	25.0
3	**Flying foxes fly abnormally**								
3.1	Heard or seen flying foxes fly abnormally								
	- Yes	16	10.7	16	10.7	11	7.3	43	28.7
	- No	34	22.7	34	22.7	39	26.0	107	71.3
3.2	Frequency occurred								
	- Very rare	9	20.9	11	25.6	9	20.9	29	67.4
	- Sometimes	6	14.0	1	2.3	2	4.7	9	20.9
	- Often	1	2.3	4	9.3	0	0.0	5	11.6
3.3	The number of flying foxes flied abnormally								
	- Little (<10 flying foxes)	13	30.2	16	37.2	10	23.3	39	90.7
	- Many (>10 flying foxes)	3	7.0	0	0.0	1	2.3	4	9.3
3.4	Actions for bats in abnormal conditions								
	- Left	16	37.2	12	27.9	10	23.3	38	88.4
	- Hunted	0	0.0	3	7.0	1	2.3	4	9.3
	- Killed	0	0.0	1	2.3	0	0.0	1	2.3

Flying foxes have been known to fly long distances [2]. They occasionally fly hundreds of kilometers from their roosts to seek food [7]. Flying foxes have the ability to efficiently track food sources throughout the archipelago [22]. During fruit season, they usually enter residential areas where fruit trees are located, thus increasing the possibility of contact with other animals, such as in the case of Garut in the present study. In Australia, spectacled flying-foxes tend to have roosts near human residences. This appears to be owing to habitual behavior rather than habitat destruction [27].

The most commonly reported physical contact made between flying foxes and humans in Garut, was through hunting. People engaging in this activity are not experts in the hunting and handling of bats; this is quite different from the situation in Australia where most people who encounter bats have been trained to handle bats. Among 205 people in Brisbane, who reported a potential exposure to Australian bat lyssavirus (ABLV), volunteer animal handlers accounted for 39%; professional animal handlers, 14%;

Table 6. Incidences of human sudden death

No	Variables	R<1 km		R=1–5 km		R=5–10 km		Total	
		Total	%	Total	%	Total	%	Total	%
1	**Seen or heard human sudden death**								
	- Yes	18	12.0	24	16.0	21	14.0	63	42.0
	- No	32	21.3	26	17.3	29	19.3	87	58.0
2	**Frequencies of the sudden death**								
	- Very rare	15	23.8	18	28.6	15	23.8	48	76.2
	- Sometimes	3	4.8	6	9.5	6	9.5	15	23.8
	- Often	0	0.0	0	0.0	0	0.0	0	0.0
3	**Suddent death in infant**								
	- Yes	8	5.3	16	10.7	15	10.0	39	26.0
	- No	42	28.0	34	22.7	35	23.3	111	74.0
4	**Frequencies of infant sudden death**								
	- Very rare	7	17.9	12	30.8	14	35.9	33	84.6
	- Sometimes	1	2.6	3	7.7	1	2.6	5	12.8
	- Often	0	0.0	1	2.6	0	0.0	1	2.6

Table 7. Physical contacts between flying foxes and the domestic animals

No	Variables	R<1 km		R=1–5 km		R=5–10 km		Total	
		Total	%	Total	%	Total	%	Total	%
1	**Dogs**								
1.1	Seen or heard of contacts between dogs and flying foxes								
	- Yes	1	0.7	2	1.3	3	2.0	6	4.0
	- No	49	32.7	48	32.0	47	31.3	144	96.0
1.2	Type of contacts								
	- Fighting	0	0.0	0	0.0	0	0.0	0	0.0
	- Hunting	0	0.0	0	0.0	2	66.7	2	33.3
	- Eating	1	16.7	2	33.3	1	16.7	4	66.7
1.3	Seen or heard dogs attacked by flying foxes								
	- Yes	0	0.0	0	0.0	0	0.0	0	0.0
	- No	50	33.3	50	33.3	50	33.3	150	100.0
2	**Cattle**								
2.1	Attacked by flying foxes before cattle sudden death cases								
	- Yes	0	0.0	0	0.0	0	0.0	0	0.0
	- No	15	28.8	21	40.4	16	30.8	52	100.0
2.2	Type of contact								
	- flying foxes entered the shed	0	0.0	0	0.0	0	0.0	0	0.0
	- flying foxes attacked the cattle	0	0.0	0	0.0	0	0.0	0	0.0

people who intentionally handled bats, 31%; and those who had spontaneously contacted bats, 4% [19].

A small proportion of the respondents in our study who had contact with bats reported having been scratched or bitten. Nearly all our respondents said they seldom used PPE, owing to a lack of awareness. People in the region believe that the bats in their residential area are in good health and are unlikely to transmit infectious diseases to them. Local residents never consider that flying foxes could be carriers of zoonotic diseases. A survey of adults in New South Wales showed that 15.5% of 821 respondents had handled bats, even though 42% of them had seen or heard warnings about holding bats. A quarter (25%) of those respondents continued to handle injured and/or trapped bats and 17% of them did so with bare hands. A total 14% of those respondents ignored minor scratches from bats; only 4 ignored severe scratches [23]. Most bat hunters and traders in Central Kalimantan are unaware of the fact that flying foxes are carriers of zoonotic diseases and only a small proportion protect themselves during physical contact [10].

Indirect contact, which includes eating fruit contaminated by bats and/or eating domestic animals infected with disease by flying foxes, also poses potential risks for infection. In Bangladesh, the primary pathway of NiV transmission from bats to people is through consumption by humans of raw date palm sap that has been contaminated with bat saliva [16]. In a study in Africa, NiV was detected in 48% and 3–4% of bat and human samples, respectively, by seroneutralization assay [24]. People who butchered bats for consumption were exclusively seropositive for NiV [24].

Among our respondents, people living near roosting sites said they had never seen flying foxes exhibiting abnormal behaviors.

Table 8. Sudden deaths of the domestic animals

No	Variables	R<1 km		R=1–5 km		R=5–10 km		Total	
		Total	%	Total	%	Total	%	Total	%
1	**Dogs**								
1.1	Seen or heard of suddent death of dogs								
	- Yes	8	5.3	16	10.7	18	12.0	42	28.0
	- No	42	28.0	34	22.7	32	21.3	108	72.0
2	**Cattle**								
2.1	Seen or heard sudden death of cattle								
	- Yes	15	10.0	20	13.3	16	10.7	51	34.0
	- No	35	23.3	30	20.0	34	22.7	99	66.0
2.2	Frequecies of sudden death of cattle								
	- Very rare	10	19.6	14	27.5	9	17.6	33	64.7
	- Sometimes	2	3.9	2	3.9	2	3.9	6	11.8
	- Often	3	5.9	4	7.8	5	9.8	12	23.5
3	**Other animal**								
3.1	Sudden death in other animal								
	- Yes	21	17.5	26	21.7	14	11.7	61	50.8
	- No	17	14.2	22	18.3	20	16.7	59	49.2
3.2	Frequecies of sudden death of other animal								
	- Very rare	5	8.2	8	13.1	4	6.6	17	27.9
	- Sometimes	11	18.0	8	13.1	4	6.6	23	37.7
	- Often	5	8.2	10	16.4	6	9.8	21	34.4

Table 9. Knowledge of village people on rabies

No	Variables	R<1 km		R=1–5 km		R=5–10 km		Total	
		Total	%	Total	%	Total	%	Total	%
1	**Level of knowledge**								
	- Poor	33	22.0	25	16.7	26	17.3	84	56.0
	- Fair	13	8.7	23	15.3	17	11.3	53	35.3
	- Good	4	2.7	2	1.3	7	4.7	13	8.7

Clinical signs have been observed among bats infected with Lyssavirus [21]. Changes in reflexes, loss of appetite, the appearance of tremors and paralysis and prostration are the main symptoms in bats. Among wild bats infected with ABLV, neurological signs have also been reported, such as paralysis or paresis of the shind and/or fore limbs [20]. Symptoms of clonic muscle spasms and changes in vocalization are also seen.

In the last 5 years in Garut District, there has been many reported cases of sudden death in humans, both adults and infants. Among these, heart attack is the most prevalent cause of sudden death in adults and elderly individuals; high fever of long duration without neurological symptoms is the most common cause of sudden death among infants. Each reported case showed that, the patient had no history of contact with bats before their death. There were no typical symptoms of the above-mentioned bat-related infectious diseases.

Sudden deaths among domestic animals, especially cattle, have also been frequently reported in the region over the last 5 years; however, most of these seem to have been caused by poisoning. Landowners often use herbicides to kill plants or weeds, which are subsequently consumed by cattle during grazing. Some landowners do not want their land to be used for grazing cattle and sometimes intentionally leave such toxins on plants and grasses for cattle to consume, often resulting in cattle death . In addition, a variety of infectious diseases endemic in the study area, such as bovine ephemeral fever and septicemia epizootica, are often the cause of sudden death in domestic cattle in that region. We did not get any information for rabies-related diseases in cattle.

Some members in the community often contact with the flying foxes, but there was no evidence of transmission of pathogens from flying foxes to humans. Nevertheless, direct and/or indirect contacts with flying foxes must be a high risk for contracting zoonotic viral diseases. The encounters among flying foxes, pigs, horses and/or humans has caused henipah virus disease [5, 16]. Holding flying foxes at rehabilitation facilities leaded Australian bat lyssavirus disease (ABL) [1]. Not only flying foxes, but also small insectivorous bats have been involved in serious respiratory syndromes, by SARS coronavirus (SARS-CoV) [9] and MERS coronavirus (MERS-CoV) [28]. The deaths of 186 persons by Ebola virus were initiated after consuming flying foxes in the Democratic Republic of Congo (DRC) in 2007 [15]. It is reported that a Japanese traveler was exposed to Nelson Bay Orthoreovirus, commonly found in flying foxes, after going to Bali, Indonesia [30].

People living near bat roosting sites have mostly poor to moderate knowledge levels about bats and rabies. Public knowledge in this area must be improved, considering that flying foxes frequently enter residential areas and come in contact with humans. Local communities and relevant government offices must equip the local population with appropriate knowledge, to prevent infectious disease from flying foxes. A study on human attitudes and public opinion in Australia about flying foxes and Hendra virus showed that most people already have moderate to high [14]. Nevertheless, only a few people in Garut believe that flying foxes can directly transmit infectious viruses to humans. Information on the involvement of bats in transmission of zoonotic diseases remains limited in that region, perhaps because no serious endemic zoonotic infectious diseases mediated by flying foxes have appeared in Garut. On the other hand, programs to increase awareness of bats being carriers of serious pathogens have not been established in Indonesia. With respect to the risk of human exposure to pathogens carried by bats in Thailand, Robertson *et al.* found that only a small proportion (11%) of people consider bats a potential source of rabies [25]. Although 27% of participants in that study had a history of being bitten or scratched by a bat, 36% of them took no action or did not know what to do in such cases. Based on these findings, it is highly recommended that people are educated on the risk of zoonoses from bats in Southeast Asian countries.

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