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Community perspectives on canine-mediated rabies risk in the Klang Valley, Malaysia: implications for outbreak preparedness

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Abstract

Background Despite being declared rabies-free in 2012, Malaysia has experienced a resurgence of canine-mediated rabies since 2015, with the Klang Valley, a densely populated urban hub, facing an increasing threat. The success of elimination efforts hinges on community engagement. Yet, baseline data on public knowledge, attitudes, and practices (KAP) in this critical region are limited. This study aimed to assess the cognitive (knowledge), affective (attitude), and behavioural (practice) domains of the Klang Valley community regarding canine-mediated rabies to inform targeted public health interventions and outbreak preparedness strategies.

Methods A cross-sectional questionnaire survey was conducted from September 2022 to March 2023 to assess community knowledge, attitudes, and behaviours regarding rabies risk factors. Knowledge was evaluated using true/false/unsure options, perceptions were measured with a Likert scale, and practices were recorded via yes/no responses. Understanding levels were quantified using Bloom's scoring system, categorised as high (80–100%), moderate (60–79%), or low (below 60%). Perceived knowledge scores were similarly classified as positive, neutral, or negative based on these percentage ranges. Univariate binary logistic regression was used to examine the association between socio-demographic factors and the likelihood of having a non-positive Cognitive-Affective-Behavioural (CAB) score, a proxy for increased rabies risk, with data analysed using Microsoft Excel and SPSS version 20.

Results The study achieved a high response rate of 73.44%, with respondents predominantly female (60.99%) and aged 18–25 (48.40%). The majority were Malaysian citizens of Malay descent (45.57%), single (59.04%), and possessed tertiary education (62.06%). The overall mean CAB score was 61.61% (±2.30%), with 38.39% (±2.29%) of respondents exhibiting a non-positive score. While 74.70% (95% CI: 71.11–78.29) demonstrated general knowledge of rabies, only 31.25% (95% CI: 27.42–35.08) reported the positive practice of immediate wound washing after a dog bite. Univariate logistic regression revealed that gender and age were significant predictors of a non-positive CAB score. Males had 34% lower odds of a non-positive CAB score compared to females (OR = 0.66, 95% CI [0.47, 0.95], $p = 0.024$).

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Furthermore, participants aged 26–33 years had 45% lower odds of a non-positive CAB score compared to the youngest group (18–25 years) (OR = 0.55, 95% CI [0.33, 0.92], $p = 0.022$).

Conclusions The study highlights significant gaps in rabies-related practices and identifies vulnerable demographic groups (females, the youngest, and the oldest age cohorts) in the Klang Valley. The low adherence to immediate post-exposure prophylaxis practices poses a critical public health risk. Hence, Public health campaigns must be urgently implemented in the Klang Valley, focusing on improving correct post-exposure wound care practices and specifically targeting vulnerable groups identified by this study to enhance rabies outbreak preparedness and support the 'Zero by 30' global goal.

Keywords Canine-mediated rabies, Community knowledge, Canine Population, Attitudes and behaviours, Health-seeking practices, Rabies prevention and control, Outbreak preparedness, Klang Valley, Malaysia

Introduction

Malaysia lost its rabies-free status in 2015 following multiple outbreaks of enzootic canine rabies within and beyond the Peninsular Malaysia rabies-immune belt [1, 2]. Despite extensive mass vaccination campaigns and population control initiatives for domestic dogs in targeted areas, canine rabies remains a pressing public health concern in Malaysia [1–4]. Urban areas, including the Klang Valley, are increasingly affected by cross-border occurrences and increasing human fatalities in various regions of Malaysia [2, 3]. The re-emergence of rabies in Malaysia, a nation declared rabies-free in 2012 [3], underscores the fragility of this status and the persistent threat posed by the disease. The East Malaysian state of Sarawak has been particularly affected, accounting for the majority of human rabies deaths in the country, with a case fatality rate of approximately 90% [1]. The primary driver of these outbreaks is low vaccination coverage among the dog population, estimated to be well below the 70% threshold recommended by the World Health Organization (WHO) for achieving herd immunity [1–4].

The complex interaction between human communities and canine populations plays a crucial role in determining the efficacy of rabies control strategies, particularly in densely populated urban settings such as the Klang Valley, Malaysia. The success of rabies control efforts relies on scientific and veterinary interventions and on an understanding of community perspectives towards canine vectors, prevention, and control measures. Several studies have been conducted in Asia, Africa, and Europe to highlight the importance of public knowledge and awareness regarding rabies and the necessity of preventive behaviours [5–13].

Despite the global emphasis on community engagement in rabies prevention, a significant research gap remains in Malaysia, particularly in the Klang Valley, where limited baseline data exist [8, 9, 13] to explore public responses towards canine-mediated rabies and dog population management. The coexistence of humans and dogs in urban environments in the Klang Valley presents unique challenges that underscore the urgency of this study. Drawing on insights from various global contexts [14–21], this research aims to address a local research gap by providing essential information to guide rabies outbreak preparedness strategies tailored to the distinctive dynamics of the Klang Valley. Understanding public perceptions and attitudes is crucial in promoting community engagement and enhancing the effectiveness of rabies control efforts in urban areas, in line with the 'One Health' approach and the global goal of 'Zero by 30' to eliminate dog-mediated human rabies deaths by 2030.

Design and methodology

Study design and sampling location

A cross-sectional study was conducted from September 2022 to March 2023 across nine randomly selected cities in the Klang Valley (Fig. 1). This densely populated region, which encompasses Kuala Lumpur, Putrajaya, and Selangor, serves as Malaysia's economic hub. The Klang Valley is characterised by its extensive urban development, high population density, significant cultural diversity, and a wide array of socioeconomic activities, including commerce, industry, and education, which contribute to its dynamic human-animal interface.

Sample size, target population, and inclusion criteria

The minimum sample size was calculated to be 384 using Thrusfield's formula [22], assuming a 50% predicted prevalence, a 95% confidence level, and 5% absolute precision. To ensure adequate data for robust statistical analysis and to account for potential non-response or incomplete questionnaires, 768 questionnaires were administered, representing a 100% amplification over the minimum calculated sample size. This amplification was a pragmatic decision to enhance the study's statistical power and generalizability, particularly given the diverse demographic landscape of the Klang Valley. The sample size was not based on the study area's approximate population but instead aimed to achieve a representative sample within the defined parameters. Participants included adults aged 18 or older who had resided in the Klang Valley for at least six months, irrespective of dog ownership.

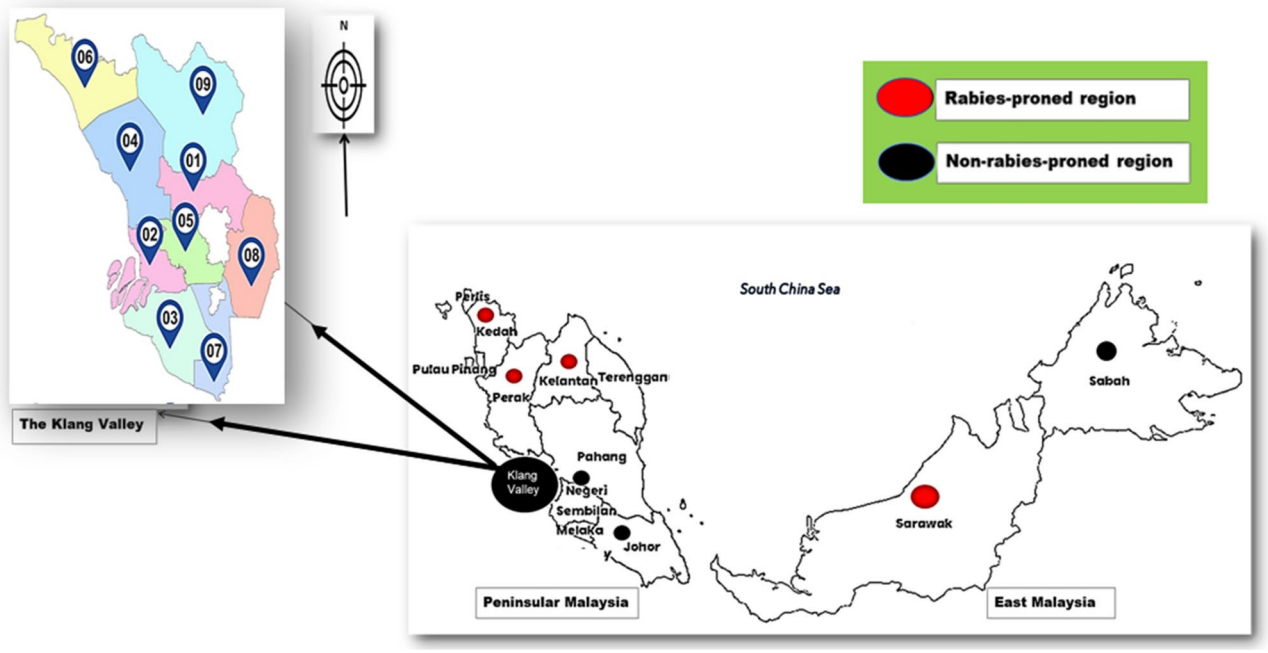

Fig. 1 Map of Malaysia illustrating Klang Valley in Peninsular Malaysia with marked Sampling Locations (top left) within the Klang Valley (Adapted from Malaysia's Department of Statistics, 2021; Scale 1:10,000)

Exclusion criteria comprised tourists, residents of hotels or guest houses, nursing home residents, individuals with hearing or vision impairments, those with mental health issues, and individuals who had resided in the Klang Valley for less than six months.

Questionnaire design, pretesting, and validation

This study utilised Bloom's taxonomy [23] as a framework to investigate the cognitive (knowledge), affective (attitude), and behavioural (health-seeking practices) domains pertinent to canine rabies prevention. A structured questionnaire, adapted and modified from a validated instrument used in the National Health and Morbidity Survey (NHMS) [24] for dog-mediated zoonoses in Malaysia, was employed. The adaptation process involved refining the wording of questions and response options to ensure clarity, cultural relevance, and precise alignment with the study objectives [25]. The questionnaire underwent pretesting with a small pilot group (n = 30) to assess comprehensibility, flow, and internal consistency (Cronbach's alpha > 0.7 for all sections), thereby ensuring reliability and validity for the target population. The survey instrument comprised four comprehensive sections:

- *Section A (13 items)*: Collected socio-demographic information.
- *Section B (17 items)*: Assessed cognitive (objective) and perceived (subjective) aspects, including knowledge about rabies, perceived risk factors, and attitudes towards disease spread and prevention.
- *Section C (9 items)*: Evaluated affective aspects, such as attitudes towards dog ownership, animal welfare laws, and consequences for mistreating animals, utilizing a Likert scale.
- *Section D (6 items)*: Examined behavioural aspects, including adherence to recommended practices, responses to dog bites, and health-seeking practices.

Following preliminary pretesting and content validation by experts in veterinary epidemiology and public health, the questionnaire was administered via various channels, including online media, face-to-face interviews, and the physical distribution of QR code flyers, with weekly reminders sent to optimise response rates.

Data analysis

The response rate was calculated as the percentage of administered questionnaires that were completed and returned by consenting respondents. Knowledge was assessed using a series of true/false/unsure questions. For each respondent, a total knowledge score was calculated by summing the number of correct answers. This score was then converted to a percentage. Based on Bloom's taxonomy, knowledge levels were categorised as 'high' (80–100% correct), 'moderate' (60–79% correct), low (40–59% correct), or non-knowledgeable (0–39%). Perceived knowledge was assessed and categorised as Positive (80%-100%), Neutral (60%-79%), and Negative (Less

than 60%). Practices were evaluated using yes/no questions. The responses were categorised as 'positive practice' (recommended health-seeking behaviour), 'neutral practice', or 'negative practice' (no action or inappropriate action). The overall Cognitive-Affective-Behavioural (CAB) scores were calculated, and univariate binary logistic regression analyses were conducted to examine the association between socio-demographic characteristics and the likelihood of having a Non-Positive Cognitive-Affective-Behavioural (CAB) score (Neutral or Negative), which serves as a proxy for increased risk of rabies exposure. All data were analysed using Microsoft Excel and SPSS version 20.

Results

Survey response rate and respondent characteristics

The survey achieved a high response rate of 73.44% (564 out of 768 administered questionnaires), with no significant rejections reported during the administration phase. The Petaling district contributed the highest proportion of respondents (32.45%). Female participants constituted the majority (60.99%), and the 18–25 age group was the most represented (48.40%). The demographic profile further indicated that most respondents were Malaysian citizens of Malay ethnicity (45.57%), unmarried (59.04%), and possessed tertiary education (62.06%). Students (43.62%) and medical/health professionals (27.84%) formed the largest occupational groups. Housing patterns varied: 64.89% owned houses and 45.92% reported 4–6 household members. Notably, 39.18% of participants reported owning a dog (Table 1).

Cognitive assessment of public knowledge and perception

The cognitive assessment revealed that a majority of respondents (74.70%, 95% CI: 71.11–78.29) had at least some knowledge of rabies, which was considered 'general knowledge' in this context. Of these, 44.44% (95% CI: 39.69–49.19) demonstrated a high level of knowledge, 33.33% (95% CI: 28.83–37.83) a moderate level, and 22.22% (95% CI: 18.25–26.19) a low level. Consequently, 25.30% (95% CI: 21.71–28.89) of the respondents were categorised as 'non-knowledgeable' about rabies (Table 2).

Further, Table 3 shows the distribution of perceptions (positive, neutral, negative) regarding various risk factors of canine-mediated rabies among 564 residents in the Klang Valley, Peninsular Malaysia. The study findings highlighted the average perceived knowledge level regarding canine-mediated rabies risk factors and transmission dynamics, with 48.33% (95% CI, 44.21–52.45) of respondents holding positive perceptions, 34.03% (95% CI, 30.12–37.94) displaying neutral perceptions, and 17.64% (95% CI, 14.49–20.79) showing negative perceived knowledge towards canine-mediated rabies risk and its transmission dynamics.

Affective assessment of public attitudes towards dog ownership and welfare in Malaysia

The affective assessment explored public attitudes towards dog ownership and animal welfare. Only 39.18% of respondents expressed a preference for owning dogs, mainly for companionship (61.09%) or security purposes (29.41%). In contrast, 40.52% of participants were not inclined to own dogs, citing religious beliefs (59.48%), personal dislike (15.09%), and concerns about potential injuries or diseases from dog bites (12.93%). Additionally, 4.13% mentioned being too busy to care for a dog (Fig. 2).

Further, the majority of respondents (64.7%) indicated that they do not allow stray dogs on their premises. However, encounters with stray dogs were common: 27.5% and 21.8% reported sightings in the evening and at night, respectively, while 32.6% rarely observed them near their homes. Regarding actions taken towards stray dogs in their vicinity, 48.9% did not intervene, 14.70% attempted to drive them away, 11.3% provided food, 7.3% allowed mating with their owned dogs, and 8.30% reported the issue to authorities. Awareness of the Animal Welfare Act was low (22.70%). However, 77.7% of respondents acknowledged the potential legal implications of mistreating dogs (Fig. 3).

Behavioural assessment of health-seeking practices when exposed to dog bites

The findings from the behavioural assessment conducted in the Klang Valley revealed important insights into the public's health-seeking practices regarding canine-mediated rabies prevention and control. According to the assessment results (Fig. 4), a significant proportion (22.70%) of respondents reported experiencing dog bites or scratches within the past year.

Further, cross-sectional analysis of health-seeking practices related to canine-mediated rabies in Klang Valley revealed suboptimal practices among participants. Specifically, only 31.25% (95% CI [27.42, 35.08]) reported the positive practice of immediately washing a dog bite wound with soap and running water for at least 15 min, while a comparable proportion demonstrated negative practices (33.11%, 95% CI [29.20, 37.02]). Similarly, while 37.23% (95% CI [33.25, 41.21]) sought professional medical treatment at a clinic or hospital after a bite, 36.17% (95% CI [32.26, 40.08]) did not. Overall, the average behavioural score was low, with only 34.24% (95% CI [30.36, 38.12]) of respondents consistently exhibiting positive practices across the measured domains (Table 4).

Table 1 Distribution and socio-demographic characteristics of respondents ($N=564$) in the Klang Valley, Peninsular Malaysia

Variable	Response	Frequency (*n*)	Percentage (%)
District	Gombak	45	7.98
	Ulu Langat	81	14.36
	Ulu Selangor	21	3.72
	Klang	62	10.99
	Kuala Langat	36	6.38
	Kuala Lumpur	87	15.43
	Petaling	183	32.45
	Putrajaya	9	1.60
	Sepang	40	7.09
Gender	Female	344	60.99
	Male	220	39.01
Age	18–25	273	48.40
	26–33	99	17.55
	34–41	84	14.89
	42–49	70	12.41
	50 or older	38	6.74
Citizenship	Malaysian	470	83.33
	Non-Malaysian	59	10.46
	Permanent resident	35	6.21
Ethnicity	Chinese	178	31.56
	Indian	93	16.49
	Malay	257	45.57
	Others	36	6.38
Marital status	Living with a partner	10	1.77
	Married	191	33.87
	Separated	22	3.90
	Single	333	59.04
	Widow/ Widower	8	1.42
Education level	No formal education	11	1.95
	Primary education	8	1.42
	Secondary education	195	34.57
	Tertiary education	350	62.06
Occupation	Government employee	79	14.01
	Private employee	151	26.77
	Self-employed	48	8.51
	Semi-government employee	25	4.43
	Student	246	43.62
	Unpaid family worker	15	2.66
Work in the medical field	No	407	72.16
	Yes	157	27.84
House ownership	Government staff quarters	16	2.84
	Living for free/squatter	14	2.48
	Owned	366	64.89
	Rented	168	29.79
Type of house	Detached house/ bungalow	101	17.91
	Flat apartment/ condominium	154	27.30
	Semi-Detached	66	11.70
	Shop House	8	1.42
	Squatters	4	0.71
	Townhouse	229	40.60
	Water house	2	0.35
Members of the household	1 to 3	247	43.79
	4 to 6	259	45.92

Table 1 (continued)

Variable	Response	Frequency (*n*)	Percentage (%)
	7 to 9	41	7.27
	10 or more	17	3.01
Dog ownership	No	343	60.82
	Yes	221	39.18

Table 2 Assessment of cognitive (general) knowledge levels regarding rabies etiology, transmission, and prevention in a Klang Valley, Peninsular Malaysia Cohort (*N* = 564)

Variables	Knowledgeable (*n* = 421)				Non-knowledgeable (*n* = 143)			
			95% CI				95% CI	
	n	Proportion	Lower	Upper	*n*	Proportion	Lower	Upper
Dogs that are infected with rabies show signs of profuse salivation and aggressive behaviour	447	79.26	75.91	82.61	117	20.74	17.39	24.09
You can get infected with rabies if a rabid dog bites you	497	88.12	85.45	90.79	67	11.88	9.21	14.55
Rabies from dogs can infect humans	502	89.01	86.43	91.59	62	10.99	8.41	13.57
Vaccination for dogs serves as a protection from infectious diseases	535	94.86	93.04	96.68	29	5.14	3.32	6.96
Prompt treatment at a clinic or hospital is necessary if bitten by a dog	531	94.15	92.21	96.09	33	5.85	3.91	7.79
Humans can be infected with rabies if their wounds are exposed to a rabid dog's saliva	417	73.94	70.32	77.56	147	26.06	22.44	29.68
A tetanus booster shot is one of the treatments given for dog bites	362	64.18	60.22	68.14	202	35.82	31.86	39.78
If bitten by a dog, the wound should be washed with soap and running water for at least 15 min	323	57.27	53.19	61.35	241	42.73	38.65	46.81
Dog scratches cannot transmit rabies to humans	177	31.38	27.55	35.21	387	68.62	64.79	72.45
Average knowledge score (%) (95% CI, L1-L2)	421	**74.70**	71.11	78.29	143	**25.30**	21.71	28.89
Level of Knowledgeable (%) (95% CI, L1-L2)	High		44.44 (39.69–49.19)					
	Moderate		33.33 (28.83–37.83)					
	Low		22.22 (18.25–26.19)					

Bloom cut-off point guide level of knowledge: High knowledge (80%-100%), Moderate knowledge (60%-79%), Low (40–59% correct), or Non-knowledgeable (0–39%); *CI* Confidence interval

Table 3 Distribution of perceived knowledge regarding canine rabies risk factors among a Klang Valley, Peninsular Malaysia Cohort (*N* = 564)

Variables	Positive perception				Neutral perception				Negative perception			
			95% CI				95% CI				95% CI	
	n	Proportion (%)	Lower	Upper	*n*	Proportion (%)	Lower	Upper	*n*	Proportion (%)	Lower	Upper
I believe dogs can spread diseases to me	166	29.40	25.64	33.16	309	54.80	50.69	58.91	89	15.80	12.79	18.81
I do not think I need any first-aid treatment after being bitten by a dog	395	70.00	66.22	73.78	117	20.80	17.45	24.15	52	9.20	6.81	11.59
I am worried that family members with health problems will be prone to contracting diseases from dogs	144	25.50	21.90	29.10	236	41.80	37.73	45.87	184	32.60	28.73	36.47
I am worried when children play with stray dogs	222	39.40	35.37	43.43	196	34.80	30.87	38.73	146	25.90	22.28	29.52
The use of personal protective equipment while cleaning the pet dog's waste is not important	235	41.60	37.53	45.67	175	31.00	27.18	34.82	154	27.30	23.62	30.98
I need to get vaccinated against rabies if a stray dog bites me within an area that has rabies cases	317	56.20	52.11	60.29	174	30.90	27.09	34.71	73	12.90	10.13	15.67
Dogs within the area with rabies cases need to be vaccinated against rabies	363	64.40	60.45	68.35	146	25.90	22.28	29.52	55	9.80	7.35	12.25
Dog owners need to bring their pet dog(s) to the veterinary clinic for annual vaccination	339	60.10	56.06	64.14	182	32.20	28.34	36.06	43	7.60	5.41	9.79
Average affective (perception)	273	48.33	44.21	52.45	192	34.03	30.12	37.94	100	17.64	14.49	20.79

Bloom's cut-off points guide on the level of attitude: Positive (80%-100%), Neutral (60%-79%), Negative (Less than 60%), *CI* Confidence interval

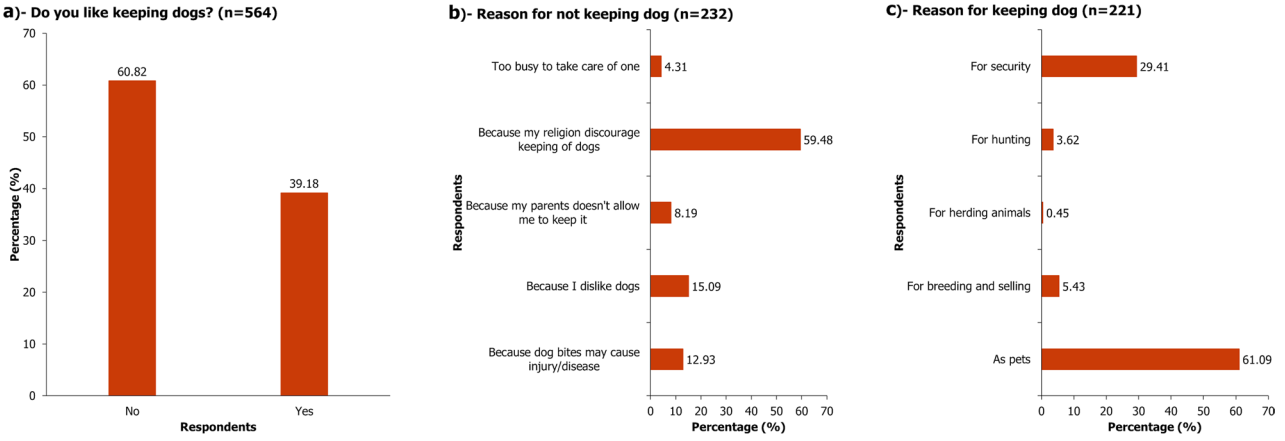

Fig. 2 Affective assessment of public perceptions and attitudes towards household dog ownership in Klang Valley, Malaysia (**a**, **b**, and **c**, are panel questions asked for affective assessment towards dog ownership)

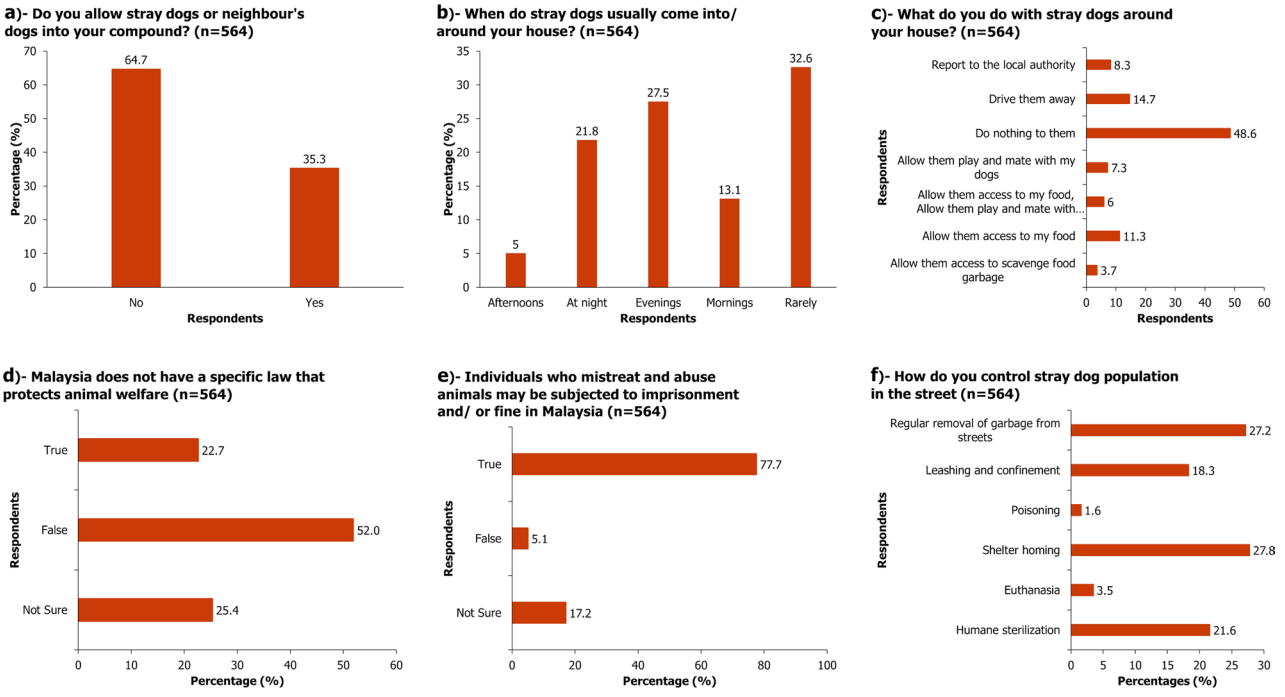

Fig. 3 Awareness of the animal welfare act 2015 and local by-laws for dog welfare among residents of Klang Valley, Malaysia (**a**, **b**, **c**, **d**, **e**, and **f** are panel questions asked for awareness of the Animal Welfare Act 2015)

Overall analysis of socio-demographic factors predicting non-positive CAB scores

A series of univariate binary logistic regression analyses was conducted to examine the association between socio-demographic characteristics and the likelihood of having a Non-Positive Cognitive-Affective-Behavioural (CAB) score (Neutral or Negative), which serves as a proxy for increased risk of rabies exposure due to inadequate knowledge, attitudes, or practices. The Positive CAB score was used as the reference outcome. The results, including the proportion of participants with Positive and Non-Positive CAB scores and the Odds Ratios (ORs), are presented in Table 5. The univariate logistic regression revealed several significant associations between socio-demographic factors and the odds of having a Non-Positive CAB score. Gender was a significant predictor, with males having 34% lower odds of a Non-Positive CAB score compared to females (OR = 0.66, 95% CI [0.47, 0.95], $p = 0.024$).

Age Group also emerged as a significant factor. Participants aged 26–33 years had 45% lower odds of a Non-Positive CAB score compared to the youngest group (18–25 years) (OR = 0.55, 95% CI [0.33, 0.92], $p = 0.022$). This is supported by the highest proportion of Positive

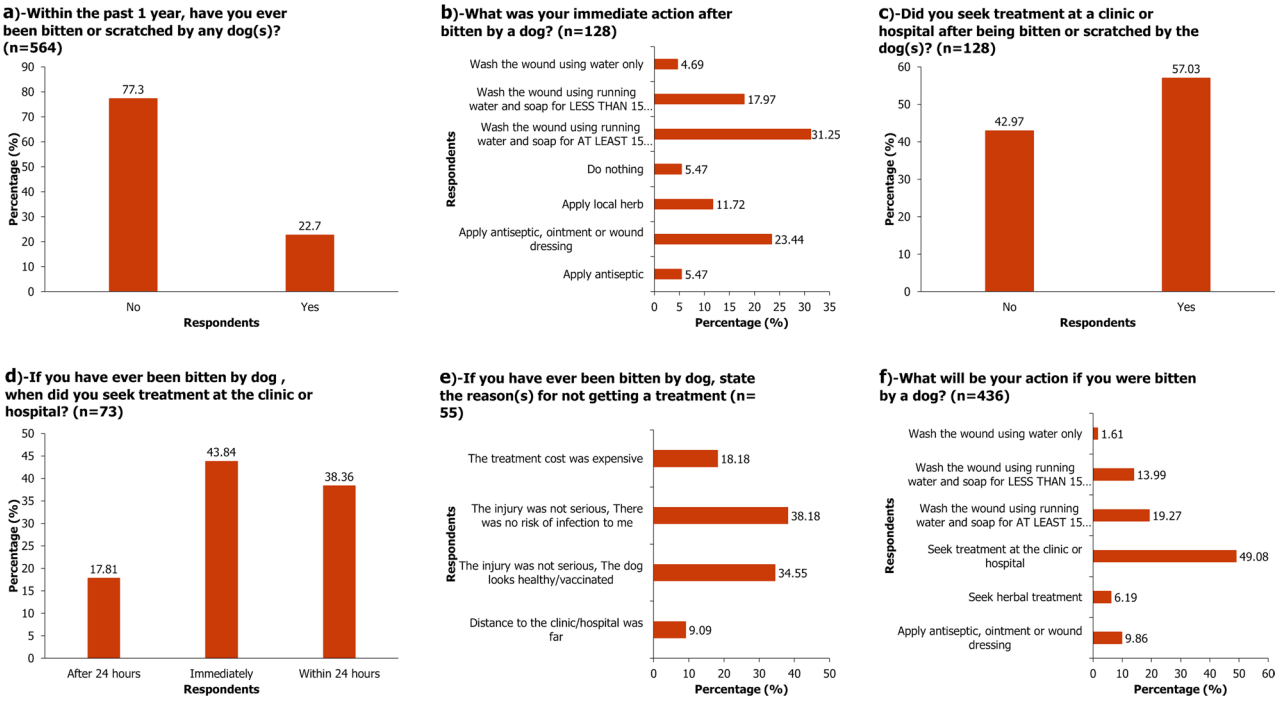

Fig. 4 Assessment of community practices and health-seeking behaviours for canine rabies prevention in Klang Valley, Malaysia (**a**, **b**, **c**, **d**, **e**, and **f** are panel questions asked for practices and health-seeking behaviour for canine rabies prevention)

Table 4 Distribution of good health-seeking behaviours (practices) regarding canine-mediated rabies risk factors in the Klang Valley, Peninsular Malaysia

Variables	Positive practice *n* (%) (95% CI)	Neutral practice *n* (%) (95% CI)	Negative practice *n* (%) (95% CI)
Immediate action after a dog bite: Wash the wound with soap and running water for at least 15 min	176 (31.25) (27.42–35.08)	201 (35.64) (31.69–39.59)	187 (33.11) (29.20-37.02)
Seek treatment at a clinic or hospital after a dog bite	210 (37.23) (33.25–41.21)	150 (26.60) (22.90–30.30)	204 (36.17) (32.26–40.08)
Average behavioural (practice)	193 (34.24) (30.36–38.12)	175 (31.12) (27.29–34.95)	195 (34.64) (30.75–38.53)

CAB scores (73.7%) found in the 26–33 age group. Conversely, the oldest age group (50 or older) showed a strong trend toward higher odds of a Non-Positive CAB score, nearly twice those of the 18–25 group (OR = 1.92, 95% CI [0.97, 3.80], $p = 0.062$). This group also had the lowest proportion of Positive CAB scores (44.7%) (Table 5).

While not statistically significant at the alpha = 0.05 level, Education Level showed a clinically important trend: individuals with no formal education were over three times more likely to have a Non-Positive CAB score compared to those with tertiary education (OR = 3.07, 95% CI [0.88, 10.70], $p = 0.078$). Overall, the majority of respondents had positive mean CAB scores of 61.61% (± 2.30%) towards canine-mediated rabies. In comparison, 38.39% (± 2.29%) were non-positive (i.e., neutral or negative) (Table 5).

Discussion

This study provides a baseline assessment of community knowledge, attitudes, and behaviour practices regarding canine-mediated rabies transmission, risk, prevention, and control in the Klang Valley, Malaysia, an area with a high population density and significant human-animal interaction. The high response rate from participants across the diverse Klang Valley region demonstrates strong community interest and engagement in the topic, thereby enhancing the credibility of the study's findings and providing valuable insights for public health interventions. Additionally, the higher response rate among female participants suggests the effectiveness of gender-specific communication strategies in health-related surveys, as supported by the literature [24, 26, 27]. Sociodemographic data, including information on dog ownership prevalence and housing types, are essential for developing targeted rabies control measures. The ethnic diversity of participants emphasises the need for culturally sensitive approaches in public health initiatives. Identifying the proportion of dog owners in the study population provides a foundational baseline for designing targeted vaccination and responsible pet ownership programs, as demonstrated in previous studies conducted

Table 5 Univariate logistic regression analysis of socio-demographic factors predicting non-positive CAB scores ($N = 564$) in the Klang Valley, Peninsular Malaysia

Predictor	Category	*n*	Positive CAB (%)	Non-Positive CAB (%)	OR (95% CI)	*p*-value
Gender	Female (Ref.)	344	58.7	41.3	—	—
	Male	220	68.2	31.8	0.66 (0.47, 0.95)	0.024*
Age Group	18–25 (Ref.)	273	60.8	39.2	—	—
	26–33	99	73.7	26.3	0.55 (0.33, 0.92)	0.022*
	34–41	84	59.5	40.5	1.05 (0.64, 1.74)	0.834
	42–49	70	65.7	34.3	0.81 (0.47, 1.40)	0.451
	50 or older	38	44.7	55.3	1.92 (0.97, 3.80)	0.062
Ethnicity	Malay (Ref.)	257	63.8	36.2	—	—
	Chinese	178	57.3	42.7	1.31 (0.89, 1.94)	0.171
	Indian	93	65.6	34.4	0.93 (0.56, 1.52)	0.759
	Others	36	69.4	30.6	0.78 (0.37, 1.65)	0.509
Education Level	Tertiary (Ref.)	350	63.7	36.3	—	—
	Secondary	195	61	39	1.12 (0.78, 1.61)	0.534
	Primary	8	75	25	0.59 (0.12, 2.94)	0.516
	No formal	11	36.4	63.6	3.07 (0.88, 10.70)	0.078
Dog Ownership	No (Ref.)	343	64.1	35.9	—	—
	Yes	221	59.7	40.3	1.21 (0.85, 1.71)	0.291
Mean CAB Scores (%)			61.61 ± 2.30	38.39 ± 2.29		

Odds Ratio; *CI* Confidence Interval. The dependent variable is Non-Positive CAB Score (Neutral or Negative) vs. Positive CAB Score (Reference) * = Statistically significant ($p \leq 0.05$)

across various Asian countries [24, 26, 27]. Although no significant rejections were reported during the administration phase, the primary reason for the few respondents' non-response was that they had not consented to participate.

The cognitive assessment results reveal significant public health implications regarding canine-mediated rabies awareness among residents. With 74.70% of respondents demonstrating general knowledge of rabies, there was notable variability in understanding, with only 44.44% demonstrating high knowledge. The fact that 25.30% were classified as non-knowledgeable highlights a critical segment of the population that may be highly vulnerable to misinformation and less likely to adopt preventive behaviours. Similar knowledge gaps have been identified in studies conducted in China [27] and India [28], highlighting a common challenge in addressing misconceptions and emphasizing the need for targeted educational campaigns to bridge knowledge gaps. The distinction between cognitive knowledge (objective understanding) and perceived knowledge (subjective belief about one's understanding) is crucial. Our results show that, while objective knowledge is moderate to high for many, perceived knowledge also varies, suggesting that individuals may over- or underestimate their actual understanding, which can influence their health-seeking behaviours.

The perception of risk factors and transmission dynamics also varied, with only 48.33% holding positive perceptions. These findings underscore the need for targeted educational interventions to enhance comprehensive rabies awareness and preventive practices, ultimately reducing rabies incidence and transmission in the community. Strategies employed in regions such as Africa and Asia, where community involvement and understanding are pivotal in rabies control efforts, can inform initiatives to alter negative perceptions and improve knowledge [10–12, 29]. Tailoring interventions to address specific concerns identified in this study could lead to more effective rabies control.

Exploring public attitudes and perceptions towards dog ownership has significant implications for public health and rabies control efforts. The varied motivations for owning dogs indicate the influence of cultural factors on community practices, which, in turn, affect the spread of rabies. The study revealed that only 39.18% of respondents cited keeping dogs for companionship or security reasons, highlighting the diverse reasons for dog ownership. Religious or cultural influences that discourage dog ownership have been observed in previous studies in [8, 13, 24, 30], and these factors play a crucial role in shaping community attitudes toward dog ownership and rabies prevention. Tailoring awareness campaigns to address these cultural nuances is essential for effective control strategies. Research in Africa and Europe has shown the effectiveness of community-specific approaches in rabies control, taking into account local beliefs and practices [18, 31]. Involving religious leaders and community influencers in awareness programs can help overcome barriers to dog ownership and promote the acceptance of rabies control measures.

The low awareness of the Animal Welfare Act (22.70%) suggests a need for increased public education on the

legal frameworks governing animal treatment, which could, in turn, indirectly impact rabies control by promoting responsible pet ownership. The prevalence of stray dog encounters and varied community responses (e.g., feeding vs. reporting to authorities) highlight the challenges in managing free-roaming dog populations, a key factor in rabies epidemiology [32, 33].

A key finding of this study is the discrepancy between knowledge and practice. While a majority of respondents recognised the seriousness of rabies, a significant proportion did not follow recommended health-seeking behaviours after a dog bite. This 'KAP-gap' is a common challenge in public health and highlights the need for interventions that go beyond simple awareness campaigns to address the barriers to appropriate health-seeking behaviours. These barriers may include cultural beliefs, financial constraints, and lack of access to healthcare facilities. This discrepancy suggests that knowledge alone is insufficient to drive behavioural change, necessitating interventions that address attitudinal barriers, cultural beliefs, and practical challenges to accessing healthcare. These findings suggest an urgent need for public health interventions to improve knowledge and behaviours regarding postexposure rabies prophylaxis, emphasising the importance of wound cleaning and prompt medical attention to prevent rabies fatalities. Insights from studies in Africa, Europe, and America emphasise the role of community engagement in dispelling myths surrounding rabies and strengthening the link between exposure and appropriate health-seeking behaviour through targeted education and community engagement to improve rabies prevention and control [33–35].

The study also found that dog ownership was significantly associated with higher knowledge scores, which is an encouraging finding. Dog owners are a critical target group for rabies control efforts, and their engagement is essential for increasing dog vaccination coverage. However, the study also revealed that a substantial proportion of dog owners did not vaccinate their dogs annually, indicating a need for more effective communication and outreach to this group.

The identification of specific demographic groups, namely, females, the youngest (18–25), and the oldest (50+) age cohorts, and those with no formal education, as having significantly higher odds of Non-Positive CAB scores translates to a higher vulnerability to rabies exposure, and provides a critical, data-driven foundation for targeted public health interventions. Males were significantly less likely to have a Non-Positive CAB score, indicating that females in the study population are at a higher risk of having inadequate knowledge, less favorable attitudes, or less safe practices regarding rabies, as evidenced by the lower proportion of Positive CAB scores (58.7% for females vs. 68.2% for males). This finding suggests gender-based differences in health literacy and access to information. However, the specific reasons in the Klang Valley warrant further qualitative investigation.

The 26–33 age group was the most protected, while the oldest age group (50 or older) showed a strong trend towards increased risk. The vulnerability of the youngest (18–25) and oldest (50+) cohorts is a common pattern in health-related KAP studies, which may be attributed to lower life experience in the younger group and lower health literacy or access to modern information in the older group. The trend showing that individuals with no formal education were over three times more likely to have a Non-Positive CAB score compared to those with tertiary education strongly suggests that educational attainment is a key determinant of rabies-related risk in the Klang Valley.

Although Ethnicity and Dog Ownership were not found to be significant predictors of Non-Positive CAB scores in this study, studies in Tanzania [10] have similarly identified a correlation between dog ownership and rabies knowledge, emphasising the need for targeted interventions to engage dog owners in rabies prevention efforts. Therefore, moving beyond general population-level recommendations by pinpointing the precise segments of the Klang Valley community, such as Petaling and Kuala Lumpur, where educational and behavioural campaigns will yield the most significant impact on reducing the proxy risk of rabies exposure, is crucial for enhancing vaccine uptake in both animal and human populations and ultimately achieving rabies elimination [30]. Specifically, the pronounced vulnerability of females and the elderly, coupled with the stark disparity in educational attainment, underscores the need to develop culturally sensitive, accessible, and age-appropriate communication strategies to close these critical knowledge and practice gaps, thereby maximising the efficiency and effectiveness of rabies control efforts in the region.

Limitations

This study, while providing valuable insights, has several limitations. The cross-sectional design precludes establishing causal relationships between variables. The reliance on self-reported data may introduce recall or social desirability bias, particularly for sensitive topics such as health-seeking behaviours. While efforts were made to ensure a representative sample within the Klang Valley, the findings may not be generalizable to other regions of Malaysia with different socio-demographic profiles or rabies epidemiological contexts. Future research could employ longitudinal designs, qualitative methods to explore underlying reasons for observed behaviours, and intervention studies to test the effectiveness of tailored public health campaigns.

Conclusions

This study provides essential baseline data on the community's KAP regarding canine-mediated rabies in the Klang Valley, Malaysia. While general knowledge is relatively high, significant gaps in knowledge, attitudes, and practices remain. The findings underscore the importance of targeted educational campaigns, improved access to PEP, and stricter enforcement of dog vaccination laws. A "One Health" approach involving all relevant stakeholders is crucial for the successful prevention and control of rabies in Malaysia and for achieving the global goal of eliminating dog-mediated human rabies deaths by 2030. The identification of gender and age as significant predictors of Non-Positive CAB scores highlights specific vulnerable populations that must be prioritised in future public health interventions. Addressing these behavioural and demographic vulnerabilities is crucial for enhancing rabies outbreak preparedness and achieving the global goal of eliminating dog-mediated human rabies deaths by 2030.

Abbreviations

CAB	Cognitive, Affective, and Behaviour
CI	Confidence Interval
QR	Quick Response
NHMS	National Health and Morbidity Survey

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Authors' contributions

YAW, MM, MMN, and MAM-L developed the research idea and plan. YAW conducted the survey, collected and analysed the data. YAW wrote the initial draft of the article. MM, MMN, MAM-L, NIUZ, LSF, and SZR supervised the research and contributed significant revisions to the manuscript. All authors have reviewed and consented to the final version submitted for publication.

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Data availability

Upon a reasonable request, the corresponding author can provide the datasets used and analysed in the current study.

Declarations

Ethics approval and consent to participate

The study was conducted in accordance with the Ethics Committee for Research Involving Human Subjects at Universiti Putra Malaysia (JKEUPM-2022-509), in compliance with the Declaration of Helsinki, the International Conference on Harmonisation (ICH) Guidelines, and local regulations and standards in ethical review.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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