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Knowledge of pet-related zoonotic diseases and pet care in Hong Kong, a heavily crowded urban setting

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Abstract

BACKGROUND: With the rapid expansion of pet animal populations worldwide, pet-related zoonotic diseases are becoming an important issue in public health. Hong Kong (HK), located in southern China, is one of the most crowded urban centres in the world. The population of pets, especially exotic pets, in HK has grown significantly in recent decades, potentially elevating the risk of pet-related zoonotic diseases. However, no studies have been conducted to explore the knowledge of HK public towards pet-related zoonotic diseases and animal husbandry practices.

OBJECTIVES: To evaluate the level of awareness among the HK public of pet-related zoonotic diseases and their understanding of proper animal husbandry practices.

METHODS: The study was carried out in HK from June–August 2019 using both online and paper versions of a questionnaire. A total of 362 completed questionnaires (74.3% return rate) were collected and the responses analysed.

RESULTS: Sixty percent of the participants were current or past pet owners or planned on becoming pet owners in the coming 2 years, irrespective of their income or size of their living space. Among the participants, pet owners (including those who planned pet ownership) had a relatively higher level of awareness of pet-related zoonotic disease. However, the overall awareness of zoonotic diseases among both pet and non-pet owners was low with a knowledge score of <50%. A similar trend was observed for knowledge about proper animal husbandry practices.

CONCLUSIONS: This study showed that the HK public was generally not familiar with pet-related zoonotic diseases and proper pet care. These knowledge gaps could potentially increase the risk of disease transmission. Further studies focusing on specific pet species and on people of different social-economic backgrounds are needed to provide future direction of efforts to reduce the risk of pet-related zoonotic diseases and to enhance pet-related animal and human welfare.

KEYWORDS
animal husbandry, exotic pet, Hong Kong China, public health, survey, zoonotic diseases

1 | INTRODUCTION

Hong Kong (HK), located in southern China, is one of the most highly urbanised and populated areas in the world. With a population of 7.5 million, the average living household space is 40 m^2 and per capita floor area is 15 m^2 (CSD, 2016). This is one of the lowest in the world (Lau & Wei, 2018). Concurrent with increased number of people living in small spaces was an increase in the number of people keeping pets. The number of pet dogs and cats in HK increased from 297,100 in 2005 to 405,200 in 2019 (CSD, 2019). Although the growth of pet dogs and cats ownership is slowing and declined from 2010 to 2019 (CSD, 2011; 2019), there was an increase in the number of exotic pets.

A rapid increase in pet birds, small mammals, and reptiles imported into HK was observed from 2012 to 2017 (HKSAR, 2017). However, the number of exotic pets in HK is likely to be underestimated as import data would not include animals brought in through illegal trade, nor animals bred by local breeders. Under the Rabies Ordinance (Cap. 421) of HK, only dogs must be licenced, and therefore, the ownership of other pet species is difficult to quantify. Nevertheless, there was an overall increase in the number of pet animals kept in HK over the last decade (CSD, 2019; HKSAR, 2017), and in 2016, exotic pets accounted for 25.1% of all pets in HK (VSB, 2016). This increase in the number of people keeping pets may be partly attributed to the increased recognition of the physiological and psychological benefits that pets can bring to their owners (Brodie & Biley, 1999; Friedmann & Son, 2009).

The majority of HK people live in high-rise buildings (Forrest et al., 2008). Pets in HK are mainly housed indoors, and thus it is common for HK pet owners (POs) to have close contact with their pets and also with animal excreta. Under these circumstances, pets could pose a significant zoonotic risk to owners (Robertson et al., 2000; Peter & Irwin, 2004; Chen et al., 2012; Anon, 2015; Šlapetaa et al., 2018). These potential risks are enhanced when there is an inadequate understanding of disease transmission and appropriate animal husbandry practices (Anon, 2015; Maaten et al., 2016; Šlapetaa et al., 2018). Despite these risks, and despite the results of studies showing that zoonotic pathogens such as *Rickettsia felis* and *Bartonella* species circulate in HK (Slapetaa et al., 2018), there have been limited studies to assess how well the HK general public understands zoonotic diseases and animal husbandry. This study therefore aimed to evaluate the awareness of pet-related zoonotic risks among the HK public and their understanding of the basics of animal care. This information would also be of interests to other emerging urban centres around the world experiencing small living spaces and growing populations.

IMPACTS

- Among the HK public, there is some lack of awareness relating to pet-related zoonotic diseases and proper pet husbandry and care.
- Pets in HK tended to spend most of their time indoors in close proximity to humans.
- Limitations in awareness of zoonotic diseases and pet husbandry, combined with small living spaces shared with pets, indicate a potential risk of zoonotic disease transmission.

2 | MATERIALS AND METHODS

2.1 | Survey using questionnaire

The research was conducted by a questionnaire survey (see Supporting Information 1) in HK from 4 June 2019 to 19 August 2019. Online study data were collected and managed using Research Electronic Data Capture (REDCap), an electronic data capture tool (Harris et al., 2009; 2019). Participants were recruited through social media, email, word-of-mouth and social contacts of fellow participants. For the paper version, five volunteers were recruited to distribute the questionnaires to different social groups, including relatives, neighbours, colleagues and religious congregations. Participants could return the completed questionnaires to the volunteers or by post. There was no particular target group, any member of the HK public aged 18 or above was invited to participate. Only one questionnaire was collected from each household.

Fifteen sample questionnaires were run initially to evaluate the clarity of questions, to ensure that non-technical language was used and to ensure that the questionnaire could be completed within 10–15 min.

The survey collected background information from the participants and information related to their awareness of zoonotic diseases, disease transmission and prevention in pet animals, husbandry of pet animals and the sources of their knowledge on zoonotic diseases. Animal husbandry practice standards are based on various sources (Sull et al. 2012, 2013, 2015; AFCD 2019; SPAC 2019) and integrated to reflect the HK context. Exotic pets were defined in this study as any pet other than a dog, cat or livestock animal species, with a focus on species such as rabbits, rodents (e.g. chinchillas, hamster, guinea pigs) and reptiles (e.g. tortoise, iguana).

2.2 | Data analyses

A Microsoft Excel file was generated by REDCap with all electronic entries of the participants. Another Microsoft Excel file was generated with all the responses to the paper version of the questionnaire. These two files were combined and all data analyses were performed without further reference to whether the response was from either version of the questionnaire. Several statistical analyses were undertaken using GenStat 64-bit Release 16.1, with the significance level set at $p = 0.05$. Confidence level of 95% and margin of error of 5% were also calculated (Waclawski, 2012).

The probability of owning a pet was first assessed with respect to the apartment size, income group and gender of the participant using Pearson's correlation analysis. It was hypothesised that participants

living in a larger apartment or with higher income would have a higher chance of owning a pet.

The knowledge of zoonotic disease and husbandry of pet animals was compared between POs and non-POs (NPOs). A zoonotic disease knowledge score (Stull et al., 2012) was first calculated by summing how frequently a participant correctly classified a disease as a pet-related zoonoses. Likewise, pet animal husbandry knowledge score was calculated by summing how frequently a participant correctly identified the appropriate practice of raising or caring for a pet animal. The mean knowledge scores were then calculated for all participants as well as for POs and NPOs and compared using a two-tailed Student's *t* test. The total knowledge score for each specific zoonotic disease, or for each specific practice of pet animal husbandry, was the sum of all knowledge scores by all participants who answered the question correctly. This was compared between POs and NPOs using Pearson chi-square test.

The knowledge score of owners for the husbandry of the types of pets that they owned was compared against the rest of the participants using Pearson chi-square test. For example, the knowledge score of the dog and cat owners on specific question related to dogs or cats was assessed against the knowledge score of the rest of the other participants on the same question. This analysis was to test the validity of the assumption that owners of specific pets, for example, dogs, should be more knowledgeable about information related to those specific pets when compared against other people who do not own the same type of pet.

Finally, participants were asked to rate their own knowledge of zoonotic disease and pet animal husbandry. Participants were grouped into five categories (Very Good, Good, Fair, A Little and No knowledge at all) based on their self-rating. Mean knowledge scores of participants in the different categories were then compared using one-way analysis of variance (ANOVA) to assess the level of their confidence against their actual ability to answer the questions about zoonotic disease or pet animal husbandry correctly.

3 | RESULTS

Overall, 362 of 487 copies (74.3% success rate of return) of both online (304 copies) and paper (58 copies) versions of responses to the questionnaire were compiled for use in data analysis.

3.1 | Background information of the participants

Among the 362 participants, 32% were male, 68% were female and 0.3% (1 participant) answered as "Others" (see details in Supporting Information Figure S1). The largest (45.6%) age group of the participants was 41–65 year old (Figure S1A), with 79% of the participants having post-secondary education (Figure S1B).

Most households did not have children aged 12 or below (78.2%) or elderly aged 65 or above (72.9%). The median family size was four (Figure S1C). The majority (90.6%) of the participants lived in apartments in high-rise buildings with a median floor area of 18.7–46.5m^2 (201–500 ft^2) (41.2%) or 46.5–92.9 m^2 (501–1000 ft^2) (47.8%) (Figure S1D). Most (61.6%) did have access to an open area (e.g. parks, gardens, sitting-out areas) within 100 m from where they lived. Most (68%) participants had a monthly household income within the range of HKD 30,000 to >70,000 (≈USD 3800 to >8900) (Figure S1E).

There was no significant correlation between participants' apartment size and their probability of owning a pet (Pearson correlation, $r = 0.513$, $p > 0.05$). This lack of significant correlation was observed irrespective of whether the participants were male ($r = 0.064$, $p > 0.05$) or female ($r = -0.184$, $p > 0.05$). Likewise, there was no significant correlation between the household income of the participants and the probability of owning a pet ($r = 0.347$, $p > 0.05$). This was also true irrespective of whether the participants were male ($r = 0.533$, $p > 0.05$) or female ($r = -0.386$, $p > 0.05$).

3.2 | Pet ownership and animal contact

A large proportion of the participants (59.9%) were POs, defined as current or past POs, or who planned to own a pet in the coming 2 years. NPOs never owned a pet but had contact with animals or never owned a pet and did not have contact with animals (Figure S2). Details of the type of animals they own or planned to own, sources of the animals they own and places where they keep their pets at home are shown in Tables S1, S2 and S3, respectively. In general, dogs (20.8% of total POs), cats (19.2%) and fishes (21.2%) were the most common pets kept in HK. For the remaining 40.1% of NPOs, 29.3% had never owned a pet but had contact with animals and 10.8% had never owned a pet and did not have contact with animals. Most POs kept pets because they love animals (40.2%) and many (37.2%) indicated that a pet is a good companion and can lift their mood. Other reasons for keeping different types of pets were provided and are shown in Table S4. For the NPOs, the top three reasons for not keeping pets were: too busy to take care of a pet (28.1%), no place to keep a pet (22.4%) and pets not being allowed where they lived (17.5%), with 2.6% indicated they did not keep a pet because they were concerned about zoonotic diseases.

The majority of the owners fed their pets with commercial pet food, cooked homemade pet food or a mix of both (Table S5A), with 8.3% feeding their pets with raw meat. Most owners washed their hands after touching animals (68.7%) and after handling animals, cages, bedding or animal droppings/excreta (75.6%). When picking up animal droppings/excreta or cleaning litter box, 17.5% wore gloves (Table S5B).

3.3 | Differences between pet and non-pet owners in their knowledge of zoonotic diseases and animal husbandry

In general, POs appeared to be more knowledgeable about zoonotic diseases than NPOs (Student's *t* test, $p = 0.018$) (Table 1). This difference was mainly due to POs more frequently correctly answering

TABLE 1 Total knowledge scores of pet-owners compared to non-pet owners relating to survey questions on zoonotic and non-zoonotic diseases

Diseases/infectious agents[a]	Pet owner total knowledge score (out of 217)	Pet owner % Correct[b]	Non-pet owner total knowledge score (out of 145)	Non-pet owner % Correct[b]	Chi-square test *p* value[c]
Ticks/Fleas/Mites	162	74.65	110	75.86	0.990
Rabies	186	85.71	117	80.69	0.393
Hepatitis A	48	22.12	38	26.21	0.704
Salmonella	96	44.24	48	33.10	0.063
Infectious diarrhoea	95	43.78	34	23.45	**<0.001**
Ringworm	51	23.50	22	15.17	0.133
Distemper	45	20.74	18	12.41	0.106
Chlamydia	52	23.96	25	17.24	0.309
HIV/AIDS	120	55.30	88	60.69	0.636
Leptospirosis	44	20.28	15	10.34	**0.031**
Fish Tuberculosis	20	9.22	6	4.14	0.215

[a]See Supporting Information for question details (Questions 28–38).
[b]The percentage of pet or non-pet owners who answered each question correctly.
[c]Significant differences ($p < 0.05$, chi-square test) between the total knowledge scores of pet owner and non-pet owners are shown in bold.

questions related to pet animals being a source of infectious diarrhoea (question 32, chi-square test, $p < 0.001$) and leptospirosis (question 37, chi-square test, $p = 0.031$). However, both POs and NPOs had relatively low scores (<50%) for most of the other diseases. The total knowledge scores were highest for questions relating to ticks, fleas and mites with ≈75% of both the POs and NPOs answering correctly. For rabies, ≈86% of POs and 81% of NPOs also answered the question correctly.

Of the 13 questions relating to pet husbandry practices (Table 2), POs were more knowledgeable about the husbandry of their pet animals than NPOs (Student's *t* test, $p = 0.023$). POs obtained a significantly higher mean (±SD) knowledge score of 5.05 (± 2.96) compared to that of the NPOs of 4.57 (± 2.96), out of a total score of 13, mainly because more POs were able to point out that feeding fruits such as grapes to dogs and cats occasionally to provide a balance diet (question 47, chi-square test, $p = 0.036$) and providing cats with vegetarian diet to keep them healthy (question 48, chi-square test, $p = 0.001$) were incorrect. However, only one practice, relating to tick prevention and removal, was correctly recognised by most (68.9%) of the POs and NPOs as a way to keep the dog healthy. For most questions in this section, 50% or <50% of the POs answered them correctly. Nearly 90% of both POs and NPOs thought that it was correct to start deworming puppies and kittens regularly from 3 months of age, whereas deworming should have started when the puppies and kittens are 2 to 4 weeks old.

Owners of specific type of pets generally had a significantly higher chance of correctly answering questions related to their pets (chi-square test, $p < 0.05$) (Table 3). An exception was question 44 "Bringing my dog to the veterinarian regularly for rabies vaccination, which can also prevent intestinal worm parasites" in which the correct scores were not significantly different (chi-square test, $p = 0.090$) between dog and cat owners and other participants. There were two questions (question 45 – the correct way of preventing tick infestation in dogs, and question 50 – the major part of diet of rabbit should not be carrot), where >60% of the specific POs scored correctly. The correct scores for questions 44 and 46, 'Deworming puppies and kittens regularly starting from 3 months old', were the lowest among all the questions.

3.4 | Information sources of zoonotic diseases

A relatively low number (29.5%) of the POs sought advice from a veterinarian before buying or adopting a pet. Among dog, cat and rabbit owners, 37.2% of them regularly take their pets to veterinarians for check-ups and vaccination.

TV/radio was ranked as the most important source of information about zoonotic diseases (Table S6) by the participants, followed by Internet and social media. Information from veterinarians ranked fourth, with books and schools ranked as least important.

A high number of participants (66%) have never been asked whether they owned or were in contact with any pet animals by their medical doctors or health care professionals. Most participants (65.2%) also never mentioned this information to their medical professionals, with 6.1% that did so frequently or every time during their medical consultation.

There were significant differences in mean knowledge scores relating to zoonotic diseases (ANOVA, $p < 0.001$) or animal husbandry (ANOVA, $p < 0.001$) among the participants grouped in different self-rated categories (Table 4), with participants who rated themselves highly obtaining higher knowledge scores. However, even participants who rated themselves as 'Good' and 'Very good' had a low total mean knowledge score of 13.29 out of 24, equivalent to correctly answering 55.4% of the questions. Participants who rated themselves 'Fair' had a

TABLE 2 Total knowledge scores of pet owners and non-pet owners relating to questions on pet animal husbandry practices

Husbandry practice[a]	Pet owner total knowledge score (out of 217)	Pet owner % Correct[b]	Non-pet owner total knowledge score (out of 145)	Non-pet owner % Correct[b]	Chi-square test *p* value[c]
44. Bringing my dog to the veterinarian regularly for rabies vaccination, which can also prevent intestinal worm parasites.	21	9.68	11	7.59	0.867
45. Applying tick preventative chemicals regularly, checking for and removing any ticks from dogs daily.	160	73.73	93	64.14	0.075
46. Deworming puppies and kittens regularly starting from 3 months old.	25	11.52	13	8.97	0.818
47. Feeding fruits to dogs and cats, such as grapes, occasionally to provide a balance diet.	119	54.84	62	42.76	**0.036**
48. Providing my cat with vegetarian diet to keep them healthy.	120	55.30	55	37.93	**0.001**
49. Housing my guinea pig and rabbit together to allow normal social interaction.	90	41.47	60	41.38	1.000
50. Providing carrot as the major part of my rabbit's diet.	105	48.39	60	41.38	0.415
51. Providing a quarantine period of a minimum of 6 weeks for any new bird before allowing contact with existing bird(s).	87	40.09	58	40.00	1.000
52. Providing an all-seed diet to give the birds enough energy and different nutrients.	44	20.28	20	13.79	0.287
53. Feeding them three small meals per day instead of one big meal at one time. If the amount of feed is appropriate, the fish can finish eating within three to five minutes per feeding.	93	42.86	69	47.59	0.723
54. Adding extra oxygen supply to the aquarium when the weather is hot.	83	38.25	59	40.69	0.947
55. Providing all my reptile pets with clean water in a container large enough for bathing.	94	43.32	60	41.38	0.974
56. Housing reptiles of different species together in one tank for better heating as they cannot function well when environmental temperature is low.	54	24.88	43	29.66	0.623

[a]Question numbers follow those in the original questionnaire.
[b]The percentage of pet or non-pet owners who answered each question correctly.
[c]Significant differences ($p < 0.05$, chi-square test) between the total knowledge scores of pet owner and non-pet owners are shown in bold.

total mean knowledge score of 10.64, equivalent to correctly answering 44.3% of the questions.

4 | DISCUSSION

This is the first study to evaluate the knowledge of the HK public of pet-related zoonotic diseases and husbandry practices for different pet species. The median monthly domestic household income of an economically active 4-people household in HK is HKD 42,800 (≈USD 5400) (CSD, 2019). In this study, 68% of the participants belonged to middle to higher income brackets; thus, the results of this survey would mainly reflect this segment of the HK populace and would not represent the full spectrum of HK society. Within this context, it may not be difficult to explain the lack of correlation between household income and pet ownership. Furthermore, as a large proportion of the households did not have children aged 12 or below, or elderly aged 65 or above, correlations between knowledge of zoonotic diseases and the presence of potentially immunocompromised individuals in the household could not be well evaluated.

The per capita space of the majority of participants was comparable, or slightly higher, than the average per capita space of 15.0 m^2 of HK (CSD, 2016). This space is relatively small when compared to that of European countries (42.6 m^2) (European Commission, 2011), Australia (87.0 m^2) (Stephan & Crawford, 2016), and Shanghai, China (17.5 m^2) (Shanghai Municipal Bureau of Statistic, 2011 in Lau & Wei, 2018). One quarter of NPOs cited lack of physical space as the reason for not keeping pets, and one-third of the POs who kept exotic pets instead of dogs or cats did so because of space concerns. This may explain why the number of exotic pets in HK has increased rapidly over the last decade.

Despite a high prevalence of pet ownership among the participants, and a generally high background level of education, the participants'

TABLE 3 Correct, incorrect and don't know responses of pet owners for questions specifically relating to the type of pets they own, compared to those of other participants

Questions[a]	Participants who owned that pet type			Other participants			Chi-square test *p* value[c]
	Correct score (%)[b]	Incorrect score (%)	Don't know score (%)	Correct score (%)	Incorrect score (%)	Don't know score (%)	
Dogs and cats							
44. Bringing my dog to the veterinarian regularly for rabies vaccination, which can also prevent intestinal worm parasites.	21 (12.2)	114 (66.28)	37 (21.51)	11 (5.85)	125 (66.49)	52 (27.66)	0.090
45. Applying tick preventative chemicals regularly, checking for and removing any ticks from dogs daily.	132 (76.74)	9 (5.23)	31 (18.02)	121 (64.36)	20 (10.64)	47 (25.00)	**0.002**
46. Deworming puppies and kittens regularly starting from 3 months old.	19 (11.05)	104 (60.47)	49 (28.49)	19 (10.11)	71 (37.77)	98 (52.13)	<**0.001**
47. Feeding fruits to dogs and cats, such as grapes, occasionally to provide a balance diet.	101 (58.72)	31 (18.02)	40 (23.26)	80 (42.78)	33 (17.65)	74 (39.57)	<**0.001**
48. Providing my cat with vegetarian diet to keep them healthy.	98 (56.98)	15 (8.72)	59 (34.30)	77 (40.96)	22 (11.70)	89 (47.34)	**0.001**
Rabbits and small rodents, for example, ghuinea pig							
49. Housing my guinea pig and rabbit together to allow normal social interaction.	36 (57.14)	5 (7.94)	22 (34.92)	114 (38.38)	13 (4.38)	170 (57.24)	<**0.001**
50. Providing carrot as the major part of my rabbit's diet.	43 (68.25)	12 (19.05)	8 (12.70)	122 (41.08)	61 (20.54)	114 (38.38)	<**0.001**
Birds							
51. Providing a quarantine period of a minimum of 6 weeks for any new bird before allowing contact with existing bird(s).	16 (47.06)	1 (2.94)	17 (50.00)	129 (39.57)	5 (1.53)	192 (58.90)	**0.047**
52. Providing an all-seed diet to give the birds enough energy and different nutrients.	13 (38.24)	9 (26.47)	12 (35.29)	51 (15.64)	68 (20.86)	207 (63.50)	<**0.001**
Fish							
53. Feeding them three small meals per day instead of one big meal at one time. If the amount of feed is appropriate, the fish can finish eating within three to five minutes per feeding.	50 (54.35)	14 (15.22)	28 (30.43)	112 (41.64)	18 (6.69)	139 (51.67)	<**0.001**
54. Adding extra oxygen supply to the aquarium when the weather is hot.	47 (51.09)	16 (17.39)	29 (31.52)	95 (35.32)	25 (9.29)	149 (55.39)	<**0.001**
Reptiles							
55. Providing all my reptile pets with clean water in a container large enough for bathing.	34 (58.62)	5 (8.62)	19 (32.76)	120 (39.87)	23 (7.64)	158 (52.49)	<**0.001**
56. Housing reptiles of different species together in one tank for better heating as they cannot function well when environmental temperature is low.	21 (35.00)	22 (36.67)	17 (28.33)	76 (25.25)	70 (23.26)	155 (51.50)	<**0.001**

[a]Question numbers follow those in the original questionnaire.
[b]The percentages of participants who answered each question correctly, incorrectly or 'don't know' for each question are given in parenthesis ( ).
[c]Significant differences ($p < 0.05$, chi-square test) between the correct scores of specific pet owners and non-owners are shown in bold.

TABLE 4 Mean knowledge scores[a] for zoonotic disease and animal husbandry grouped in different categories according to the participants self-rating[b] of their own knowledge

Self-rated category	Topic	Range of knowledge scores	Mean knowledge score	Standard deviation
Good/Very Good[c] ($n = 7$)	Zoonotic disease	0–11	6.14	3.44
	Husbandry	0–13	7.14	4.71
	Total	0–24	13.29	7.57
Fair ($n = 83$)	Zoonotic disease	0–11	4.92	2.38
	Husbandry	0–13	5.72	2.95
	Total	0–24	10.64	4.44
A little ($n = 181$)	Zoonotic disease	0–11	3.91	2.04
	Husbandry	0–13	5.09	2.77
	Total	0–24	8.99	3.98
No knowledge at all ($n = 90$)	Zoonotic disease	0–11	3.13	1.95
	Husbandry	0–13	3.47	2.67
	Total	0–24	6.60	3.80

[a]The range of knowledge scores is given in parenthesis ( ) and the mean values were calculated based on data in Tables 1 and 2.
[b]Participants were asked to rate their knowledge of zoonotic diseases and basic pet husbandry practices using a score of 1 (no knowledge at all), 2 (a little knowledge), 3 (fair) and 4 (good) to 5 (very good).
[c]Self-rated groups 4 and 5 were combined due to the low number of respondents in these two categories.

knowledge of zoonotic disease and pet husbandry practices showed some limitations, with most knowledge scores equating to <50% of questions answered correctly. One possible reason for this lack of awareness of zoonoses among the HK public may be because there had been no major outbreaks of pet-related zoonotic diseases in HK in the two decades preceding the survey. Nonetheless, POs tended to register a higher knowledge score in both zoonotic diseases and husbandry practice than the NPOs, and POs were more knowledgeable in areas related to the type of pet they owned. The exception to this was identifying ticks/fleas/mites as zoonotic diseases where POs were not more knowledgeable than NPOs. Apparently, pets having ticks/fleas/mites are commonly known and even NPOs are aware of this.

Some important gaps relating to the participants knowledge of zoonotic diseases and the correct husbandry of their pets were recognised. Both POs and NPOs obtained low scores (<50% correct answers) in identifying zoonotic diseases from the list. Zoonotic diseases can be acquired from pets through direct contact with animals or with their excreta (Robertson et al., 2000). The risk of transmission of zoonotic disease increases when pets are housed in small dwellings with close human contact, such as micro-apartments that are common in HK (Mani & Maguire, 2009). This survey revealed that most pets spent most of their time in the living room, suggesting close contact with their owners. Furthermore, 50% of dogs and 80% of cats were found to urinate and defaecate indoors, mainly in the living room and toilet, potentially increasing the risk of infectious zoonotic diseases such as cryptosporidiosis, leptospirosis, giardiasis and toxoplasmosis (Hemsworth & Pizer, 2006; Mani & Maguire, 2009; Day, 2011; Hill & Brown, 2011). This risk could be further amplified with one-quarter of owners, indicating that they did not wash their hands after contacting animals or even animal excreta, and only 18% wore gloves when picking up animal droppings/excreta or cleaning litter box.

There was also inadequate knowledge of dog and cat owners about the deworming regime, which was similarly found in other studies (Matos et al., 2015; TroCCAP, 2019), and the purpose of vaccination. This has implications for the effectiveness of zoonotic disease prevention, including diseases such as toxocariasis and cutaneous larva migrans which rely on anti-parasite treatments, and rabies which depends on vaccination (Robertson et al., 2000; Stull et al., 2015). Less than 60% of POs correctly answered questions related to the proper diet of their pets and only half of the exotic POs were aware of the proper housing environment of their pets. This poses a potential negative effect on pet health and could increase the risk of zoonotic disease transmission (Stull et al., 2015).

Some features of HK pet ownership may work to reduce the chance of zoonotic diseases. Only 7.1% of HK pets spent most of their time outdoors. This differs from countries with more extensive suburban or rural areas where many pet animals live both indoors and outdoors (Stull et al., 2013). These outdoor pets may have a higher chance of contracting zoonotic diseases through interacting with wildlife or stray animals (Freiwald et al., 2014). However, having most pets kept indoors may lead HK POs to underestimate the risks of zoonosis, such as the role of fomite contamination in toxocariasis (Paller & de Chavez, 2014) and giardiasis (İnci et al., 2018), as shown similarly in other urban centres (Wells, 2007; Matos et al., 2015). Additionally, only 8.3% of owners in HK fed raw meat to their pets. This is lower than in other countries, such as the USA (37%) and Netherlands (51%), and could reduce the potential for infection with zoonotic pathogens such as *Salmonella* spp. that may be present in raw meat diets (Robertson et al., 2000; Bree et al., 2018).

TV/radio and Internet were identified by the participants as the most important source of information about pets. This finding may be helpful for stakeholders, such as government and animal welfare organisations, to further develop their policies or strategies to achieve better public education in the areas of pet-related zoonotic diseases and pet husbandry and care. It also indicates that veterinarians could be more proactive in reaching out to POs on animal and public health issues (Matos et al., 2015; TroCCAP, 2019). A potential gap was revealed regarding awareness of zoonotic diseases during medical consultations, with few human health consultations involving any discussion of contact with pets. Awareness of zoonotic diseases among human health professionals helps to identify any zoonotic diseases in human and limit their impact (Kahn et al., 2007). Further work to characterise the awareness of zoonotic diseases among HK human health professionals is indicated.

This study had several limitations. Most participants were in higher income categories, potentially a result of predominately using an online survey (Jang & Vorderstrasse, 2019). Future surveys should endeavour to reach more participants in lower income groups to obtain a more complete picture. As this was the first time such survey had been carried out in HK, the scope was broad and included many different types of pets but some individual questions were very specific. Future surveys may benefit from having a different focus and different types of questions, including more general (less specific) questions, and questions to gain more detailed demographic knowledge of participants and household members. It would be useful for such studies to be conducted with some regularity to monitor any change in HK public awareness towards zoonotic diseases, pet animal husbandry and veterinary care of animals. This will also allow an assessment of the trends in the diversity of exotic animals being kept and the welfare conditions of HK pet animals in general. Knowledge gaps related to zoonoses, or a lack of information about the level of zoonoses knowledge, have been identified across major urban centres in different countries including China (Li et al., 2014; Pereira et al., 2016; Conduto, 2017). Further studies in other crowded urban settings could help to understand zoonotic disease risks in these high-risk areas to tailor appropriate policy, with the ultimate goal of improving both animal and human health.

AUTHOR CONTRIBUTION

Joanne Devlin: Project administration, Resources, Supervision, Writing-review & editing. Elsa Lee: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing-original draft, Writing-review & editing.

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ETHICS STATEMENT

This survey was approved by the Human Ethics Committee, Faculty of Veterinary and Agricultural Science, University of Melbourne (Approval No. 1953822.1).

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

DATA AVAILABILITY STATEMENT

All relevant data are within the paper and supporting information files.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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