

Cat management in an unregulated shelter environment: Relationship between care provision and cat health in Hong Kong

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Abstract

Cat (*Felis silvestris catus*) shelter practices may have important implications for cats' health and well-being. This study explored the relationship between husbandry practices and cat health in Hong Kong's shelters which are unregulated. Cat health was measured via body condition score (BCS), coat condition and signs of oculo-nasal discharge. A total of 314 cats in 24 cat shelters were assessed. A satisfactory BCS was associated with regular veterinary input, more than once per day disinfection and more than once per day change of water. The presence of oculo-nasal discharge — as a marker for upper respiratory tract infection — was associated with a lack of regular veterinary input and less frequent change of water within the shelter. A lack of regular feeding was the only factor associated with a dull coat. In summary, this study showed that certain husbandry practices had important associations with different aspects of cats' health for cats housed in an unregulated shelter environment in Hong Kong. These findings provide evidence-based support for husbandry guidelines or regulations for cat shelters which could have a positive impact on shelter cats' health and welfare.

Keywords: animal welfare, cat health, cat shelters, feeding regime, husbandry, regulation

Introduction

Cats (*Felis silvestris catus*) are popular household pets worldwide (Sparkes *et al* 2013). According to Hong Kong's Government Census, the total number of surveyed households keeping cats is 4% (Census & Statistics Department HKSAR 2019). With a local population of seven million people, there is therefore a high density of cats in Hong Kong. Unfortunately, not all cats are owned and homed. Currently, there are both government and non-government organisations helping the unowned or abandoned/stray cat population. Traditionally, these may include municipal shelters and a mixture of rescue group facilities and foster homes.

Shelters can be defined as those that provide a temporary home for dogs, cats, and other animals that are offered for adoption and may receive charitable funding (Association of Shelter Veterinarians 2017). Over time, many novel cat-holding facilities have evolved and, in Hong Kong, these include cat cafes, 'shared office' type facilities that double-up as cat adoption centres, commercial offices and even a bookshop that acts as a cat sanctuary. In this study all types of cat-holding facilities/units are referred to as 'shelters' given the extreme heterogeneity of provision (Association of Shelter Veterinarians 2017).

The management and practices of cat shelters vary substantially and there is no 'shelter registry' or strict regulation/licensing system to guide husbandry practices in Hong Kong. Hence, the welfare of the animals held within these premises is completely contingent on the organisations' processes and can be a welfare concern (Rioja-Lang *et al* 2019).

The Guidelines for Standards of Care in Animal Shelters published by the Association of Shelter Veterinarians covers generalised aspects of cat care (Newbury *et al* 2010). The Rescue Group Best Practice Guide published by the Humane society (Humane Society USA 2017) and the International Society for Feline Medicine (ISFM) Guidelines (Sparkes *et al* 2013) are similar, laying out the basic principles of care across different cat-holding facilities with substantial focus on population control. International Cat Care (UK) has recently launched their 'Cat Friendly Solutions for Unowned Cats', targeting the logistic of care for this particular group of cats (International Cat Care 2021). In Hong Kong, the Agriculture, Fisheries and Conservation Department (AFCD) has issued some general information on good cat care practice, with a proposal to amend the Prevention of Cruelty to Animals Ordinance (HKSAR 2019, 2020). Currently, no definitive international guidelines exist on how to optimise cats' welfare through husbandry practices and also how to monitor cats' health in shelters.

Welfare assessment indicators

The wealth of animal welfare assessment literature stems primarily from the Welfare Quality® consortium for farm animals (Mellor 2015a,b, 2016a,b; Mellor & Beausoleil 2015). Reliable health assessments need to be species-specific and ideally non-invasive. Previous studies have used behavioural observations and physiological measures of stress to reflect cats' health (Kry & Casey 2007; Rochlitz 2014). Currently, no single indicator can be reliably used to reflect the overall welfare of a cat. Nonetheless, physical parameters, such as coat condition and body condition score (BCS) have both been found to be stable over time and have inter-rater reliability (Arhant *et al* 2015; Zito *et al* 2019), and BCS is also consistently used as a welfare indicator for different farm and companion animals (Wemelsfelder & Mullan 2014; Barnard *et al* 2015; Zito *et al* 2019).

Cats in shelters can be easily stressed (McCobb *et al* 2005) and stress can be translated into poor appetite and reduced immunity with an enhanced risk of infection; the first sign of which often includes oculo-nasal discharge. Indeed, an association between stress-induced weight loss and upper respiratory infection (URI) has been reported in cats (Tanaka *et al* 2012). In addition, a poor coat condition is also related to stress in cat shelters (Arhant *et al* 2015). As such, weight loss resulting in a lower than normal bodyweight, infection and poor coat condition can all potentially be considered as reliable physical indicators of a cat experiencing stress.

Currently, little is known about the health and welfare of cats in unregulated shelter environments which are commonplace in Hong Kong. Many of these unregulated shelters rely not only on financial donations, but also material donations of food and cat litter. In addition, many factors may remain unmanaged, including environmental issues such as noise from other animals, frequent addition of unfamiliar cats, failure to provide hiding places or perches/scratching posts, unfamiliar human encounters, and a lack of regular supply of food and litter substrates. Because variations in housing and husbandry practices may affect cats' health (Ottway & Hawkins 2003; Gourkow & Fraser 2006; Ng 2011), we sought to characterise the welfare situation of cats housed in unregulated cat shelters in Hong Kong. Specifically, we aimed to assess the factors that are important in determining the health and welfare of Hong Kong's shelter-housed cats.

Materials and methods

Ethical approval

This project was approved by the University of Edinburgh Human (Research) Ethical Review Committee and School of Veterinary Medicine Ethical Review Committee (HERC_349_19).

Selection of cat shelters for the study

Since no publicly available registry exists for cat shelters in Hong Kong, we recruited them via:

- The local Inland Revenue Department's list of charitable organisations, with the words 'cat', 'animal', and 'pet' searched in both languages (Chinese and English) (Inland Revenue Department HKSAR, undated);
- Volunteer network referrals.

Each shelter was invited with a letter which briefly summarised the study, outlining the logistics. Shelter visits and data collection took place between June and November 2019.

Criteria for entering the study included:

- Shelters with definite catteries;
- Premises that hold at least ten cats that were adopted or rescued;
- Cats were recruited if they had been in the shelter for more than four weeks. Cats entering shelters take about two weeks to adjust, therefore a four-week period had been identified as a suitable cut-off time-point considered as a 'long stay' (Rochlitz 2014).

Shelters holding cats for less than four weeks only, or cats staying in shelters for less than four weeks were excluded from the study.

Consent for recruitment into the current study was obtained from the shelter representatives. No financial incentive was offered for participation in this project, and participants could withdraw from the study at any point. Many of the shelters expressed specifically that the cats were not to be handled or disturbed; hence assessments were carried out via observable welfare indicators.

Data collection

The shelter representative or contact person was interviewed via the use of a questionnaire (see Appendix in supplementary material to papers published in *Animal Welfare*: <https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material>) which included information on shelter managerial characteristics (eg funding support of the shelter, record-keeping, staff numbers) and husbandry practices (eg frequency of feeding, litter change, disinfection, etc). Regular feeding was defined as food provided daily at roughly similar time-points and removed after a set interval. 'Non-regular feeding' was considered to be those shelters which provided *ad libitum* feeding or free feeding where food is accessible for 24 h.

Any information that could not be obtained from the questionnaire was gathered during the visit. Using our previous unpublished data (Kong *et al* 2018), a sample size of 15 cats per shelter would allow us to have 90% to estimate the mean BCS of all the cats housed within the same shelter, assuming that the mean and standard deviation of the BCS were 2.5 and 2.7, respectively, and an alpha value of < 0.05 was taken as significant. Thus, upon visiting, 15 cats were randomly chosen for BCS observation, coat condition and presence of oculo-nasal discharge.

Cats were included in the study if they had stayed in the shelter for longer than four weeks. Cats that were intact, sick (in isolation or in quarantine or with chronic oculo-nasal disease), kittens, pregnant, in hiding and/or where the

face was not visible were not included. Randomisation was performed with the rolling of a die. The first cat seen by the assessor on entry to the premises was taken as subject number one. Then a die was rolled to generate a number, eg a three. The third cat seen from the first subject would then be chosen as the second subject. For shelters with free-roaming cats, a convenience sample of cats was obtained. For shelters with group housing and free-roaming cats, the same cat would not be chosen twice. For shelters that held fewer than 15 cats, all cats that fulfilled the inclusion criteria were assessed.

A single assessor (S-KK) visited all cat shelters and carried out all the assessments. The estimated age/breed/sex of the randomly selected cats were recorded. The BCS of each cat recruited into the study was assessed using the 'Body and Muscle Condition Score' (International Cat Care, undated), where the body condition was scored and grouped into five categories: 1 = very thin; 2 = thin; 3 = normal; 4 = overweight; and 5 = obese. Oculo-nasal discharge was graded as 'none/low' (no clinical discharge or mild clinical signs involving a single site), 'mild' (clinical signs involving more than one site, mild, purulent ocular or nasal discharge without any other signs, or severe clinical infection involving one site), or 'moderate to severe' (severe clinical signs involving one site in addition to purulent ocular or nasal discharge, or mild clinical signs involving one or more site and presence of sneezing during examination) (Tanaka *et al* 2012). Cat coat condition was dichotomised as either 'shiny' or 'dull' (Arhant *et al* 2015).

In addition, cleanliness of the premises was graded as good, moderate or poor. Cleaning involved 'sweeping and dusting followed by washing with a detergent to leave a clean surface' whereas disinfection involved 'applying a disinfectant agent to an already clean surface to kill micro-organisms such as viruses, ringworm spores and bacteria' (Haughi 1998). The cleanliness was considered good when there was no visible debris on the floor, moderately clean when there was some visible debris on the floor. Poor cleanliness was when the premises were dirty with substantial visible debris, and mould in the environment (Arhant *et al* 2015). Odour (of cat urine) at the premises was rated as strong, mild, or none on first entry.

Statistical analysis

Data collected were analysed using SPSS for Windows (version 22, IBM, USA). In this study, three outcomes—BCS, upper respiratory tract signs (oculo-nasal discharge) and coat condition—were considered as the main outcomes of interest. For ease of interpretation, all three outcomes were dichotomised in the multivariable logistic regression analysis and a BCS more than or equal to three was considered as satisfactory (although scores of four or five are considered problematic, in this case under nutrition/poor condition was considered a more pressing issue). One-way analysis of variance (ANOVA) was first used to assess whether regular feeding and veterinary check-ups were associated with a higher BCS. Predictors related to husbandry practices that could have affected cats' health conditions were then further

analysed by multivariable logistic regression with Generalised Estimating Equation (GEE) (Wang 2014) to account for potential clustering effect within each shelter. All analyses were two-tailed and a *P*-value < 0.05 was considered significant. Raw data can be assessed by contacting S-KK

Results

The characteristics and the other relevant parameters of each cat shelter are described in Table 1 (see supplementary material to papers published in *Animal Welfare*: <https://www.ufaw.org.uk/the-ufaw-journal/supplementary-material>).

Shelter management characteristics

Of the 45 shelters recruited, 18 did not respond and three responded but did not fulfil the inclusion criteria. Of the 24 cat shelters (with 314 cats) included in our analysis, four were foster homes, three were rescue group holding facilities, six were sanctuaries, and eleven were shelters with charitable status. Some of the latter eleven shelters also housed animals other than cats, mostly dogs. Cat movement in/out of the premises: addition of new cats; 'live exit', whether adopted or moved to another shelter; or died, naturally or euthanased over 12 months (on date of visit) were reported in 17 shelters (71%). Management policies, including documentations on admission/isolation, adoption, cleaning guidelines, disaster protocols, and staff training records were complete in 12 (50%), incomplete in three (12%), and absent in nine shelters (38%).

Health records were complete in only 13 shelters (54%); health records were either incomplete ($n = 10$; 42%) or absent ($n = 1$; 4%) in other shelters. For those shelters with complete health records, all the cats were vaccinated and dewormed. For shelters where the records were incomplete or absent, the vaccination/deworming status of the cats were unknown.

Of the eight shelters (33%) that provided regular veterinary checks for the residing cats, the shelter representatives were unable to elaborate what type of veterinary care was provided. Most of the time, in addition to one employed staff member, there were two volunteers looking after the cats in each location.

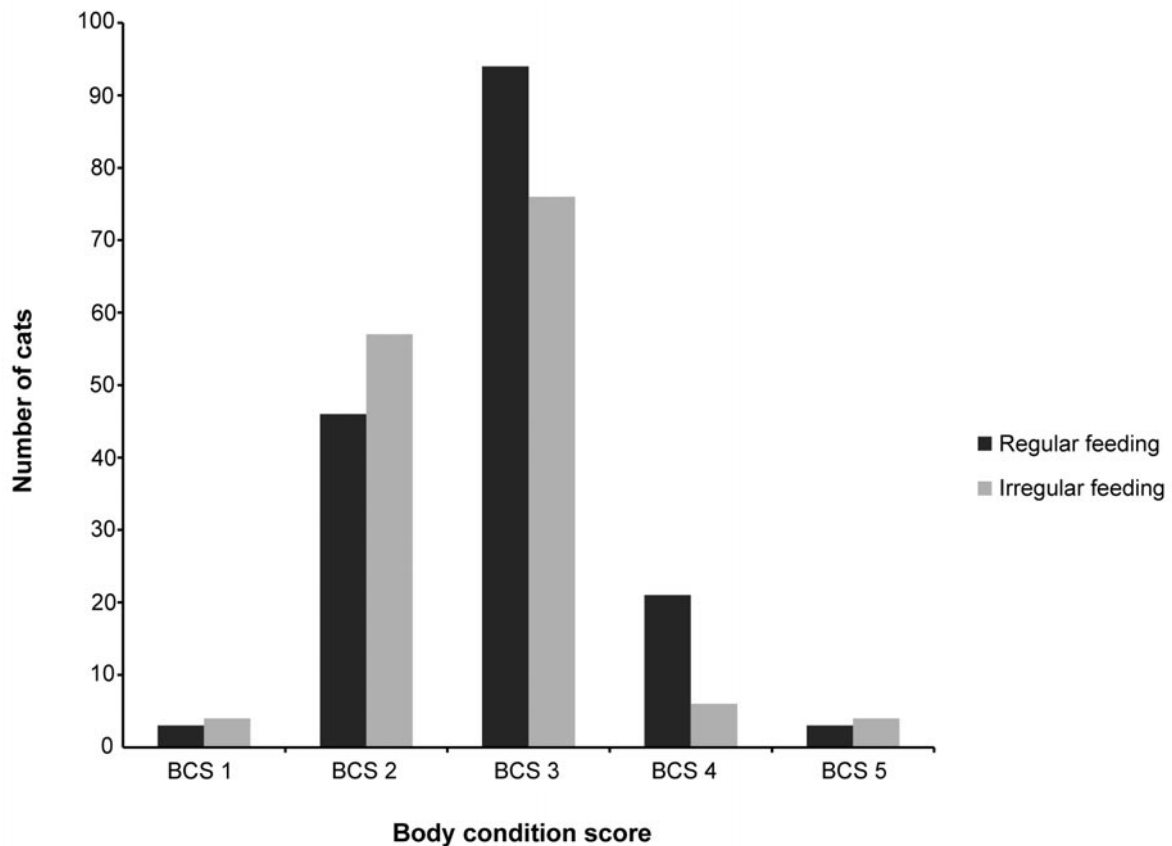
Husbandry practices

Daily cleaning was conducted in two (17%) shelters, and in 20 (83%) shelters cleaning of the cat holding area was performed more frequently than once daily. Disinfection was carried out less than once daily in nine shelters (38%), daily in nine (38%) and more than once daily in six shelters (24%). Cats were regularly fed (at fixed times with the food bowls removed and cleaned between meals) in 13 shelters (54%). In 14 shelters (58%), the brand of food remained constant.

Of the 181 cats in the 14 shelters offering same-brand food, 73% (144/181) had a BCS of more than three, compared to 53% (70/133) of cats that were not fed the same brand of food (133 cats in ten shelters).

Water was changed daily in 29% (7/24) of the shelters and more than once daily in 17% (17/24). Litter was changed less

Figure 1



Relationship between number of cats ($n = 314$), body condition score (BCS) and feeding schedule in cat shelters in Hong Kong ($n = 24$).

frequently than once daily in 4% (1/24), daily in 33% (8/24) and more than once daily in 63% (15/24) of the shelters; in 83% (20/24) of the facilities, the brand of cat litter remained constant. The mean (\pm SD) number of litter-boxes per cat was 0.6 (\pm 0.3), and the number of cats per litter-box was 1.5 (\pm 2.0).

Cat health data

Almost all the study cats were Domestic Short Hair (DSH) (96%). The premises were deemed clean in 71% (17/24), moderately clean in 25% (6/24), and poor in 4% (1/24) of cases. Odour of cat urine was strong in 4% (1/24), mild in 50% (12/24) and absent in 38% (9/24).

Most cats had a BCS of three (170/314 [54%]), and 110 cats (35%) had a BCS of less than three. Only 34 cats (11%) had a BCS more than three. Oculo-nasal discharge and a dull coat were noted in 28 (88/314) and 16% (51/314) of the cats, respectively.

In shelters where regular feeding ($n = 167$; 53%) and regular veterinary checks ($n = 96$; 30%) were provided, cats were more likely to have a higher mean (\pm SD) BCS (regular feeding: 2.9 [\pm 0.7] vs *ad hoc* feeding: 2.7 [\pm 0.7], one-way ANOVA; $P = 0.017$; and regular veterinary checks: 3.0 [\pm 0.6] vs without regular veterinary checks: 2.7 [\pm 0.8], one-way ANOVA; $P = 0.001$) (Figures 1 and 2).

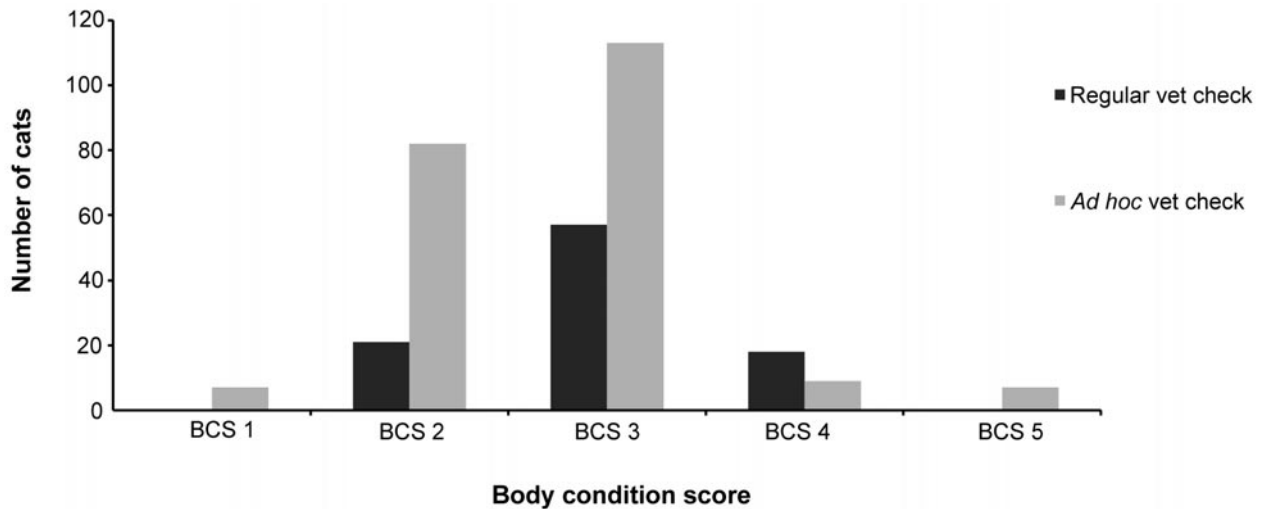
The results of the multivariable model showed that cats with a satisfactory BCS were associated with (i) regular veterinarian checks (odds ratio [OR] 8.21, 95% confidence interval [CI] 2.97–22.7; $P = 0.001$); (ii) frequent disinfection, more than once per day (OR 2.37, 95% CI 1.06–5.31; $P = 0.038$); and (iii) regular change of water more frequent than once per day (OR 5.30, 95% CI 2.24–12.5; $P = 0.001$). Cats with oculo-nasal discharge were less frequently observed in premises with (i) regular veterinarian checks (OR 0.35, 95% CI 0.16–0.77; $P = 0.014$) and (ii) regular change of water more frequent than once per day (OR 0.38, 95% CI 0.17–0.81; $P = 0.013$). Regular feeding was the only predictor associated with a reduced risk of dull coat (OR 0.10, 95% CI 0.04–0.29; $P = 0.008$) (Table 2).

The overall key findings of the predictors of cats' health housed in the unregulated cat shelters are summarised in Table 3.

Discussion

The predictors of cat health reported in both models A and B in the current study were consistent and similar to a smaller study conducted by the first author (Kong *et al* 2018). Namely, regular veterinary input, disinfection, changes of water and feeding were all associated with better health, as defined by a higher but not the highest BCS; less

Figure 2



Significant difference ($P = 0.001$) in body condition score (BCS) of cats ($n = 314$) in cat shelters in Hong Kong ($n = 24$) relative to frequency of veterinary care. ANOVA P -value across all categories of BCS = 0.001.

oculo-nasal discharge, and the coat being less dull. These results have some health implications for shelter cats.

Feline URI is one of the commonest diseases in cat shelters (Steneroden *et al* 2011a) and the second highest reason for euthanasia (Bannasch & Foley 2005). As such, it is a major welfare concern.

Previous studies have identified a number of factors that may reduce the development of URI, including:

- Veterinary services on-site (Bannasch & Foley 2005);
- Regular vaccination (Binns *et al* 2000);
- Increased length of stay (Edwards *et al* 2008: duration 50 days);
- Quarantine and isolation area available (Edwards *et al* 2008);
- Intake housing/floor space more than eight square feet (Wagner *et al* 2018); and
- Less movement between cages during first week in shelter (Wagner *et al* 2018).

As per Bannasch and Foley (2005), the present study found that with increased frequency of veterinary check-ups, the number of cats with oculo-nasal discharge decreased. This may be due to the associated proxy (or surrogate) measures such as better vaccination and prompt detection and treatment of medical illnesses. We noted that only 33% (8/24) of the cat shelters in Hong Kong instigate regular veterinary checks for the cats, and only two have in-house veterinary services provided. These results suggest that shelters in an unregulated space may not seek appropriate veterinary care, the reasons for this require further investigation but may include financial constraints or a lack of awareness of the problem. The situations in the UK and US appear to be better; 85% of vets surveyed in a UK study stated they provided vet services (free or discounted) for animal charities (Stavisky *et al* 2017) and 99.6% of shelters

surveyed in the US had some form of relationship with a veterinary practice (Laderman-Jones *et al* 2016). Laderman-Jones *et al* (2016) also reported that most shelters preferred to have an on-site veterinary service and 97% of shelters regarded veterinary input as essential.

The multiple roles veterinarians play in shelters have been outlined by the Association of Shelter Veterinarians (2014). Apart from providing direct and preventive medical care (vaccination/surgery/euthanasia/trap-neuter-return programmes); the veterinarians also have a supervisory role in infection control and in education, training and forensics which, in Hong Kong, appear to be underdeveloped. Veterinarians' role in shelters has been described as synergistic for success by Taylor *et al* (2021). Steneroden *et al* (2011a) found that only 6% of shelters in the US involved the veterinary surgeon in their infection control practices.

This study found that presence of more volunteers/carers was associated with better health for cats (in the multivariable Model A). This may be due to the fact that increasing social interaction decreases stress in shelter cats (Rehnberg *et al* 2015; Vitale & Udell 2019). Indeed, cats have been shown to prefer human contact over inanimate objects (Shreve *et al* 2017). It may also increase the likelihood of earlier recognition of problems, allowing timely intervention; or be associated with the size, wealth and popularity of the shelter.

In support of this, a recent study investigating the incidence of URI in shelter cats found that those handled more frequently had less incidence of URI (Burns *et al* 2020).

Whether more volunteers/carers were associated with better disinfection was not studied. Certainly, if managed properly, more manpower would help in the everyday running of the shelter, including cleaning and taking the cats to the veterinarians for check-up. However, the management of volunteers poses problems, such as consistency of

Table 2 Multivariable models assessing only the predictive ability of husbandry practices on health conditions of the 314 cats.

Predictors	Satisfactory body condition score (≥ 3) OR (95% CI)	P-value*	Dull coat OR (95% CI)	P-value*	Nasal discharge (+ve) OR (95% CI)	P-value*
Regular veterinary check-up	8.21 (2.97–22.7)	0.001	1.60 (0.44–5.85)	0.705	0.35 (0.16–0.77)	0.014
Cleaning > 1 per day (vs daily)	0.95 (0.21–4.23)	0.949	n/a	n/a	0.67 (0.21–2.15)	0.724
<i>Disinfection</i>						
a) More than once per day (vs less frequent than daily)	2.37 (1.06–5.31)	0.038	0.26 (0.08–0.76)	0.104	0.54 (0.26–1.11)	0.325
b) Daily (vs less frequent than daily)	0.58 (0.30–1.14)	0.226	0.20 (0.07–0.56)	0.357	0.73 (0.38–1.40)	0.259
Regular feeding	1.35 (0.77–2.38)	0.521	0.10 (0.04–0.29)	0.008	1.23 (0.69–2.17)	0.480
More than once per day change in water (vs daily)	5.30 (2.24–12.5)	0.001	0.44 (0.14–1.41)	0.347	0.38 (0.17–0.81)	0.013
<i>Litter change</i>						
a) Daily (vs less frequent than daily)	0.50 (0.07–3.81)	0.399	n/a	n/a	n/a	n/a
b) More than once per day (vs less frequent than daily)	0.29 (0.04–2.46)	0.221	n/a	n/a	n/a	n/a
Average number of cats per litter-box	1.06 (0.92–1.23)	0.383	1.14 (0.97–1.34)	0.354	1.06 (0.94–1.21)	0.380

All predictors are reported in odds ratio (OR) with 95% confidence interval (CI). Not estimated (NA) due to non-convergence of the model by including these predictors.

* P-values were generated by a multivariable binary logistic regression model using Generalised Estimating Equation (GEE) allowing for possible clustering of data within each shelter.

Table 3 Key findings of the study.

Significant predictors	
A satisfactory body condition score was more likely to occur with:	(a) Regular veterinarian checks (b) Regular disinfection (> once per day) (c) Regular change of water (> once per day)
Nasal ocular discharge was more likely to occur with:	(a) No regular veterinarian check-ups (b) Less frequent change of water
Dull coat was likely to occur with:	Regular feeding

practice/burn-out/infection control/training/turnover, etc; which is beyond the scope of this study (Neumann 2010; Steneroden *et al* 2011b; Guenther 2017).

Our study highlights the importance of regular disinfection, which was associated with a better BCS, less oculo-nasal discharge and reduced likelihood of having a dull coat.

One cause of URI in cat shelters is from viruses. The pathogens were prevalent in comparable amounts in different cat-holding facilities (McNamus *et al* 2014). Most cats carry viruses with FCV (feline calicivirus) being shed continuously with it able to live in the environment for up to a month (Möstl *et al* 2013). FHV (feline herpes

virus) is shed when cats are stressed. The virus survives in the environment for a few days. URI pathogens can be transmitted via a variety of routes. Although direct contact and aerosol transmission are, in many cases, the most important, for environmentally resistant pathogens such as FCV, or when hygiene is poor, fomite spread can play an extremely important role in transmission. Hence, regular disinfection is one of the essential components of infection control. Poor premises hygiene (reflected in intensity of odour of the premises) has been associated with increased risk of URI (Helps *et al* 2005). Baumworcel *et al* (2019) showed viral loads to be higher in shelters not purposefully designed as shelters. Many of the shelters in the present study came under this category.

In order to promote effective control of infection, adherence to good policies and training of shelter workers are paramount. A guideline on the prevention of infection in cat shelters was published by the European Advisory Board on Cat Disease (Möstl *et al* 2013). Four main areas were addressed:

- Housing: isolation and quarantine areas should be available and separate from main residency;
- Protocols should be written and available (infection control/management);
- All cats should be vaccinated on admission; and
- Hygiene: regular training of staff is recommended.

In a survey of 157 shelters in the US, Steneroden *et al* (2011a) found 15% of responding shelters had written protocols on infection control whereas 75% had policies on disinfection and cleaning. In the present study, policy documentation (including infection control) was only complete in 50% of shelters, and absent in 38%. Improper vaccination strategies predispose to URI (Crawford *et al* 2018). Shelter workers' knowledge on infection control was not investigated in this study. This may warrant further research given the importance of infection to animals' well-being in shelters.

Increasing the number of cats per litter-box and the intensity of odour of the premises are indirectly associated with the cleanliness of the premises, which again have been shown to affect cats' health (Arhant *et al* 2015). Litter-box conflict also causes undue stress for cats (Gourkow 2016; Ellis *et al* 2017a). However, there is no evidence to guide us how to define the optimal number of cats per litter-box, either in the home setting or in a shelter. The number of litter-boxes required is commonly regarded as 'number of cats plus one.' In a survey on pet cats in the UK, the mean number of cats per litter-box was 1.7 (Grigg *et al* 2019). In our study, the mean number of cats per litter-box was 1.5; less than that described by Grigg and co-workers.

The number of key resources (litter-boxes/scratching posts, etc) and inappropriate access to these resources have been quoted as welfare concerns (Rioja-Lang *et al* 2019).

One factor affecting cat health is regular feeding; which is associated with better cat health. Food preference may be one reason why cats have a lower BCS in some shelters. Shelters are stressful for cats. Thorne (1982) found that when cats are stressed, they chose familiar items to eat. An inconsistent supply/type of food creates another source of stress. When faced with novelty food items, many cats also under-eat (Bradshaw *et al* 1996). Other factors which may have contributed to this finding include inter-cat relationship during mealtimes, food competition, food preference and the consistency of food supply which was not thoroughly examined.

The present study found that regular feeding instead of *ad libitum* feeding was associated with a higher BCS. This is in contradiction with current literature which associated *ad libitum* feeding with obesity (Russell *et al* 2000; Serisier *et al* 2013). Scarlett's study (1994) on risk factors for developing obesity in pet cats was the only study that found *ad libitum* feeding not to be associated with obesity. The feline obesity literature was focused primarily on pet cats and used questionnaires to analyse risk factors in the cats' home environment. The studies also used a single food source. The shelter environment is stressful for cats and the food source varied, even with shelters that fed cats *ad libitum*, the variability of the food may have contributed to the difference in findings, not excluding the confounding factor of group housing.

Most literature examining BCS and associated illnesses used pet cats, with an emphasis on obesity. Low BCS are associated with diseases, including chronic kidney disease, gastro-intestinal diseases, thyroid and heart illnesses. (Scarlett & Donoghue 1998; Freeman *et al* 2016; Peterson

et al 2016). Stavisky *et al* (2017) looked at the prevalence of feline leukaemia virus at two cat shelters in the UK and found cats with lower BCS had a greater likelihood of contracting the virus.

Feeding as a husbandry practice (feeding schedule not described) was included in various studies on cat shelters but was found not to be significant in affecting cat welfare (Arhant *et al* 2015; Eriksson *et al* 2009; Hirsch *et al* 2014). The presentation of food in shelters (same time, same place, same mode) has also been criticised for prohibiting foraging behaviour in cats. This often results in boredom which may manifest as over- or under-eating (Stella & Cronney 2016; Sadek *et al* 2018). Stress eating has also been described in cats (McMillan 2013). The shelter environment is stressful, and feeding is not a social event for shelter cats (Finka 2020). Whether the manner of feeding (*ad libitum*/regular) affects shelter cat health is influenced by multiple factors (for example group vs single housing, history of being surrendered or stray cat, intercat relationship, etc), and the fact that cats are versatile and can be adaptable to a flexible diet (Zoran & Buffington 2011; Buffington 2015). This complicates the issue of singling out feeding as a sole factor in affecting shelter cats' health.

It is envisioned that our study could contribute to improving the welfare of shelter cats locally, similar to the descriptive survey of animal shelters by Hirsch *et al* (2014) which was conducted in Sweden where the husbandry practices and management were recorded with the aim of improving the welfare of shelter cats.

The mean BCS of the cats in this study was three; 32% of cats had a score less than three, 11% had a score of four and above (scattered across all types of holdings). This is in accordance with Zito *et al* (2019) where managed and unmanaged/stray cats in New Zealand were found to have satisfactory health. Hence, the feeding schedule and consistency of food supply may have an impact on cats' health in shelters, but this warrants further studies.

Having regulations or guidelines may serve to improve the welfare of the shelter cats. As yet, there are no international guidelines on cat shelter management, but many countries have 'best practice' or 'code of practice' for cats (US, Canada, UK, Australia, Lithuania); and 'shelter' comes under the umbrella of 'cat carer.' The American Association of Feline Practitioner has a positional statement on the welfare of shelter cats (AAFP 2009).

The American Society for the Prevention of Cruelty to Animals (ASPCA) and the Association of Shelter Veterinarian has also published guidelines (Newbury *et al* 2010) on general shelter management. With reference to farm animals, Dale (2009) argues that codes and regulations may not necessarily protect farm animals in New Zealand and Australia; and often succumbed to economic pressure and political red tape. In Zito *et al*'s (2019) study looking at managed and unmanaged stray cats in New Zealand, most cats observed were of satisfactory health. Hence, it seems with or without regulations; cats fare well, at least in Zito and co-workers' study. Across the

globe, education of the general public seems to be a common theme in improving the welfare of all animals, not just cats (New Zealand National Cat Management Strategy Group Report [NCNMS] 2020).

This study has a number of limitations, which are in and of themselves integral to its findings. Operating an animal organisation in Hong Kong does not require a license and therefore there is no registry of cat shelters making it infeasible to gain a representative sample. The inter-facility assessments' variations also present a substantial hurdle meaning only the most common factors could be reliably assessed at each site (eg BCS). Full parameters were difficult to assess due to a lack of availability of formal records and assessment tools specifically tailored to a heterogeneous shelter environment.

Confounding factors relating to stress in cats were not addressed in the present study, in part because the overarching impacts of major variations in practices had not been quantified. For example, group against individual housing (reflecting accessibility of resources), non-randomly selected subjects in some shelters, cat population turnover causing undue stress for cats, presence of enrichment in the cat enclosure and their utilisation (Ottway & Hawkins 2003; Gourkow & Fraser 2006; Eriksson *et al* 2009; Moore & Bain 2013; Vinke *et al* 2014; Hirsch *et al* 2014; Finka *et al* 2014; Hirsch 2016; Ellis *et al* 2017a,b). Pheromone therapy was used in one shelter, its effect was not included in our analysis (Chadwin *et al* 2017; Shreve & Udell 2017). For feeding regime, factors which may have influenced the association between feeding regime and BCS were not examined. These include the amount and type of food fed, consistency of food supply, meal duration, inter-cat relationship and food competition. Length of stay per cat was also not recorded. Gouveia *et al* (2011) found that increased length of stay in shelters was associated with decreased feeding in 46 cats that had been in a shelter for over seven years. Cat nutritional status prior to admission was not examined, although all cats studied have been in the shelter for over four weeks and cats take about two to five weeks to settle into a new environment (Rochlitz 2014).

Even though oculo-nasal discharge has been used in some studies as a reflection of cat health (Tanaka *et al* 2012; Arhant *et al* 2015), it has not been fully validated. Feline upper respiratory tract infection remains a clinical diagnosis and not all cats exhibiting oculo-nasal discharge will progress to full upper respiratory tract infection. The severity of the signs were recorded (none/low, mild, moderate/severe) and then dichotomised to presence or absence of signs for ease of interpretation. More objective grading systems for upper respiratory tract infections are available (Litster *et al* 2012; McNamus 2014) and would have offered greater clarity to our results. Examining the chosen cat's health record, where available, may provide a more objective supplementary parameter in determining cat health although, again, many of the venues either had no records or only had *ad hoc* veterinary provision.

Animal welfare implications and conclusion

Relinquishment to shelters potentially constitutes a compromise of animal welfare. Shelter animals are often more in need of better care but may receive substandard care (eg expired food and medicines) (Turner *et al* 2012). This is especially problematic in unregulated shelter environments, as resources and expertise may often be limited. The development of respiratory tract infection is the second most common reason for euthanasia for cats in shelters (after over-crowding). Shelter cats are vulnerable if they are housed in a variable, unregulated shelter environment in which sub-optimal care can be common (Rioja-Lang *et al* 2019). The results of this study concur with what we know from the current literature. It is envisioned that with the expansion of shelter medicine and the public's awareness of animal welfare, a guideline to standardise the care delivered to cats housed in Hong Kong's shelters could be developed which may be pertinent to other unregulated systems. A local shelter registry, licensing system with regular inspections for compliance with acceptable standards will have the potential to safeguard the welfare of cats housed in shelters.

Conflict of interest

S-KK is an unpaid board member of an animal shelter.

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