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Cat Management in an unregulated shelter environment:

Relationship between care provision and cat health in Hong Kong

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Raw data can be assessed by contacting S-KK

Abstract

Cat shelter practices may have important implications for cats' health and wellbeing. This study explored the relationship between husbandry practices and cat health in Hong Kong's shelters which are unregulated. Cat health was measured by 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 (**odds ratio 8.21, 95% confidence interval [CI] 2.97-22.7; p=0.001**), more than once per day disinfection (**OR 2.37, 95%CI 1.06-5.31; p=0.038**) and more than once per day change in water (**OR 5.30,**

22 95CI 2.24-12.5; p=0.001). The presence of oculo-nasal discharge — as a marker of upper
23 respiratory tract infection — was associated with a lack of regular veterinary input (OR 0.35,
24 95CI 0.16-0.77; p=0.014) and less frequent change of water within the shelter (OR 0.38, 95CI
25 0.17-0.81; p=0.013). A lack of regular feeding (OR 0.10, 95CI 0.04-0.29; p=0.008) was the
26 only factor associated with a dull coat. In summary, this study showed that some husbandry
27 practices had important associations with different aspects of cats' health for cats housed in
28 an unregulated shelter environment in Hong Kong. These findings provide evidence-base
29 support for husbandry guidelines or regulations for cat shelters which could have a positive
30 impact on cats' health and welfare for cats housed in a shelter.

31

32 **Keywords:** cat shelters, cat health, feeding regime, husbandry, regulation, welfare.

33

34 **Introduction**

35 Cats (*Felis silverstris catus*) are popular household pets worldwide (Sparkes et al 2013).
36 According to Hong Kong's Government Census, the total number of surveyed households
37 keeping cats increased from 19% in 2005 to 76% in 2018 (Census & Statistics Department
38 HKSAR, 2019). With a local population of seven million people, there is therefore a high
39 density of cats in Hong Kong. Unfortunately, not all cats are owned and homed. Currently,
40 there are both government and non-government organizations helping the un-owned or
41 abandoned/stray cat population. Traditionally, these may include municipal shelters and a
42 mixture of rescue group facilities and foster homes.

43 Shelters can be defined as those that provide a temporary home for dogs, cats, and other
44 animals that are offered for adoption and may receive charitable funding (Shelter
45 Terminology, Association of Shelter Veterinarians). With societal development, many novel
46 cat holding facilities have evolved. In Hong Kong, these include cat cafes, "shared office"
47 type facilities that double up as cat adoption centers, commercial offices and even a bookshop
48 that acts as a cat sanctuary. In this study we refer to all types of cat holding facilities/units as
49 "shelters" given the extreme heterogeneity of provision (Association of Shelter Veterinarians
50 Shelter Terminology 2017).

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

55 The "Guidelines for Standards of Care in Animal Shelters" published by the Association of
56 Shelter Veterinarians covers generalized aspects of cat care (Newbury et al 2010). The

57 “Rescue Group Best Practice Guide” published by the Humane society (Humane society
58 USA PetSmart 2017) and the International Society for Feline Medicine (ISFM) Guidelines
59 (Sparkes et al 2013) are similar, laying out the basic principles of care across different cat
60 holding facilities with substantial focus on population control. **International Cat Care (UK)**
61 **has recently launched their “Cat friendly solutions for unowned cats”, targeting the logistic of**
62 **care for this particular group of cats. (International cat care 2021).** In Hong Kong, the
63 Agriculture, Fisheries and Conservation Department (AFCD) has issued some general
64 information on good cat care practice, with forthcoming public consultation on duty of care
65 and how to enhance the provisions for the prevention of cruelty for specific animal species
66 (Agriculture Fisheries & Conservation Department, HKSAR n.d.). Currently, there are no
67 definitive international guidelines on how to optimize cats’ welfare through husbandry
68 practices and also how to monitor cats’ health in shelters.

69 ***Welfare Assessment Indicators***

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

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

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

99

100 **Methods**

101 *Selection of cat shelters for the study*

102 Because there is no publicly available registry for cat shelters in Hong Kong, we recruited cat
103 shelters via:

104 1. The local Inland Revenue Department's list of charitable organisations, with the words
105 "cat", "animal", and "pet" searched in both languages (Chinese and English) (Inland Revenue
106 Department HKSAR, n.d.)

107 2. Volunteer network referrals

108 Each shelter was invited with a letter which included a brief summary and logistics of the
109 study. Shelter visits and data collection were conducted between June 2019 and November
110 2019.

111 Criteria for entering the study included:

112 1. Shelters with definite catteries

113 2. Premises that hold at least 10 cats that were adopted or rescued.

114 3. Cats were recruited if they have been in the shelter for more than four weeks. Cats entering
115 shelters take about two weeks to adjust, therefore a four-week period had been identified as a
116 suitable cut-off time-point considered as a "long stay" (Rochlitz 2014).

117 Shelters holding cats for less than four weeks only, or cats staying in shelters for less than
118 four weeks were excluded in this study.

119 Consents for recruitment into the current study were obtained from the shelter representatives.

120 No financial incentive was offered for participation in this project, and participants could
121 withdraw from the study at anytime. Many of the shelters expressed specifically that the cats
122 were not to be handled or disturbed; hence the cats were assessed using welfare indicators
123 that could be observed.

124 *Data collection*

125 The shelter representative or contact person was interviewed via the use of a questionnaire
126 (see appendix) which included information on shelter managerial characteristics (e.g. funding
127 support of the shelter, record keeping, staff numbers) and husbandry practices (e.g. frequency
128 of feeding, litter change, disinfection, etc). Regular feeding was defined as food provided
129 daily at roughly similar time points and removed after a set interval. “Non-regular feeding”
130 was considered to be those shelters which provided *ad lib* feeding or free feeding where food
131 is accessible for 24h.

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

139 Cats were included in the study if they had stayed in the shelter for more than four weeks.
140 Cats that were un-neutered, sick (in isolation or in quarantine or with chronic oculo-nasal
141 disease), kittens, pregnant cats and cats in hiding or where the face was not visible were not
142 included. Randomisation was performed with the rolling of a die. **The first cat seen by the**
143 **assessor on entry to the premises was taken as subject number one.** Then a die was rolled to
144 generate a number. Eg three. The third cat **seen** from the first subject was then chosen as the
145 second subject. **For shelters with free roaming cats, a convenience sample of cats was**
146 **obtained.** For shelters with group housing and free **roaming** cats, the same cat would not be

147 chosen twice. For shelters that held fewer than 15 cats, all cats that fulfilled the inclusion
148 criteria were assessed.

149 A single assessor (S-KK) visited all cat shelters and performed all the assessments. The
150 estimated age/breed/sex of the randomly selected cats were recorded. The body condition
151 score of each cat recruited into the study was assessed using the “Body and Muscle Condition
152 Score” (International Cat Care, n.d.), where the body condition was scored and grouped into
153 five categories: 1=“very thin”, 2=“thin”, 3=“normal”, 4=“overweight” and 5= “obese”.
154 Oculo-nasal discharge was graded as “none/low” (no clinical discharge or mild clinical signs
155 involving a single site), “mild” (clinical signs involving more than one site, mild , purulent
156 ocular or nasal discharge without any other signs, or severe clinical infection involving one
157 site), or “moderate to severe”(severe clinical signs involving one site in addition to purulent
158 ocular or nasal discharge, or mild clinical signs involving one or more site and presence of
159 sneezing during examination) (Tanaka et al 2012). Cat’s coat condition was dichotomised as
160 either “shiny” or “dull” (Arhant et al 2015).

161 In addition, cleanliness of the premises was graded as good, moderate or poor. Cleaning
162 involved “sweeping and dusting followed by washing with a detergent to leave a clean
163 surface” whereas disinfection involved “applying a disinfectant agent to an already clean
164 surface to kill micro-organisms such as viruses, ringworms spores and bacteria” (Haughi
165 1998). The cleanliness was considered good when there were no visible debris on the floor,
166 moderately clean when there was some visible debris on the floor. Poor cleanliness was when
167 the premises were dirty with substantial visible debris, and mould in the environment (Arhant
168 et al 2015). Odour (of cat urine) of the premises was rated as strong, mild, or none on first
169 entry.

170 *Ethics approval*

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

173 *Statistical analysis*

174 Data collected were analysed using SPSS for Windows (version 22, IBM, USA). In this study,
175 three outcomes — body condition score, upper respiratory tract signs (oculo-nasal discharge)
176 and coat condition — were considered as the main outcomes of interest. For ease of
177 interpretation, all three outcomes were dichotomised in the multivariable logistic regression
178 analysis and a body condition score more than or equal to three was considered as
179 satisfactory (although body condition scores of four or five are considered problematic, in
180 this case under nutrition/poor condition was considered a more pressing issue). **One-way**
181 **analysis of variance (ANOVA) was first used to assess whether regular feeding and**
182 **veterinary check-ups were associated with a higher BCS. Predictors related to husbandry**
183 **practices that could have affected cats' health conditions were then further analysed by**
184 **multivariable logistic regression with Generalised Estimating Equation (GEE) (Wang 2014)**
185 **to account for potential clustering effect within each shelter.** All analyses were two-tailed and
186 a p value <0.05 was considered significant.

187

188 **Results**

189 **The characteristics and the other relevant parameters of each cat shelter are described in**
190 **Table 1.**

191 *Shelter management characteristics*

192 Of the 45 shelters recruited, 18 did not respond and three responded but did not fulfil the
193 inclusion criteria. Of the 24 cat shelters (with 314 cats) included in our analysis, four were
194 foster homes, three were rescue group holding facilities, six were sanctuaries, and 11 were
195 shelters with charity status. Some of the latter 11 shelters also housed animals other than cats,
196 mostly dogs. Cat movement in/out of the premises- addition of new cats; “live exit”- whether
197 adopted or moved to another shelter; or died – naturally or euthanized over 12 months (on
198 date of visit) were reported in 17 shelters (71%). Management policies — including
199 documentations on admission/ isolation, adoption, cleaning guidelines, disaster protocols, and
200 staff training records — were complete in 12 (50%), incomplete in three (12%), and absent in
201 9 shelters (38%).

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

207 Of the eight shelters (33%) that provided regular veterinary checks for the residing cats, the
208 shelter representatives were unable to elaborate what type of veterinary care was provided.

209 Most of the time, in addition to one employed staff member, there were two volunteers
210 looking after the cats in each location.

211 *Husbandry practices*

212 Daily cleaning was conducted in two (17%) shelters, and in 20 shelters (83%) cleaning of the
213 cat holding area was performed more frequent than once daily. Disinfection was carried out
214 less than once daily in nine shelters (38%), daily in nine (38%) and more than once daily in

215 six shelters (24%). Cats were regularly fed (at fixed times with the food bowls removed
216 between meals) in 13 shelters (54%). The same brand of food was offered to cats in 14
217 shelters (58%).

218 Of the 181 cats in the 14 shelters offering same-brand food, 73% (144/181) had a body
219 condition score of more than three, compared to 53% (70/133) of cats that were not fed the
220 same brand of food (133 cats in 10 shelters).

221 Water was changed daily in 29% (7/24) of the shelters and more than once daily in 17%
222 (17/24). Litter was changed less frequent than once daily in 4% (1/24), daily in 33% (8/24)
223 and more than once daily in 63% (15/24) of the shelters; 83% (20/24) of the facilities used
224 the same brand of cat litter. The mean number of litter boxes per cat was 0.6 (standard
225 deviation 0.3), and the mean number of cats per litter box was 1.5 (standard deviation 2.0).

226 *Cat health data*

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

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

233 In shelters where regular feeding (n=167, 53%) and regular veterinary checks (n=96, 30%)
234 were provided, cats were more likely to have a higher BCS (regular feeding: mean 2.9 with
235 standard deviation 0.7 vs ad hoc feeding: mean 2.7 with standard deviation 0.7, one-way
236 ANOVA p=0.017; and regular veterinary checks: mean 3.0 with standard deviation 0.6 vs

237 without regular veterinary checks: mean 2.7 with standard deviation 0.8, one-way ANOVA
238 $p=0.001$) (**Figure 1 and 2**).

239 The results of the multivariable model showed that cats with a satisfactory BCS were
240 associated with (a) regular veterinarian checks (odds ratio [OR 8.21, 95% confidence interval
241 [CI] 2.97-22.7; $p=0.001$, (b) frequent disinfection than once per day (OR 2.37, 95CI 1.06-
242 5.31; $p=0.038$) and (c) regular change of water more frequent than once per day (OR 5.30,
243 95%CI 2.24-12.5; $p=0.001$). Cats with oculo-nasal discharge were less frequently observed in
244 premises with (a) regular veterinarian checks (OR 0.35, 95%CI 0.16-0.77; $p=0.014$) and (b)
245 regular change of water more frequent than once per day (OR 0.38, 95%CI 0.17-0.81;
246 $p=0.013$). Regular feeding was the only predictor associated with a reduced risk of dull coat
247 (OR 0.10, 95%CI 0.04-0.29; $p=0.008$) (**Table 2**).

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

250

251 **Discussion**

252 The predictors of cat health reported in both model A and B in the current study were
253 consistent and similar to a smaller study conducted by the first author (Kong et al 2018).
254 Namely, regular veterinary input, regular disinfection, regular change of water and regular
255 feeding were associated with better health, as defined by a higher but not the highest body
256 condition score; less oculo-nasal discharge, and the coat being less dull. These results have
257 some health implications for shelter cats.

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

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

- 263 1. Veterinary services on site (Bannasch & Foley 2005)
- 264 2. Regular vaccination (Binns et al 2000)
- 265 3. Increase length of stay (Edwards et al 2008 – duration 50 days)
- 266 4. Quarantine and isolation area available (Edwards et al 2008)
- 267 5. Intake housing/ floor space more than eight square feet (Wagner et al 2018)
- 268 6. Less movement between cages during first week in shelter (Wagner et al 2018)

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

280 of relationship with a veterinary practice (Laderman-Jones et al 2016). Laderman-Jones et al
281 (2016) also reported that most shelters preferred to have an on- site veterinary service and
282 97% of shelters regarded veterinary input as essential.

283 The multiple roles veterinarians play in shelters have been outlined by the Association of
284 Shelter Veterinarians (2014 Feb). Apart from providing direct and preventive medical care
285 (vaccination/ surgery/ euthanasia/ trap neuter return programmes); the veterinarians also have
286 a supervisory role in infection control and in education, training and forensics which, in Hong
287 Kong, appear to be underdeveloped. Steneroden et al, (2011a) found that only 6% of shelters
288 in USA involved the veterinary surgeon in their infection control practices.

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

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

297 Whether more volunteers/ carers were associated with better disinfection was not studied.

298 Certainly, if managed properly, more manpower would help in everyday running of the
299 shelter, including cleaning and taking the cats to the veterinarians for check up. However, the
300 management of volunteers poses problems such as consistency of practice/ burnout/ infection
301 control/ training/ turnover etc; which is beyond the scope of this discussion. (Neumann 2010,
302 Steneroden et al 2011b, Guenther 2017)

303 Our study highlights the importance of regular disinfection, which was associated with a
304 better body condition score, less oculo-nasal discharge and less likely to have a dull coat.

305 **One cause of URI in cat shelters is from viruses.** The pathogens were prevalent in comparable
306 amounts in different cat holding facilities ((McNamus et al 2014). Most cats are carriers of
307 the viruses with FCV (feline calici-virus) being shed continuously and the virus can live in
308 the environment for up to a month (Möstl et al 2013). **FHV (feline herpes virus) is shed when**
309 **cats are stressed.** The virus survives in the environment for a few days. **URI pathogens can be**
310 **transmitted via a variety of routes. Although direct contact and aerosol transmission are in**
311 **many cases the most important, for environmentally resistant pathogens such as FCV, or**
312 **when hygiene is poor, fomite spread can be extremely important in transmission.** Hence
313 regular disinfection with disinfectant is one of the essential components of infection control.
314 Poor premise hygiene (reflected in intensity of odour of the premises) has been associated
315 with increased risk of URI (Helps et al 2005). Baumworcel et al showed that viral loads are
316 higher in shelters that were not purposefully designed as shelters (Baumworcel et al 2019).
317 Many of the shelters in the present study were of this type.

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

- 322 1. Housing – isolation and quarantine areas should be available and separate from main
323 residency
- 324 2. Protocols should be written and available (infection control/ management)
- 325 3. All cats should be vaccinated on admission

326 4. Hygiene – regular staff training recommended

327 In a survey on 157 shelters in the USA, Steneroden et al, (2011a) found 15% of responding
328 shelters had written protocols on infection control whereas 75% had policies on disinfection
329 and cleaning. In the present study, policy documentation (including infection control) was
330 only complete in 50% of shelters, and absent in 38%. Improper vaccination strategies
331 predisposes to URI (Crawford et al, Maddies University n.d.). Shelter workers' knowledge on
332 infection control was not investigated in this study. This may warrant further research given
333 the importance of infection on animal's wellbeing in shelters.

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

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

345 One factor affecting cat health is regular feeding; which is associated with better cat health.
346 Food preference may be one reason why cats have lower body condition score in some
347 shelters. Shelters are stressful for cats. Thorne (1982) found that when cats are stressed, they
348 chose familiar items to eat. An inconsistent supply/type of food creates another source of

349 stress. When faced with novelty food items, many cats also under-eat (Bradshaw et al 1996).
350 Other factors which may have contributed to this finding include inter-cat relationship during
351 mealtimes, food competition, food preference and the consistency of food supply which was
352 not thoroughly examined.

353 The present study found that regular feeding instead of ad libitum feeding was associated
354 with a higher body condition score. This is in contradiction to current literature which
355 associated ad libitum feeding with obesity (Russell et al 2000; Serisier et al 2013). Scarlett's
356 study (1994) on risk factors for developing obesity in pet cats was the only study that found
357 ad libitum feeding not being associated with obesity. The feline obesity literature revolved
358 around pet cats and used questionnaires to analyze risk factors in the cat's home environment.
359 The studies also used single food source. The shelter environment is stressful for cats and the
360 food source varied, even with shelters that fed the cats ad libitum, the variability of the food
361 may have contributed to the difference in findings, **not excluding the confounding factor of**
362 **group housing.**

363 Most literature examining body condition score and associated illnesses used pet cats, with an
364 emphasis on obesity. Low body condition scores are associated with **diseases including**
365 chronic kidney disease, gastro-intestinal diseases, thyroid and heart illnesses. (Scarlett &
366 Donoghue 1998; Freeman et al 2016; Peterson et al, 2016). **Stavisky** et al (2017) looked at the
367 prevalence of feline leukaemia virus at two cat shelters in the United Kingdom and found cats
368 with lower body condition score were more likely to have the virus.

369 Feeding as a husbandry practice (feeding schedule not described) was included in various
370 studies on cat shelters but was found not to be significant in affecting cat welfare (Arhant et
371 al 2015; Eriksson, Loberg, & Andersson 2009; Hirsch, Andersson, & Loberg 2014). The
372 presentation of food in shelters (same time, same place, same mode) has also been criticized

373 for prohibiting foraging behaviour in cats. This often results in boredom which may manifest
374 as over or under eating (Stella & Cronney 2016; Sadek 2018). Stress eating has also been
375 described in cats (McMillan 2013). The shelter environment is stressful, and feeding is not a
376 social event for shelter cats (Finka 2020). Whether **the manner of feeding (ad lib/ regular)**
377 affect shelter cat health is affected by multiple factors (for example group vs single housing,
378 history of being surrendered or stray cat, intercat relationship, etc), and the fact that cats are
379 versatile and can be adaptable to a flexible diet (Zoran & Buffington 2011; Buffington 2015).
380 **This** complicates the issue of singling out feeding as a sole factor in affecting shelter cat's
381 health.

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

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

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

397 The American Society for the Prevention of Cruelty to Animals (ASPCA) and the
398 Association of Shelter Veterinarian has also published guidelines (Newbury et al 2010) on
399 general shelter management. **With reference to farm animals**, Dale (2009) argues that codes
400 and regulations may not necessarily protect the farm animals in New Zealand and Australia;
401 and often succumbed to economic pressure and political red tape. In Zito's study looking at
402 managed and unmanaged stray cats in New Zealand; most cats observed were of satisfactory
403 health. **Hence it seems with or without regulations; cats fare well, at least in Zito's study.**
404 Across the globe, education of the general public seemed to be a common theme in
405 improving the welfare of all animals, not just cats (NCNMS 2020).

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

413 Confounding factors relating to stress in cats were not addressed in the present study, in part
414 because the over-arching impacts of major variations in practices had not been quantified. For
415 example, group against individual housing (reflecting accessibility of resources), **non**
416 **randomly selected subjects in some shelters, cat population turnover causing undue stress for**
417 **cats**, presence of enrichment in the cat enclosure and their utilisation (Ottway & Hawkins
418 2003; Gourkow & Fraser 2006; Eriksson et al 2009; Moore & Bain 2013; Vinke et al 2014;
419 Hirsch et al 2014; Finka et al 2014; Hirsch 2016; Ellis et al 2017). Pheromone therapy was
420 used in one shelter, its effect was not included in our analysis (Shreve & Udell, 2017;

421 Chadwin, Bain & Kass 2017). For feeding regime, factors which may have influenced the
422 association between feeding regime and body condition score were not examined. These
423 include the amount and type of food fed, consistency of food supply, meal duration, inter-cat
424 relationship and food competition. Length of stay per cat was also not recorded. Gouveia
425 (Gouveia et al 2011) found that increased length of stay in shelters was associated with
426 decreased feeding in 46 cats that had been in a shelter for over seven years. Cat nutritional
427 status prior to admission was not examined – although all cats studied have been in the
428 shelter for over four weeks and cats take **about** two to five weeks to settle in a new
429 environment (Rochlitz 2014).

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

440 ***Welfare implications and conclusion***

441 Relinquishment to shelters potentially constitutes a compromise of animal welfare. Shelter
442 animals are often more in need of better care but may receive substandard care (e.g. expired
443 food and medicines) (Turner et al 2012). This is especially problematic in unregulated shelter
444 environments, as resources and expertise may often be limited. The development of

445 respiratory tract infection is the second most common reason for euthanasia for cats in
446 shelters (after over-crowding). Shelter cats are vulnerable if they are housed in a variable,
447 unregulated shelter environment in which suboptimal care can be common (Rioja-Lang et al
448 2019). The results of this study concur with what we know from the current literature. It is
449 envisioned that with the expansion of shelter medicine and the public's awareness of animal
450 welfare, a guideline to standardize the care delivered to cats housed in Hong Kong's shelters
451 could be developed which may be pertinent to other unregulated systems. A local shelter
452 registry, licensing system with regular inspections for compliance with acceptable standards
453 will have the potential to safeguard the welfare of cats housed in shelters.

454

455 **Conflict of interest**

456 Main author is an unpaid board member of an animal shelter.

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695 **Legend of figures**

696 **Figure 1.** Bar chart showing the distribution of the body condition scores of the cats stratified
697 by whether there was regular feeding regimen in the shelter

698 **Figure 2.** Bar chart showing the distribution of the body condition scores of the cats stratified
699 by whether there was regular veterinary check-ups in the shelter

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