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Influence of living in a multi-cat household on health and behaviour in a cohort of cats from the United Kingdom

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Abstract

Background

Living in a multi-cat household has been implicated as a risk factor for various feline issues, but evidence is often anecdotal or based on retrospective studies.

Methods

Data from the Bristol Cats Study, a UK longitudinal study of pet cats, were used. Cats were included if they had remained in either a single or multi-cat household between questionnaires one (two to four-month-old) and five (two-and-a-half-year-old). Univariable and multivariable logistic regression models were used to analyse associations between single/multi-cat households and measures of health and behaviour (overweight/obesity, abscesses/cat bites, negative interactions with owner, periuria). Multi-cat households were also subcategorised according to whether owners had reported agonistic behaviour between household cats.

Results

There was no evidence of association between household type and the likelihood of obesity, abscesses or periuria. The likelihood of negative interactions with the owner (for example growling or hissing) was influenced by the cats' relationships; cats in non-agonistic multi-cat households had decreased odds of negative interactions with the owner, compared to single and agonistic multi-cat households ($P < 0.001$).

Conclusion

Living in a multi-cat households *per se* was not a risk factor for the health and behaviour issues investigated, but the inter-cat relationship is important.

Introduction

The problems and benefits afforded by multi-cat households can be a contentious issue, with strong views expressed regarding the welfare of cats housed with other cats. Although multi-cat households can be an enforced abnormal social structure, the influence of domestication and the ability of cats to adapt should be considered, and information based on evidence rather than anecdotes and preconceptions. Although traditionally regarded as an asocial species¹, cats are able to form stable colonies around resources, as seen in populations of feral and farm cats^{2,3}. Nearly half of pet cats in the UK live with other cats; estimates of the proportion of pet cats residing in a multi-cat household in the UK are around 42 to 43 per cent^{4,5} of an estimated population of between 9 and 11 million^{5,6}. If living in a multi-cat household is a risk factor for stress, disease and/or behavioural problems, this would apply to around four million cats in the UK.

Various health issues have been scientifically and anecdotally associated with living in a multi-cat household. For example, obesity is one of the most frequent health issues in cats⁷. This could be associated with multi-cat households where it is more difficult to control food intake, although results from a cross-sectional study found no evidence that this was the case⁸. Cat bite injuries and resulting abscesses are another frequent health issue⁷, and fighting can lead to the transmission of some infectious diseases. To our knowledge no studies have investigated association between abscesses/cat bites and multi-cat households, although bite wounds from inter-cat fighting were proposed as a reason for an association between multi-cat households and pyothorax⁹.

Multi-cat households could also be associated with unwanted behaviours. A reported 38% of returns and 7% of relinquishments of cats to rehoming shelters within a UK sample were as a

result of unwanted behaviours, with house-soiling and aggression towards people two of the main issues¹⁰. These are also both common reasons for behavioural referral in the UK¹¹. House-soiling includes periuria; although this can be an indicator of feline lower urinary tract disease¹², there is evidence that stressful events can lead to an increase in this behaviour¹³ and it has been reported to occur more commonly in multi-cat households¹⁴. There also appears to be an increased risk of lower urinary tract signs where there is conflict between the cats¹⁵ and relationships between cats in the household should therefore be considered. Conversely, the other behavioural issue, aggression towards people, has been linked with living in a single cat household, where it was most commonly directed towards the owner¹⁶.

Many of these studies on associations between health/behaviour and multi-cat households, have been retrospective^{14,15,17} and/or cross-sectional^{8,18}. Longitudinal studies have some distinct advantages, including the use of prospective data which are less susceptible to recall bias than retrospectively collected data¹⁹. Using owner-reported rather than veterinary-reported data allows the inclusion of cats who may have had, for example, an abscess, but did not visit a veterinary practice. Additionally, many studies on behaviour use a cohort of cats selected from a behaviour referral centre^{14,15,17}. Inclusion of cats who have not visited a veterinary surgery or been referred is likely to be more representative of the whole UK pet cat population.

The objective of this study was to use prospectively-collected data from a longitudinal study to identify evidence of associations between multi-cat households and potentially associated health and behaviour issues (overweight/obesity, abscesses/cat bites, negative interactions with owner, periuria). A distinction between multi-cat households where cats had reported conflict and no reported conflict was also made.

Materials and methods

Data collection

The Bristol Cats Study (BCS) is an ongoing longitudinal study of health, behaviour and environment of pet cats in the UK. Owners of pet kittens between two and four months of age were recruited between May 2010 and December 2013. Recruitment was initially restricted to the Bristol area and expanded nationwide in 2011. Recruits were self-selected through advertisements placed in locations including veterinary practices, rehoming centres and cat interest websites. Owners could register multiple cats from the same household. The BCS has been described in more detail elsewhere²⁰.

The BCS is primarily based on owner-completed questionnaires at specific ages of the registered cat(s). For this study, questionnaire one (Q1: age two to four months), two (Q2: age six months), three (Q3: age 12 months), four (Q4: age 18 months) and five (Q5: age two-and-a-half years) were used. These can be accessed at: <https://smvsfa.onlinesurveys.ac.uk/bristol-cats-study-questionnaire-1-kitten-aged-8-16-wks-2> (Q1), <https://smvsfa.onlinesurveys.ac.uk/bristol-cats-study-questionnaire-2-6-month-old-cats-c> (Q2), <https://smvsfa.onlinesurveys.ac.uk/bristol-cats-study-questionnaire-3-12-month-old-cats-c> (Q3), <https://smvsfa.onlinesurveys.ac.uk/q4bc> (Q4) and <https://smvsfa.onlinesurveys.ac.uk/bristol-cats-study-questionnaire-5-25-years-old-cats-2> (Q5).

Participants

Cats from the BCS were included in this study if their owners had completed Q1 through Q5 inclusive. Only cats who had remained either in a multi-cat (defined as two or more cats) or

a single cat household throughout the selected time period were included. Cats with incongruent data, that is where the owner reported interactions between household cats, but the household was classified as single cat household, or where the owner reported no cat-cat interactions within a multi-cat household, were excluded. Where more than one cat from the same household was eligible for the study, one was chosen at random for inclusion. Figure 1 describes how the study sample was reached after removal of ineligible cats.

Household

Cats reported to have lived with no other cats in Q1 to Q5 inclusive were classed as living in single cat households. Cats reported to have lived with one or more other cats in Q1 to Q5 were classified as living in multi-cat households. Owners were asked “which of these statements best describes how your Bristol Study cat interacts with other cats in the household”. Within multi-cat households, cats for whom the owner answered ‘yes’ to this question for one of the following behaviours: ‘hisses or spits at another cat’, ‘is hissed or spat at by another cat’, ‘is reluctant to pass another cat in a narrow space’ and/or ‘blocks or inhibits the movement of another cat’ were classed as agonistic multi-cat households. Multi-cat households where none of these behaviours were selected were classed as non-agonistic multi-cat households.

Health and behaviour outcomes

The outcomes were chosen to reflect common health and behaviour issues in pet cats anecdotally or scientifically associated with single or multi-cat households. They were also based on the data available for the Bristol Cats Study, having sufficient frequency within the population to allow statistical power.

Overweight/obesity

Cases were cats who were reported by their owner at Q5 to have been at body condition score four (overweight) or five (obese) within the past year, based on a five point scoring system²¹. Controls were cats who were reported by their owners to have not been at body condition score four or five within the past year.

Abscess/cat bite

Cases were obtained from two questions in Q5; cats whose owner reported them to have visited a veterinary surgeon for an abscess or cat bite wound within the past 12 months, and those whose owners had reported that their cat had had an abscess or bite wound within the past 12 months but had not been presented to a veterinary surgeon. Control cats were those who were reported by their owner to have not had an abscess or bite wound within the past 12 months.

Periuria

The frequency with which the owner reported that the cat urinated in the house but not in the litter tray was recorded in Q5 as ‘always’, ‘usually’, ‘occasionally’ and ‘never’. Cats who ‘never’ urinated in the house (excluding the litter tray) were classed as controls and cats whose owners had selected ‘always’, ‘usually’ or ‘occasionally’ were cases.

Negative interactions with owners

Owners were asked in Q5 how the cat responded (sometimes or always) when approached or handled ‘nowadays’, with a selection of answers. Those who had chosen one or more of the following statements were defined as cases: ‘runs away’, ‘growls, hisses or spits’, ‘swipes at me’. Cats who had not shown any of these behaviours, but where the owner had selected one

or more of the other options were classified as controls.

Calculations indicated that based on the sample size for the four outcomes (at least 63 cases and 315 controls), at a significance level of 0.05 there was 80% power to detect an odds ratio of at least 2.5. Hence this study had the power to detect fairly large effect sizes only. (Epi Info 2000).

Explanatory variables

Potential explanatory variables for the four outcomes of interest were extracted from Q1 and Q5 (supplementary table 1). These were mostly variables that could be reasonably expected to cause stress (for example presence of children, neighbourhood cat density), along with demographics of the owners. Whether or not the cat was from the initial cohort (limited to the Bristol 'BS postcode' area) was included to address potential bias from this sampling method. Six factors had categories that were combined for analysis, based on the results of initial univariable analyses: income, education, playing time, time spent outdoors and cat density.

Risk factor analysis

Univariable logistic regression models were used to analyse associations between the four outcomes and single/multi-cat household status. Univariable analyses were then repeated with agonistic and non-agonistic multi-cat households as separate categories. The outcomes that showed an association with household status of $P < 0.2$ were taken to further analysis. Outcomes with an association of $P > 0.2$ with household were not analysed further, since household was the focus of interest.

Subsequent univariable analyses were run to identify other explanatory factors which were associated at $P < 0.2$ for each outcome. These were then entered into the modelling process for multivariable analysis. For two variables (abscesses/cat bites and negative interactions with the owner) no unneutered cats were cases. One control cat for each of these variables was selected at random to become a case for these two univariable analyses to be conducted, then returned to controls for the other analyses. For each outcome, cats with missing data for any of the explanatory factors with $P < 0.2$ were removed in order to have a complete dataset for each multivariable analysis.

For the multivariable analyses, the distinction between agonistic and non-agonistic multi-cat households was retained. Backward elimination was used in the multivariable model building process for each outcome; the explanatory factor with the highest P value greater than 0.05 was removed at each stage until all remaining variables had P values less than 0.05. Interactions considered biologically plausible were tested for within each final multivariable model.

IBM SPSS Statistics version 23 was used for all data analyses. The Bristol Cats Study has ethical approval from the University of Bristol ethical committee (reference UIN/13/026).

Results

Descriptive data

The number of cats eligible for, and included in the study, is summarised in Figure 1. Of the cats included in the study, 21.3% were in single cat households and 78.7% in multi-cat households. Of the multi-cat households, the majority (62.2%) were in agonistic households, with 37.8% in non-agonistic households. The minimum number of cats in a multi-cat

household was two, with a maximum number of 30 (supplementary table 2). The median of cats in a multi-cat household was three cats and the interquartile range was two-five cats. About half (410/780: 52.4%) of the total number of cats were male and 182/776 (23.5%) were purebred cats. There were 22/783 (2.8%) cats (three male and 19 female) who were not neutered by age two-and-a-half years.

For overweight/obesity, 150/755 (19.9%) cats were reported by their owners at Q5 to be at body condition score four or five (on a 5-point scoring system) within the past 12 months. Sixty-eight of 783 (8.7%) cats had been reported by the owner to have had an abscess or cat bite within the past 12 months, whether or not they had been to a veterinary surgeon, and 83/783 (10.6%) cats were reported to have urinated outside of the litter tray (with no specified timescale). Cats who were reported to have negative interactions with their owner numbered 132/782 (16.9%).

Univariable analysis

The results of the univariable analyses for association of the four outcomes with living in a single/multi-cat household are shown in table 1. No evidence of a significant association ($P>0.2$) was found between living in a single vs multi-cat household and the odds of owner-reported overweight/obesity or periuria. Subsequently, no association was found when multi-cat households were split into agonistic or non-agonistic multi-cat households (supplementary table 3,4) These outcomes were therefore not assessed further.

Abscesses/cat bites and negative interactions with owner had P values less than 0.2 associated with single/multi-cat household (table 1). For both outcomes, a distinction was then made between agonistic and non-agonistic multi-cat households. The univariable analyses with

potential explanatory factors can be found in the supplementary material (supplement 5,6)
These factors were taken forward to multivariable risk factor analysis, and the final
multivariable models for each of the three outcomes are shown in table 2. As a result of
different amounts of missing data for different questions, the total number of cats varies
between outcomes.

Multivariable analysis

The final multivariable models can be seen in table 2.

Abscess/cat bite

The complete dataset for abscesses/cat bites consisted of 465 cats, of which 53 (11.4%) were
cases. Household status was not associated with owner-reported abscess/cat bite within the
previous 12 months at multivariable level.

Negative interactions with owner

For reported negative interactions with the owner, the complete dataset consisted of 656 cats
of which 116 (17.7%) were cases. Agonistic multi-cat households were not significantly
different from single cat households in the odds of the outcome, but non-agonistic multi-cat
households had reduced odds of having a negative interaction with the owner when compared
with single cat households (OR 0.26; 95% CI 0.14-0.50).

Discussion

This study aimed to use longitudinal prospectively collected data from the Bristol Cats

Study to analyse associations between single/multi-cat households and measures of health and behaviour, and to distinguish whether this differed for cats in agonistic and non-agonistic multi-cat households.

No evidence was found for an association between single/multi-cat households and owner-reported overweight/obesity or periuria in this sample of cats. Although the lack of an association within our dataset could be due to a lack of statistical power, our results do support previous findings for both outcomes^{8,17}. Obesity is one of the most common health issues in cats⁷ and a potential risk factor for numerous diseases²². Periuria is a common reason for relinquishment¹⁰ and behavioural referral¹¹. The finding that neither of these issues is associated with living in a multi-cat household is therefore important. Urination outside the litter tray has been used as an indicator of feline lower urinary tract disease¹². Risk factors for other owner-reported lower urinary tract signs (haematuria, straining and vocalizing when urinating) have already been reported for the BCS cohort²³, where living in multi-cat households was not found to put cats at greater risk. Inappropriate urination can also be a behavioural issue. Periuria as a behavioural issue could have confounding factors associated with the number of cats in a household for which data was not available, for example the location and number of litter trays within the household, although a behaviour-focussed retrospective study supports no association between single/multi-cat households and house soiling¹⁷.

Cat bites are another common health issue⁷ and fighting is implicated in the spread of infectious disease. Living in a single cat household was associated at univariable level with having an abscess or cat bite within the past 12 months, indicating that abscesses and cat bites are more likely to be a result of an agonistic encounter with an unfamiliar cat rather than

between cats within a household. However, household was not retained in the final multivariable model. It may be that confounding factors existed which were not detected, resulting in removal from the final model.

The finding that negative interactions with the owner were associated with living in a single cat household supports a cross-sectional study where cats living without conspecifics had greater likelihood of aggression towards people¹⁶. In that study, the authors suggested play-related aggression as a potential reason for this finding, and this would be a likely explanation for the young cats in the present study. The distinction between agonistic and non-agonistic multi-cat households in the current study revealed that this association was only found in comparison with non-agonistic households. An explanation for this could be that inter-cat conflict in agonistic multi-cat households can lead to redirected aggression towards the owner²⁴.

There are several implications for human-directed aggression. It is a common reason for relinquishment to rehoming centres; one study reports 14% of relinquishment in the UK were a result of this¹⁰. There are human health implications, such as cat bite infections and cat scratch fever. Finally, the human-cat relationship may be affected by negative interactions. Cats with whom their owners feel a weaker bond are less likely to receive preventative care²⁵ and owners with a weaker bond are less likely to feel emotional support from their pets²⁶. The current study highlights the importance of establishing and maintaining good inter-cat relationships in multi-cat households and human-cat relationships in all households.

Limitations

The nature of the cohort, that is, motivated cat owners who are willing to complete annual

questionnaires, means that the results from the study are not necessarily representative of the general population of cat owners in the UK. One noticeable difference is the high percentage of cats in multi-cat households (79%), when compared with the general population of 42 to 43 per cent^{4,5}. However, this bias is considered more likely to affect prevalence estimates than risk factor analyses²⁰. Additionally, one challenge of longitudinal studies is the retention of participants. Several retention strategies are implemented in the Bristol Cats Study, and have been described elsewhere²⁰. Although the Bristol Cats Study is a reasonably large cohort, the occurrence of health and behaviour outcomes is often low, resulting in a lack of power to detect small but possibly clinically relevant effects. Indeed, limited statistical power within this study may have contributed to one or more of the non-significant findings, if they occurred as a result of a type-I error.

A final point is that the definition of an agonistic household was derived from the presence of agonistic behaviours, rather than the absence of affiliative behaviours. It is possible that some of the cats in households classed as agonistic by this definition may actually be in mostly harmonious relationships. This could also account for the high proportion of agonistic multi-cat households in the cohort. The relationships between cats within the Bristol Cats Study as well as the influence of number of cats within each household could be assessed more fully in future research.

Conclusion

Of the health and behaviour outcomes investigated, none were associated with living in a multi-cat household, despite a seemingly large proportion of agonistic multi-cat households. This suggests that cats may not necessarily be at increased risk of health and behavioural issues when living with other cats and should be taken into account when considering the

welfare of cats in multi-cat households. The likelihood of negative interactions with the owner was influenced by the cats' relationships, rather than the multi-cat household itself; veterinary practices and rehoming centres should promote methods of establishing and maintaining good inter-cat and cat-human relationships.

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Table 1 Univariable regression for cats two-and-a-half years in from the Bristol Cats Study cohort showing the association of single and multi-cat households with six health, behaviour and care outcomes

Outcome*	N (%) Cases	N (%) Controls	P-value	OR (95% CI)
Overweight/obesity Single cat Multi-cat	28 (17.5) 122 (20.5)	132 (82.5) 473 (79.5)	0.398	1.0 0.82 (0.52-1.30)
Abscess/cat bite Single cat Multi-cat	22 (13.2) 46 (7.5)	145 (86.8) 570 (92.5)	0.022	1.0 0.532 (0.31-0.91)
Periuria Single cat Multi-cat	15 (10.8) 68 (13.8)	124 (89.2) 424 (86.2)	0.352	1.0 1.33 (0.73-2.40)
Negative interactions with owner Single cat Multi-cat	40 (24.1) 92 (14.2)	126 (75.9) 524 (85.1)	0.006	1.0 0.58 (0.38-0.88)

*For definition of cases/controls, see materials and methods

Table 2 Final multivariable logistic regression models for cats aged 2.5 years from the Bristol Cats Study cohort showing factors associated with abscess/bite wounds, negative interactions with owner and unvaccinated/lapsed vaccinations

Variable	Factors	N (%) cases	N (%) controls	P-value	OR (95% CI)
Abscess/bite	Education Up to A-level	7 (6.1)	108 (93.9)	0.034	1
	Degree and above	46 (13.1)	305 (86.9)		2.46 (1.07-5.64)
	Location Town/city	23 (8.4)	251 (91.6)	0.012	1
	Rural/village	30 (15.7)	161 (84.3)		2.11 (1.18-3.78)
Negative interactions with owner	Household SCH	36 (25.9)	103 (74.1)	<0.001	1
	AMCH	63 (20.1)	251 (79.9)	0.178	0.72 (0.44-1.16)
	NMCH	17 (8.4)	186 (91.6)	<0.001	0.26 (0.14-0.50)
	Age of owner (years)* 55+	13 (10.8)	107 (89.2)	0.024	1
	16-54	103 (19.2)	433 (80.8)		2.09 (1.10-3.96)
	Gender of cat Male	48 (13.5)	308 (86.5)	0.001	1
	Female	68 (22.7)	232 (77.3)		2.11 (1.38-3.22)
	Breed of cat Pure breed	12 (8.2)	135 (91.8)	0.005	1
	Mixed/DSH/DLH	104 (20.4)	405 (79.6)		2.53 (1.33-4.80)

*For negative interactions with owner, there was no significant difference between age groups 16-24 and 25-54, so these were recoded into one category

420 SCH= single cat household; AMCH= agonistic multi-cat household, NMCH= non-agonistic multi-cat
421 household; DLH= domestic longhair; DSH= domestic shorthair