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

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Abstract

Background Living in a multicat 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 cat or multicat household between questionnaires 1 (two months old to four months old) and 5 (two-and-a-half years old). Univariable and multivariable logistic regression models were used to analyse associations between single cat/multicat households and measures of health and behaviour (overweight/obesity, abscesses/cat bites, negative interactions with owner and periuria). Multicat 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 (eg, growling or hissing) was influenced by the cats' relationships; cats in non-agonistic multicat households had decreased odds of negative interactions with the owner, compared with single and agonistic multicat households (P<0.001).

Conclusion Living in a multicat households per se was not a risk factor for the health and behaviour issues investigated, but the intercat relationship is important.

Introduction

The problems and benefits afforded by multicat households can be a contentious issue, with strong views expressed regarding the welfare of cats housed with other cats. Although multicat 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 species,[1] 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 multicat household in the UK are around 42–43 per cent[4 5] of an estimated population of between 9 and 11 million.[5 6] If living in a multicat household is a risk factor for stress, disease and/or behavioural problems, this would apply to around 4 million cats in the UK.

Various health issues have been scientifically and anecdotally associated with living in a multicat household. For example, obesity is one of the most frequent health issues in cats.[7] This could be associated with multicat households where it is more difficult to control food intake, although results from a cross-sectional study found no evidence that this was the case.[8] Cat bite injuries and resulting abscesses are another frequent health issue,[7] and fighting can lead to the transmission of some infectious diseases. To our knowledge, no studies have investigated association between abscesses/cat bites and multicat households, although bite wounds from intercat fighting were proposed as a reason for an association between multicat households and pyothorax.[9]

Multicat households could also be associated with unwanted behaviours. A reported 38 per cent of returns and 7 per cent of relinquishments of cats to rehoming

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shelters within a UK sample were as a result of unwanted behaviours, with house-soiling and aggression towards people two of the main issues.[10] These are also both common reasons for behavioural referral in the UK.[11]

House-soiling includes periuria; although this can be an indicator of feline lower urinary tract disease,[12] there is evidence that stressful events can lead to an increase in this behaviour,[13] and it has been reported to occur more commonly in multicat households.[14] There also appears to be an increased risk of lower urinary tract signs where there is conflict between the cats,[15] 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 owner.[16]

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 that are less susceptible to recall bias than retrospectively collected data.[19] 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

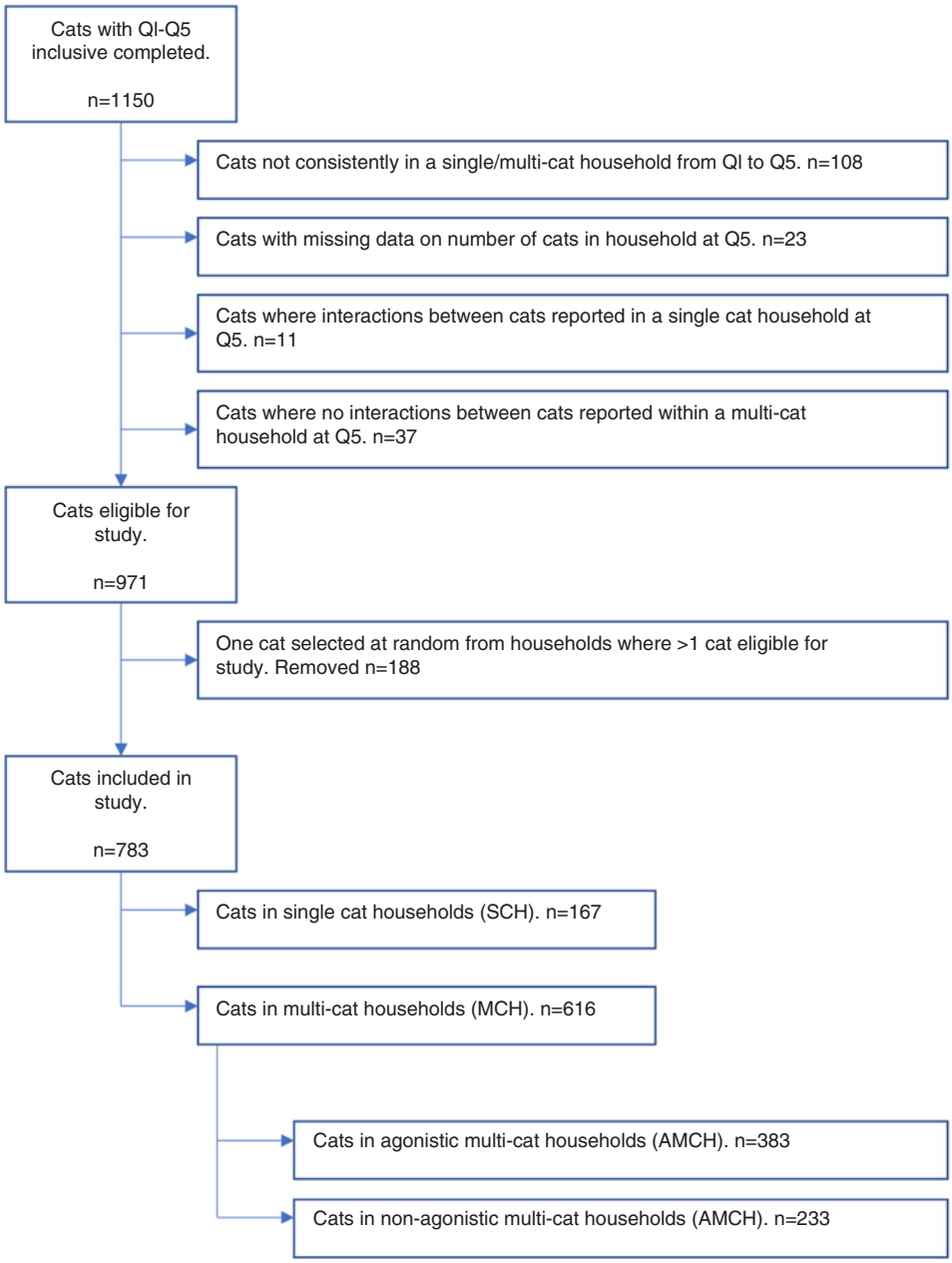

Figure 1 Flow chart summarising the exclusion and inclusion of cats from the Bristol Cats Study for the analysis of association with single cat and multicat households and six specific health and behaviour outcomes at age two-and-a-half years. Q1, questionnaire 1 (age two to four months); Q5, questionnaire 5 (age two-and-a-half years).

evidence of associations between multicat households and potentially associated health and behaviour issues (overweight/obesity, abscesses/cat bites, negative interactions with owner and periuria). A distinction between multicat 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 elsewhere.[20]

The BCS is primarily based on owner-completed questionnaires at specific ages of the registered cat(s). For this study, questionnaire 1 (Q1: age two to four months), 2 (Q2: age six months), 3 (Q3: age 12 months), 4 (Q4: age 18 months) and 5 (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–Q5 inclusive. Only cats who had remained either in a multicat (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 multicat 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–Q5 inclusive were classed as living in single cat households. Cats reported to have lived with one or more other cats in Q1–Q5 were classified as living in multicat households. Owners were asked 'which of these statements best describes how your Bristol Study cat interacts with other cats in the household'. Within multicat 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 multicat households. Multicat households where none of these behaviours were selected were classed as non-agonistic multicat 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 cat or multicat households. They were also based on the data available for the BCS, 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 4 (overweight) or 5 (obese) within the past year, based on a five-point scoring system.[21] Controls were cats who were reported by their owners to have not been at body condition score 4 or 5 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' and '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 per cent power to detect an OR of at least 2.5. Hence, this study had the power to detect fairly large effect sizes only (Epi Info 2000).[22]

Explanatory variables

Potential explanatory variables for the four outcomes of interest were extracted from Q1 and Q5 (online supplementary table 1). These were mostly variables that could be reasonably expected to cause stress (eg, presence of children and neighbourhood cat density), along with demographics of the owners. Whether the cat was from the initial cohort (limited to the Bristol 'BS postcode' area) was included to address potential bias from this sampling method. Five 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 cat/multicat household status. Univariable analyses were then repeated with agonistic and non-agonistic multicat 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 that 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 multicat 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 V.23 was used for all data analyses.

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 per cent were in single cat households and 78.7 per cent in multicat households. Of the multicat households, the majority (62.2 per cent) were in agonistic households, with 37.8 per cent in non-agonistic households. The minimum number of cats in a multicat household was two, with a maximum number of 30 (online supplementary table 2). The median of cats in a multicat household was three cats, and the IQR was two to five cats. About half (410/780: 52.4 per cent) of the total number of cats were male and 182/776 (23.5 per cent) were purebred cats. There were 22/783 (2.8 per cent) cats (three male and 19 female) who were not neutered by age two-and-a-half years.

For overweight/obesity, 150/755 (19.9 per cent) cats were reported by their owners at Q5 to be at body condition score four or five (on a five-point scoring system) within the past 12 months. Sixty-eight of 783 (8.7 per cent) cats had been reported by the owner to have had an abscess or cat bite within the past 12 months, whether they had been to a veterinary surgeon, and 83/783 (10.6 per cent) 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 per cent).

Univariable analysis

The results of the univariable analyses for association of the four outcomes with living in a single cat/multicat household are shown in table 1. No evidence of a significant association (P>0.2) was found between living in a single cat versus multicat household and the odds of owner-reported overweight/obesity or periuria. Subsequently, no association was found when multicat households were split into agonistic or non-agonistic

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

Outcome*	N (%) cases	N (%) controls	P value	OR (95% CI)
Overweight/obesity				
Single cat	28 (17.5)	132 (82.5)	0.398	1.0
Multicat	122 (20.5)	473 (79.5)		0.82 (0.52 to 1.30)
Abscess/cat bite				
Single cat	22 (13.2)	145 (86.8)	0.022	1.0
Multicat	46 (7.5)	570 (92.5)		0.532 (0.31 to 0.91)
Periuria				
Single cat	15 (10.8)	124 (89.2)	0.352	1.0
Multicat	68 (13.8)	424 (86.2)		1.33 (0.73 to 2.40)
Negative interactions with owner				
Single cat	40 (24.1)	126 (75.9)	0.006	1.0
Multicat	92 (14.2)	524 (85.1)		0.58 (0.38 to 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 to 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 to 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 to 1.16)
	NMCH	17 (8.4)	186 (91.6)	<0.001	0.26 (0.14 to 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 to 3.96)
	Sex of cat				
	Male	48 (13.5)	308 (86.5)	0.001	1
	Female	68 (22.7)	232 (77.3)		2.11 (1.38 to 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 to 4.80)

*For negative interactions with owner, there was no significant difference between age groups 16–24 and 25–54 years, so these were recoded into one category.
AMCH, agonistic multicat household; DLH, domestic longhair; DSH, domestic shorthair; NMCH, non-agonistic multicat household; NMCH, non-agonistic multi-cat household; SCH, single cat household.

multicat households (online supplementary table 3). 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 cat/multicat household (table 1). For both outcomes, a distinction was then made between agonistic and non-agonistic multicat households. The univariable analyses with potential explanatory factors can be found in the supplementary material (online supplementary table 4 and 5). 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 per cent) 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 per cent) were cases. Agonistic multicat households were not significantly different from single cat households in the odds of the outcome, but non-agonistic multicat 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 to 0.50).

Discussion

This study aimed to use longitudinal prospectively collected data from the BCS to analyse associations between single cat/multicat households and measures of health and behaviour and to distinguish whether this differed for cats in agonistic and non-agonistic multicat households.

No evidence was found for an association between single cat/multicat 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 cats[7] and a potential risk factor for numerous diseases.[23] Periuria is a common reason for relinquishment[10] and behavioural referral.[11] The finding that neither of these issues is associated with living in a multicat household is therefore important. Urination outside the litter tray has been used as an indicator of feline lower urinary tract disease.[12] Risk factors for other owner-reported lower urinary tract signs (haematuria, straining and vocalising when urinating) have already been reported for the BCS cohort,[24] where living in multicat 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 were not available, for example, the location and number of litter trays within the household, although a behaviour-focused retrospective study

supports no association between single cat/multicat households and house soiling.[17]

Cat bites are another common health issue,[7] 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 agnostic 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 that 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 people.[16] 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 multicat 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 intercat conflict in agonistic multicat households can lead to redirected aggression towards the owner.[25]

There are several implications for human-directed aggression. It is a common reason for relinquishment to rehoming centres; one study reports 14 per cent of relinquishment in the UK were a result of this.[10] 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 preventive care,[26] and owners with a weaker bond are less likely to feel emotional support from their pets.[27] The current study highlights the importance of establishing and maintaining good intercat relationships in multicat 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 multicat households (79 per cent), when compared with the general population of 42–43 per cent.[4 5] However, this bias is considered more likely to affect prevalence estimates than risk factor analyses.[20] Additionally, one challenge of longitudinal studies is the retention of participants. Several retention strategies are implemented in the BCS and have been described elsewhere.[20] Although the BCS 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 multicat households in the cohort. The relationships between cats within the BCS 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 multicat household, despite a seemingly large proportion of agonistic multicat 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 multicat households. The likelihood of negative interactions with the owner was influenced by the cats' relationships, rather than the multicat household itself; veterinary practices and rehoming centres should promote methods of establishing and maintaining good intercat and cat–human relationships.

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Competing interests None declared.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information.

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