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ORIGINAL RESEARCH ARTICLE

The Inclusion of Cat Dens in a Population of Shelter Cats and Their Effect on Upper Respiratory Infection and Length of Stay

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Abstract

***Introduction*:** Feline upper respiratory infection (URI) is common in high-density populations, such as those in animal shelters. URI treatment delays time to adoption, often resulting in welfare concerns and significant expenditure of shelter labor, medication, and foster care resources. The purpose of this pragmatic, randomized controlled trial was to determine if the presence of enrichment via a consistent hiding den (i.e. feral den) throughout a cat's time in shelter reduces their URI incidence and time to adoption.

***Methods*:** Cats enrolled in this study were assigned either a den or no den and tracked from shelter intake to outcome (i.e. adoption, return to owner, and euthanasia). Cats in both groups received the usual standard of care and were monitored daily by shelter staff. The impact of a cat den on both URI occurrence and length of stay (LOS) was modeled using logistic regression and competing risks regression models, respectively. A mediation analysis was also performed to assess the den's effect on LOS through URI occurrence.

***Results*:** The impact of a cat den on LOS was mediated through a decreased probability of URI. Participant cats assigned to the den group had a 33.7% lower incidence of URI diagnosis compared to those in the control group. For cats who developed URI, the presence of a den did not significantly affect the severity of disease when compared to the control group. Cats diagnosed with URI while in shelter were 27.2% less likely to be adopted at any given time when compared to cats with no URI, regardless of den presence.

***Conclusion*:** Cats who did not experience URI while in shelter were adopted at higher rates, thus experienced shorter LOS. Since the presence of a hiding den was significantly associated with lower URI incidence, their inclusion in kennel enclosures may have positive welfare, LOS, and adoption implications for shelter cats.

Keywords: *shelter*; *feral den*; *housing*; *stress*; *hiding*; *enrichment*; *euthanasia*; *infectious disease*; *contagion*; *live outcome*

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An estimated 2.9 million domestic cats entered shelters and rescues across the U.S. in 2024.[1] While 37% fewer cats experienced non-live outcomes (e.g. euthanasia) in 2024 as compared to 2019, there has been a largely upward trend in non-live outcomes since 2021, with 273,000 cats euthanized in U.S. shelters in 2024.[1,2] As illness is a primary cause of suffering and a reason for euthanasia, it is important to recognize what factors may contribute to feline illness to decrease its occurrence and severity in shelters, as well as maximize and expedite adoption and other live outcomes (e.g. returning to owner). Likewise, it is essential for shelters to provide cats with a good quality of life (QOL) during their stays by meeting, at minimum, the five domains of animal welfare.[3]

Cats entering novel, high-density housing, such as animal shelters, experience stress related to changes in routine and environment, interactions with unfamiliar people and other animals, confined spaces that inhibit species-typical behaviors, and medical handling.[4–6] Research has found that it can take weeks to months for cats to acclimate to this kind of stress.[4] Conversely, other studies attest that extended length of stay (LOS) can lead to chronic stress and even illness, thereby reducing adoptability, increasing

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euthanasia risk, and hindering the shelter's overall capacity for care.[7,8] Enrichment can help cats both acclimate to the shelter environment and cope with its long-term effects,[9–11] which has positive implications for preventing common infectious diseases,[7,12,13] including upper respiratory infection (URI), and decreasing LOS.

The main types of environmental enrichment provided by shelters to alleviate feline stress are hiding opportunities (e.g. a den/box or private kennel structure), elevated perches, and toys.[9] Having the option to hide – a basic need and adaptive behavior that many cats enjoy – has been shown to correlate negatively with cortisol concentration, playing an important role in feline stress management.[5,10–12,14–16] Research has demonstrated that, when given a choice, shelter cats spend a significantly greater percentage of their time in a hiding compartment versus an empty control space or with a prey-simulating toy.[15] Plausibly, cats with options in regard to their surroundings and interactions may find the shelter more comfortable than cats with fewer enrichment opportunities.

Additionally, cats exposed to mental and physical stressors will often increase their attempts to hide.[5] When a proper hiding place is not available, cats not only become more distressed[7] but also frequently crouch behind a bed or litter pan or turn their litter box upside down to conceal themselves.[11] It was previously thought that providing shelter cats with hiding spaces could limit their visibility and appeal to the public, thus decreasing their adoption potential.[10] However, research has found the opposite to be true[10,17]; in fact, one study showed that cats with a 'hide and perch box' were significantly more likely to approach the front of their kennel than those given an open bed only, with no significant differences between the two cohorts in days until adoption.[10] It has even been suggested that providing access to a hiding space 'leads cats to spend less time trying to hide' and more time engaging with adopters.[18]

Enrichment and other strategies to mitigate stress are essential to a cat's overall health and well-being. Stressors increase cortisol levels, which, in turn, decrease secretory immunoglobulin A (S-IgA) and suppress immune system function.[11–13] S-IgA prevents inhaled and ingested respiratory pathogens from penetrating epithelial walls at mucosal sites, serving as the first line of defense against URI.[12] Stressed cats are also more prone to diminished appetite and weight loss, both of which predispose them to developing URI.[7] In addition to decreasing QOL,[19] URI represents one of the most common health conditions resulting in the euthanasia of shelter cats and kittens,[20] and shelters invest significant resources to treat affected cats. While these treatment regimens often improve feline health, they can also lead to extended LOS, increased severity of disease, decreased live release rates, and higher costs of care.[19]

Furthermore, apparently healthy cats often enter shelters as subclinically infected with common pathogens, such as feline herpesvirus (FHV-1) and calicivirus (FCV).[21,22] These pathogens, which often lead to URI, can be reactivated during stressful periods when the immune system is compromised, and opportunities for transmission are more likely to occur.[7] Any stressor can cause a recrudescence of latent infections,[21] underlying the importance of ongoing stress reduction in preventing disease transmission and maintaining healthy cat populations in shelters.

This study's objective was to determine whether providing shelter cats, who were ultimately adopted, with enrichment via a consistent hiding den reduced their incidence of URI, thereby decreasing their time to adoption. It was hypothesized that the effect of a den would be mediated through a decreased incidence of URI, leading to a shorter LOS for adopted cats when compared to adopted cats who were not provided with a den.

Methods

Study design

The present study was a pragmatic, parallel group, randomized controlled trial designed to evaluate the effects of providing a cat den compared to the usual standard of feline care in a shelter setting. A cat den is a plastic box with two doors that measures approximately 12" x 13" x 17.5". The trial was conducted at Humane Colorado after review of the study design and pre-planned analysis.[23]

Table 1. Inclusion and exclusion criteria used to enroll cats in the cat den pragmatic trial

Inclusion criteria	- Single cats
	- Cats appearing outwardly healthy
	- 6 months to 12 years old (estimated)
	- Owner-surrendered or stray cats
Exclusion criteria	- Younger than 6 months old (estimated)
	- Older than 12 years old (estimated)
	- History of chronic URI
	- Cats with active URI
	- Cats weighing over 15 lbs.
	- Bonded pairs of cats
	- Cats needing immediate veterinary care
	- Feral cats
	- Cats from shelter partners with known contagion risk

URI: upper respiratory infection.

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Cats who presented to the shelter either as stray or owner-surrendered animals between November 1, 2023, and April 5, 2024, were screened for eligibility. Cats who met the inclusion criteria (Table 1) were enrolled by shelter staff and randomly assigned a cat den (i.e. the 'den group') or usual standard of care with no den (i.e. the 'control group'). Cats were assigned to cohorts via a systematic alternating allocation approach. Using a random number generator to decide that Day 1 of the study was a control group allocation day, cohort assignment was then alternated daily for the duration of the study.

All enrolled cats, regardless of cohort assignment, were housed in individual enclosures or colony environments during their shelter stay. Cats diagnosed with URI during the study period were quarantined in individual kennels. Single enclosures and colony rooms ranged in size from 5–12 ft^2 to 55–430 ft^2, respectively.

At Humane Colorado, trained shelter staff, including registered veterinary technicians and evaluation team coordinators, score URI severity and subsequently start treatment as needed per standard operating procedure (SOP) instructions. Cats diagnosed with URI are re-evaluated every 3 days for worsening, improvement, or resolution. In the event of worsening or no resolution, the cat is then evaluated by a veterinarian. To prevent the spread of any contagion via transporting cats throughout the shelter, exams are performed kennel side. As such, veterinarians and shelter staff were not blinded to group allocation.

The primary outcome for cats enrolled in this study was the incidence of URI while in the shelter, as determined by Humane Colorado protocols. Humane Colorado uses a URI Scoring Matrix of 0 to 3. URI 1 is consistent with viral causes not requiring medical intervention; animals receiving this score can be available for surgery and adoption. Animals with URI scores of 2 or 3 require medical interventions and are not available for surgery or adoption; they will remain in care until their score improves, or the URI is resolved. Score 0 indicates resolution of URI (Appendix A). The secondary outcome for enrolled cats was their LOS at the shelter, defined as the number of days from shelter intake to shelter exit via adoption [as opposed to euthanasia or being returned to their owner (RTO)].

A power analysis for a two-sample mean comparison to detect a 1-day difference in LOS between groups, with 80% power and a 5% significance level, was used to determine a required total sample size of 450 total cats (225 per cohort). To account for possible cat dropout (e.g. removal due to behavioral reasons) and competing risks that preclude adoption (e.g. RTO, euthanasia due to a health condition), the sample size was adjusted to 500 cats (250 per cohort).

In addition to the intervention and outcomes, other cat-level variables (i.e. day/month of, and reason for, shelter intake; age; weight; breed; sex; coat color; reason for shelter exit) and shelter-level variables (e.g. daily number of cats in shelter) were recorded during each cat's time in the shelter setting. Data were entered, managed, and stored using Chameleon (HLP, Inc.; Chicago, IL; Version 46h20), an electronic medical records software designed for use in shelters. Adherence to initial cohort assignment was confirmed by shelter staff via visual inspection of enrolled cats' housing configuration three times a week throughout the study.

Statistical analysis

A descriptive analysis was initially performed to ensure randomization was successful by comparing the distributions of cat- and shelter-level variables between study groups using a Chi-Squared test of independence. Regression analyses focused on the differences in URI occurrence and LOS between cohorts and were conducted on an intention-to-treat basis.

The occurrence and maximum severity of URI were modeled separately using logistic regression models. Due to the low number of severe URI cases, severity scores were aggregated into two categories: scores 0/1 versus scores 2/3 (Appendix A), which served as the binary outcome in the logistic regression model. The primary exposure of interest for both the occurrence and severity models was the presence of a den. Cat- and shelter-level covariates were included in the final logistic regression model if they met one of the following criteria: (1) they were statistically significant at the 95% confidence level, or (2) they altered the strength of the intervention-outcome relationship by more than 10%. Logistic models were fitted using the glm function in R (R Core Team, Version 4.1.1).

When modeling a den's impact on all potential outcomes (i.e. adoption, RTO, euthanasia) simultaneously with traditional survival analysis methods, LOS estimates can be biased as they may overestimate the association between the presence of a den and LOS for cats who were adopted. Time between intake and shelter exit was analyzed using the Fine and Gray subdistribution hazards model[24] to estimate the impact of cat- and shelter-level covariates on LOS, allowing for the direct estimation of the cumulative incidence of adoption while appropriately considering the influence of competing risks, such as cats who were RTO, euthanized, or lost to follow-up during the trial. Cats who were lost to follow-up were either removed from the trial due to transfer to a different facility, placement in a foster home, or remaining in the shelter without an outcome at the end of the study. These cases were treated as right censored at their last known date in the shelter. In the competing risks regression (CRR) model, censoring is explicitly accounted for and does not

introduce bias under the assumption of non-informative censoring (i.e. that the likelihood of censoring is unrelated to the outcome).

In the first step of this analysis, the subdistribution hazard function, $\widetilde{h_c}(t|X)$, was used to express the instantaneous probability of event c (e.g. adoption) at time t, given a cat is still in the shelter environment at time t and given a value for covariates X (Equation 1). The CRR model was fitted using the CRR function from the cmprsk package in R.

Equation 1: $\widetilde{h_c}(t|X) = \widetilde{h_{c0}}(t) \cdot exp\left(\beta_c^T X\right)$

Where:

$\widetilde{h_c}(t|X)$ = Subdistribution hazard for cause c (i.e. adoption, RTO, euthanasia) at time t, given covariates X

$\widetilde{h_{c0}}(t)$ = Baseline subdistribution hazard for cause c

β_c = Vector of regression coefficients for covariates X

X: Covariate vector (e.g. age, treatment group, etc.)

Next, the subdistribution hazard ratio (sHR) quantified the effect of treatment status and other covariates on the subdistribution hazard for adoption, under the assumption of proportional subdistribution hazards, which implies that the effect of treatment status (den vs. control) and other covariates remains constant over time.

The cumulative incidence function (CIF) represents the probability of event c (e.g. adoption) occurring by a given time t, accounting for competing risks, treatment status, and other covariates. The CIF was derived by integrating the subdistribution hazard over time while adjusting for survival probabilities in the presence of competing risks (Equation 2).

Equation 2: $F_c\left(t|X\right) = 1 - \exp\ -\int_0^t \widetilde{h_{c0}}\left(t\right) \cdot exp\left(\beta_c^T X\right) dt$

Where:

$F_c(t|X)$ = Cumulative incidence function for event c given covariates X

$\widetilde{h_{c0}}(t)$ = Baseline subdistribution hazard at time t

β_c = Vector of regression coefficients for covariates X

$exp\left(\beta_c^T X\right)$ = Risk score from the proportional hazards model

The CRR model was bootstrapped (10,000 samples with replacement) to calculate robust 95% prediction intervals for the sHRs and CIF estimates, allowing for an incorporation of variability and uncertainty in the model predictions.

To explore whether the den's effect on LOS was mediated through URI diagnosis, a mediation analysis was performed, combining a logistic regression model for the mediator (path a), a CRR model to estimate the effect of URI on LOS (path b), and the direct effect of the den on LOS controlling for URI (path c'). The indirect effect ($a \times b$) and total effect ($c = c' + a \times b$) were calculated, and confidence intervals for all effects were obtained via nonparametric bootstrapping with 10,000 replications.

Results

A total of 2,799 cats were presented to Humane Colorado between 11/1/2023 and 4/5/2024, when the trial ended after target enrollment was met. Of these, 823 cats were initially enrolled and assigned to a study cohort. After enrollment, 33 cats were removed because they were assigned to the wrong group (e.g. given a cat den on a control assignment day), and an additional 44 cats were removed after not meeting the inclusion criteria. Ultimately, 746 cats were included in the final analysis, with 279 cats randomly assigned to the den group and 467 assigned to the control group (Fig. 1). Despite the control group being larger, randomization was balanced, as there were no significant differences in demographic or intake variables between the two groups (Table 2).

Among the 746 cats analyzed, 553 were adopted [Den: 213/279 (76.3%) vs. Control: 340/467 (72.3%); $p = 0.33$]. A total of 118 cats experienced a competing event that precluded adoption, such as RTO or euthanasia [Den: 37 (13.2%) vs. Control: 81 (17.3%); $p = 0.17$]. Additionally, 75 cats [Den: 29 (10.4%) vs. Control: 46 (9.6%); $p = 0.91$] remained in the shelter without experiencing an event by the end of the trial period and were censored. Mean LOS was slightly lower for the den group [9.0 days, standard deviation (SD) = 6.5] compared to the control group (10.5 days, SD = 9.0), although the difference was not statistically significant ($p = 0.31$) (Table 2, Fig. 2A). Regarding respiratory health outcomes, cats provided a den had 33.7% lower odds of developing URI compared with control cats [odds ratio (OR): 0.663; 95% confidence interval: 0.460–0.948]. However, among cats who developed URI, the presence of a den did not significantly affect the severity of infection (OR: 1.58; 0.834–3.04).

Accounting for outcomes that preclude adoption, cats diagnosed with URI while at the shelter were 27.2% less likely to be adopted at any given time when compared to cats with no URI (sHR: 0.728; 0.614–0.862). However, the presence of a den itself had no direct impact on adoption likelihood (sHR: 1.01; 0.837–1.19), suggesting that the effect of dens on time to adoption is mediated primarily through reducing URI risk.

The CIF from the CRR model further illustrates this relationship (Fig. 2B). Cats who did not contract URI,

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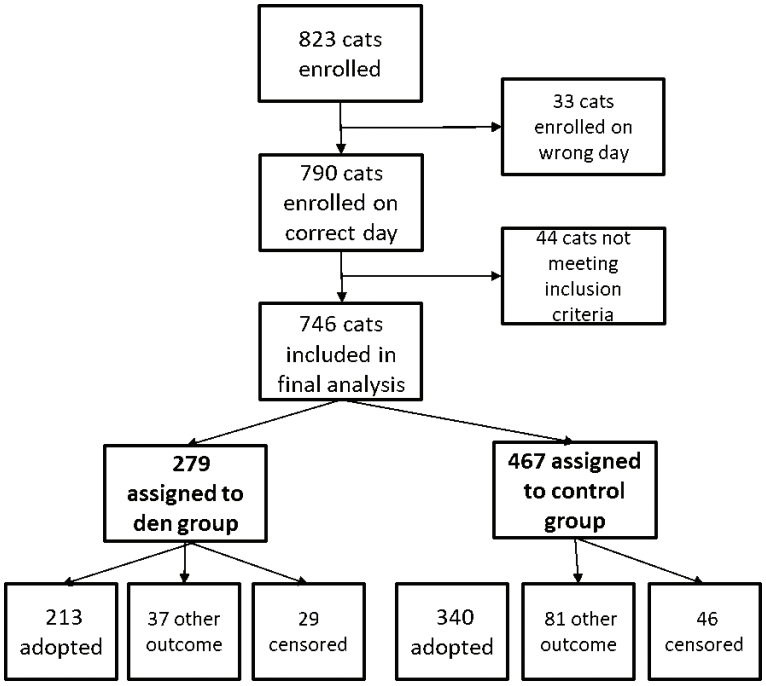

Fig. 1. Number of cats initially enrolled in the cat den pragmatic trial, along with number of cats excluded during the study and reasons for exclusion. Other outcomes include return-to-owner (RTO) and euthanasia due to a health condition.

regardless of den status, had an increasing probability of adoption over time [5 days = 13.7% (95% prediction interval: 11.1–16.7%), 10 days = 42.5% (37.3–47.8%), 15 days = 58.9% (53.0–64.9%), 20 days = 66.7% (62.6–74.4%), and 55 days = 78.7% (73.3–83.8%)] vs. cats with URI [5 days = 10.2% (8.1–12.5%), 10 days = 33.1% (28.9–37.4%), 15 days = 47.7% (42.7–52.7%), 20 days = 55.1% (49.5–60.3%), and 55 days = 67.2% (61.2–72.5%)].

Mediation analysis revealed a significant indirect effect of the den on LOS through decreased URI odds (0.348, 95% CI: 0.035–0.688), while the direct effect of the den alone, controlling for URI, was not statistically significant (sHR = 1.13, 95% CI: 0.94–1.37), again indicating that decreased occurrence of URI mediates the treatment effect of the den on LOS.

Discussion

The acute stress of entering a shelter environment is a typical challenge for most cats, but the effects of chronic stress are especially problematic and costly.[7] When confined to spaces smaller than a room in a typical home, cats may be unable to engage in species-typical behaviors (e.g. hiding, playing, stretching, scratching, and grooming).[18,25,26] Consequent environmental and emotional stress causes increased cortisol secretion with a corresponding decreased immune response, leading to an increased risk of URI.[5]

This study demonstrates that shelter cats provided with a cat den as a form of enrichment (Fig. 3) had a significantly lower risk of contracting URI when compared to the control group. Additionally, it was observed that cats who developed URI experienced longer LOS in the shelter as compared to cats without URI, regardless of den status. Mediation analysis indicated that the direct effect of the den did not significantly impact LOS, suggesting that the primary benefit of the den housing intervention functioned via reducing URI incidence.

At Humane Colorado's main shelter, the daily feline population fluctuates between 150 and 350 cats depending on season, but the facility can house up to 400 cats at any given time without sacrificing standards of care. Depending on seasonality and population density, the incidence of URI fluctuates typically from 0 to 20%. Data were not collected during the late spring and summer, when the feline shelter population typically swells, and different population health dynamics occur, which could somewhat limit the translation of these results from low-intake to high-intake periods. Given the significant impact of URI on cat well-being, as well as on shelter operations and resources,[19] minimizing the risk of URI incidence year-round is paramount. This study suggests that adding a den to a cat's housing during their shelter stay can play a positive role in maintaining feline respiratory health status.

To our knowledge, this study includes the largest sample size to date for exploring the use of cat dens in a shelter environment, supporting the overall generalizability of these results. Indeed, generalizability could be expanded

Table 2. Cat- and shelter-level variables among den (n = 279) vs. control (n = 467) cats

Variable		Den cats (n = 279)	Control cats (n = 467)	P-value
	Weight (lbs.)	Mean: 9.31, SD: 2.18	Mean: 9.18, SD: 2.31	0.44
	Age (years)	Mean: 2.89, SD: 2.32	Mean: 2.99, SD: 2.69	0.61
Breed	DSH	212 (76.0%)	373 (79.9%)	0.51
	DMH	35 (12.5%)	53 (11.3%)	
	DLH	22 (7.9%)	31 (6.6%)	
	Other	10 (3.6%)	10 (2.1%)	
Sex	Neutered male	139 (48.9%)	212 (45.4%)	0.65
	Spayed female	126 (45.2%)	230 (49.2%)	
	Intact male	7 (2.5%)	15 (5.6%)	
	Intact female	6 (2.1%)	10 (3.7%)	
Coat color	Black	46 (16.5%)	70 (15.0%)	0.87
	Fancy	12 (4.3%)	19 (4.1%)	
	Grey	13 (4.6%)	23 (4.9%)	
	Red/Orange	42 (15.1%)	59 (12.6%)	
	Tabby/Tort	75 (26.9%)	125 (27.7%)	
	White/Other	91 (32.6%)	171 (36.6%)	
Intake month	November	49 (17.6%)	71 (15.2%)	0.06
	December	49 (17.6%)	67 (14.3%)	
	January	54 (19.3%)	85 (18.2%)	
	February	38 (13.6%)	106 (22.7%)	
	March	68 (24.3%)	112 (23.9%)	
	April	21 (7.5%)	26 (5.5%)	
Intake day	Monday	47 (16.8%)	51 (10.9%)	0.09
	Tuesday	33 (11.8%)	60 (12.8%)	
	Wednesday	27 (9.7%)	65 (13.9%)	
	Thursday	38 (13.6%)	79 (16.9%)	
	Friday	39 (14.0%)	71 (15.2%)	
	Saturday	49 (17.6%)	62 (13.3%)	
	Sunday	46 (16.5%)	79 (16.9%)	
Intake reason	Stray	168 (60.2%)	281 (60.2%)	0.99
	Owner-surrender	111 (39.8%)	186 (39.8%)	
Total cats at intake	Less than 500	246 (88.2%)	413 (88.4%)	0.99
	500 or more	33 (11.8%)	54 (11.6%)	
Reason for shelter exit	Adoption	213 (76.3%)	340 (72.8%)	0.57
	Euthanasia	17 (6.1%)	42 (9.0%)	
	Foster	1 (0.30%)	1 (0.21%)	
	RTO	19 (6.8%)	38 (8.1%)	
	Transfer	26 (9.3%)	37 (7.9%)	
	No outcome	3 (1.1%)	9 (1.9%)	
URI	Yes	54 (19.4%)	124 (26.6%)	0.03
	No	225 (80.6%)	343 (73.4%)	
URI severity	0	2 (0.7%)	2 (0.4%)	0.31
	1	21 (7.5%)	65 (13.9%)	
	2	29 (10.4%)	51 (10.9%)	
	3	2 (0.7%)	6 (1.3%)	
LOS (days)		Mean: 9.0, SD: 6.5	Mean: 10.5, SD: 9.0	0.31

SD: standard deviation; RTO: returned to their owner; URI: upper respiratory infection; LOS: length of stay; DSH: domestic short hair; DMH: domestic medium hair; DLH: domestic long hair.

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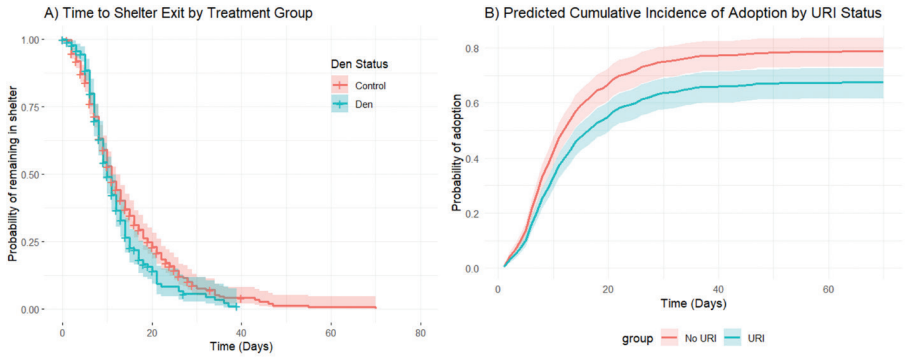

Fig. 2. (A) Survival curves showing the probability of remaining in the shelter over time for cats in the den and control groups. Time on the x-axis reflects the number of days from shelter intake to outcome (e.g. adoption, euthanasia, return to owner, and censor). Shaded areas represent 95% confidence intervals. (B) Cumulative incidence function (CIF) for adoption over time, stratified by upper respiratory infection (URI) diagnosis status. This plot shows the estimated probability of adoption, accounting for the competing risks (i.e. outcomes other than adoption) as predicted by the competing risks regression model.

further by assessing den performance in other facilities across the country at different times of the year. The randomized nature of the study controlled for other variables may impact the incidence of URI and LOS. However, there was a disparity between the number of den cats (n = 279) and control cats (n = 467). Inclusion and exclusion criteria (Table 1) were targeted primarily for den cats rather than control cats and may not have been applied equally. It is suspected that during den enrollment days, more cats were excluded from the trial based on selection criteria than on control days, meaning the criteria were more strictly applied to den cats. For example, a cat over 15 pounds should have been excluded from the trial based on size constraints of the den but may not have been excluded from the control group. As a pragmatic trial, the aim was to alter no other protocols in the operation of intakes or movement of cats throughout the shelter. As such, it is possible that employees responsible for assigning cats to cohorts may have mistakenly enrolled cats who should have also been excluded from the trial into the control group. Additionally, staff turnover could have contributed to these discrepancies.

During data collection, PIs ensured that group assignment adhered to protocols at least three times weekly. Dens were added to the kennels of participant cats when they were not present and were removed from the kennels of control cats when they were present. Additionally, PIs or shelter staff removed cats from the trial when they could not be observed at the shelter (i.e. transfer to a foster home, different Humane Colorado location, or shelter partner) or if they were enrolled into a behavior program requiring den removal. Occasionally, feral cats who were not initially identified as unsocial were enrolled and later removed from the study. At Humane Colorado, feral cats are always given dens for their comfort and safety in handling. Likewise, their paths are expedited, and they do not follow the same trajectory as social cats. Thus, feral cats were not included in the study because PIs were not able to evaluate a feral cat control group.

Humane Colorado uses a URI Scoring Matrix of 0 to 3 (Appendix A) in a well-delineated SOP. Notably, there is subjectivity in this matrix that influences the need for (or absence of) treatment. PIs did not observe statistical relevance among the URI severity scores. However, because the difference in this scoring matrix can influence LOS and adoptability, this is an area that deserves additional exploration. If a den cat was moved to an isolation room due to URI or FCV, the den remained with the cat; once the contagion was cleared, the cat was given a new den, and the old den was sanitized. PIs recognized that the dens could have served as a fomite and should not be placed in areas with healthy cat habitats. Presumably, the hiding place itself provides comfort, although the den with the cat's own scent, which is often calming,[27] could be an influencing factor and is an area for future study.

Dens were also intended to aid as transportation for den cats throughout the shelter in lieu of carriers (which is how control cats were transported). It was thought that moving a cat in a familiar structure that contained their own scent would help reduce the stress of an inherently stressful event. This also reduced the workload of thoroughly cleaning carriers (vs. spot cleaning) after each use. During these relocations, the PIs could not reliably ensure the den stayed with the participant cat, although routine checks ensured that each participant was not without a den for more than 24 h. Arguably, these kennel moves may be the most stressful event during a cat's shelter stay and warrant further investigation.

Once cats were available for adoption and on view for the public, each was moved to either a single adoptable kennel (5–12 ft²) that may or may not have had a separate cubby for hiding or litter box placement or to a larger colony room (55–430 ft²) due to space constraints (Figs. 3 and 4). If moved to a colony, the assigned den no longer stayed

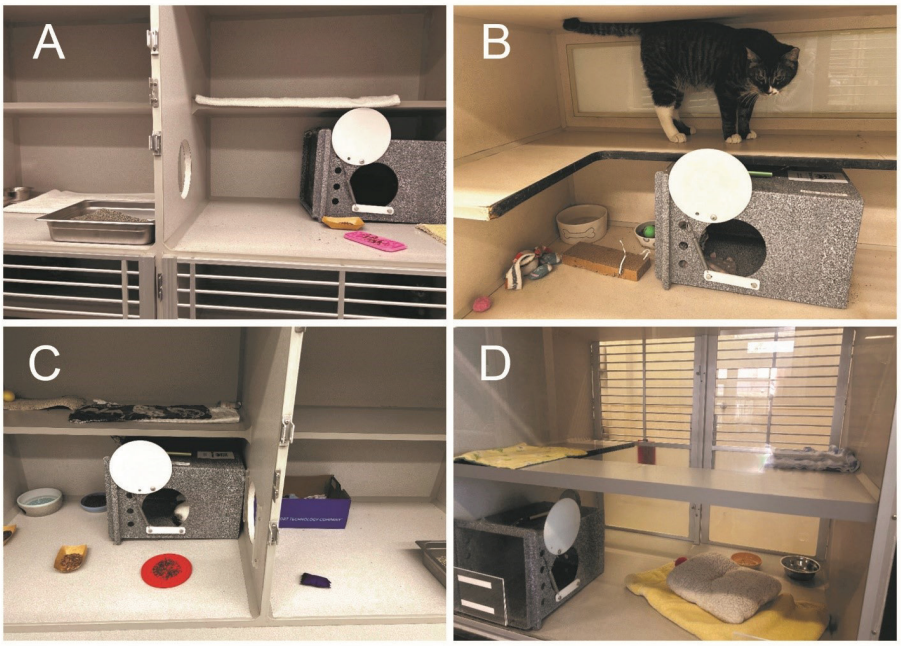

Fig. 3. Images A, B, C, and D are examples of typical individual housing with a cat den at Humane Colorado.

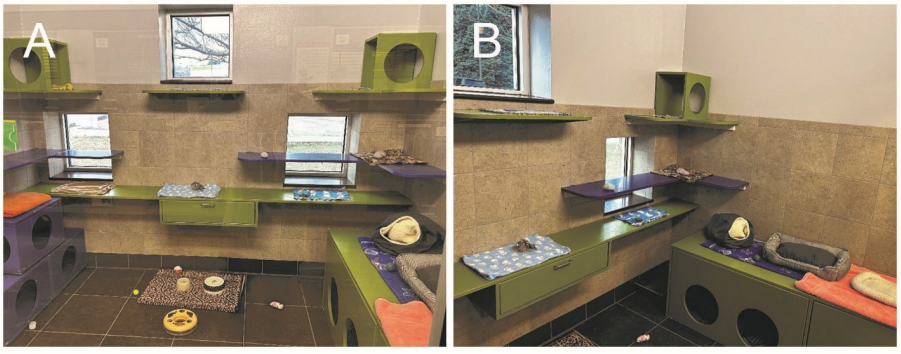

Fig. 4. Images A and B are colony rooms on the shelter's adoption floor.

with the cat. This decision, reflective of the study's designation as a pragmatic trial, was made because the colonies already contain numerous hiding places, and the addition of dens would increase the cleaning workload of shelter staff. Likewise, it limited changes for shelter operations.

Given that increased floor space is associated with lower URI incidence,[21] the move to a larger colony space could have led to a disparity in URI between those cats and cats who were only housed in single adoptable kennels, potentially impacting study outcomes. In contrast, moving a cat without their specified den to a colony with unfamiliar cats may have increased stress, thereby potentially leading to an increase in URI occurrence. Additionally, there is variability in the size and shape of Humane Colorado's single adoptable kennels and back-of-house kennels; not every kennel type can accommodate the dens used in this trial. These size factors represent important areas for future research into the effects of cat dens on URI and LOS.

In addition, individual cats were not observed for the time they spent inside the den. It is possible this could correlate with URI incidence. On a smaller scale, other studies have used cameras to observe subjects 24 h a day; however, this would be difficult to achieve with the larger population in this study.[5,16] Still, kennel cameras would allow PIs to measure the amount of time cats spent inside the den over a 24-h period (versus outside or on top of the den). Recording would also allow for cataloging of known stress and affiliative behaviors, as well as how these behaviors correlate to time spent inside dens. The use of cameras on a large scale could provide greater context as to the source of lower URI incidence among den cats. Likewise, as mentioned previously, increased floor space is correlated with lower stress scores and URI incidence in cats.[18,21,25,26]

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The current study does not account for the addition of the den changing square footage or acting as an extra perch, an additional area of future research.

Conclusion

This trial's findings suggest that the presence of a hiding den throughout a cat's shelter stay significantly decreases their risk of URI under real-life shelter conditions. Likewise, cats who did not experience URI had a shorter LOS, thereby broadening the potential benefits of dens in shelter settings. Over time, the costs of providing a den to every cat entering a shelter may be offset by savings associated with a decline in URI treatment and shorter LOS across cat populations. The results show that cat dens may play an important role in improving physical and mental health, QOL, and overall welfare for cats in high-density settings.

Author contributions

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References

1. Shelter Animals Count. *2024 Annual Analysis: Comparing 2024 to 2023 and 2019*. 2024. Accessed February 3, 2025. https://www.shelteranimalscount.org/wp-content/uploads/YearEndReport_3.13_Website_FINAL.pdf
2. Shelter Animals Count. *2023 Annual Analysis: Comparing 2023 to 2022, 2021, and 2019*. 2023. Accessed January 30, 2025. https://www.shelteranimalscount.org/wp-content/uploads/2024/01/Full-Year-2023-Report.pdf
3. Mellor DJ, Beausoleil NJ, Littlewood KE, et al. The 2020 Five Domains Model: Including Human-Animal Interactions in Assessments of Animal Welfare. *Animals.* 2020;10(10):1870. doi: 10.3390/ani10101870
4. Burns CC, Redding LE, Watson B. The Effects of Frequency and Duration of Handling on the Development of Feline Upper Respiratory Infections in a Shelter Setting. *Animals*. 2020;10(1828):1–10. doi: 10.3390/ani10101828
5. Carlstead K, Brown JL, Strawn W. Behavioral and Physiological Correlates of Stress in Laboratory Cats. *Appl Anim Behav Sci*. 1993;38:143–158. doi: 10.1016/0168-1591(93)90062-t
6. Vojtkovska V, Voslarova E, Vecerek V. Methods of Assessment of the Welfare of Shelter Cats: A Review. *Animals.* 2020;10(9):1527. doi: 10.3390/ani10091527
7. Tanaka A, Wagner DC, Kass PH, Hurley KF. Associations among Weight Loss, Stress, and Upper Respiratory Tract Infection in Shelter Cats. *J Am Vet Med Assoc*. 2012;240(5):570–576. doi: 10.2460/javma.240.5.570
8. UC Davis Koret Shelter Medicine Program. *Length of Stay (LOS)*. 2024. Accessed January 30, 2025. https://www.shelter-medicine.com/library/resources/length-of-stay-los
9. Ellis S. Environmental Enrichment: Practical Strategies for Improving Feline Welfare. *J Feline Med Surg.* 2009;11:901–912. doi: 10.1016/j.jfms.2009.09.011
10. Kry K, Casey R. The Effect of Hiding Enrichment on Stress Levels and Behaviour of Domestic Cats (Felis Sylvestris Catus) in a Shelter Setting and the Implications for Adoption Potential. *Anim Welf.* 2007;16:375–383. doi: 10.1017/s0962728600027196
11. Vinke CM, Godijn LM, van der Leij WJR. Will a Hiding Box Provide Stress Reduction for Shelter Cats? *Appl Anim Behav Sci*. 2014;160:86–93. doi: 10.1016/j.applanim.2014.09.002
12. Gourkow N, LaVoy A, Dean GA, Phillips CJC. Associations of Behaviour with Secretory Immunoglobulin A and Cortisol in Domestic Cats during their First Week in an Animal Shelter. *Appl Anim Behav Sci*. 2014;150:55–64. doi: 10.1016/j.applanim.2013.11.006
13. McCobb EC, Patronek GJ, Marder A, Dinnage JD, Stone MS. Assessment of Stress Levels among Cats in Four Animal Shelters. *J Am Vet Med Assoc.* 2005;226(4):548–555. doi: 10.2460/javma.2005.226.548
14. Ellis JJ, Stryhn H, Cockram MS. Effects of the Provision of a Hiding Box or Shelf on the Behaviour and Faecal Glucocorticoid Metabolites of Bold and Shy Cats Housed in Single Cages. *Appl Anim Behav Sci*. 2021;236:105221. doi: 10.1016/j.applanim.2021.105221
15. Ellis JJ, Stryhn H, Spears J, Cockram MS. Environmental Enrichment Choices of Shelter Cats. *Behav Processes*. 2017;141:291–296. doi: 10.1016/j.beproc.2017.03.023
16. van der Leij WJR, Selman LDAM, Vernooij JCM, Vinke CM. The Effect of a Hiding Box on Stress Levels and Body Weight in Dutch Shelter Cats; a Randomized Controlled Trial. *PLoS One*. 2019;14(10):1–14. doi: 10.1371/journal.pone.0223492
17. Moore AM, Bain MJ. Evaluation of the Addition of In-Cage Hiding Structures and Toys and Timing of Administration of Behavioral Assessments with Newly Relinquished Shelter Cats. *J Vet Behav*. 2013;8:450–457. doi: 10.1016/j.jveb.2011.10.003

18. Wagner D, Hurley K, Stavisky J. Shelter Housing for Cats 1: Principles of Design for Health, Welfare, Rehoming. *J Feline Med Surg*. 2018;20:635–642. doi: 10.1177/1098612x18781388
19. Spindel ME, Slater MR, Boothe D. A Survey of North American Shelter Practices Relating to Feline Upper Respiratory Management. *J Feline Med Surg*. 2013;15(4):323–327. doi: 10.1177/1098612x13477801
20. Dinnage JD, Scarlett JM, Richards JR. Descriptive Epidemiology of Feline Upper Respiratory Tract Disease in an Animal Shelter. *J Feline Med Surg*. 2009;11:816–825. doi: 10.1016/j.jfms.2009.03.001
21. Wagner DC, Kass PH, Hurley KF. Cage Size, Movement in and Out of Housing during Daily Care, and Other Environmental and Population Health Risk Factors for Feline Upper Respiratory Disease in Nine North American Animal Shelters. *PLoS One*. 2018;13(1):1–15. doi: 10.1371/journal.pone.0190140
22. McManus CM, Levy JK, Andersen LA, et al. Prevalence of Upper Respiratory Pathogens in Four Management Models for Unowned Cats in the Southeast United States. *Vet J*. 2014;201:196–201. doi: 10.1016/j.tvjl.2014.05.015
23. Zwarenstein M, Treweek S, Gagnier JJ, et al. Improving the Reporting of Pragmatic Trials: An Extension of the CONSORT Statement. *BMJ*. 2008;337:a2390. doi: 10.1136/bmj.a2390
24. Fine JP, Gray RJ. A Proportional Hazards Model for the Subdistribution of a Competing Risk. *J Am Stat Assoc*. 1999;94(446):496–509. doi: 10.1080/01621459.1999.10474144
25. Kessler MR, Turner DC. Effects of Density and Cage Size on Stress in Domestic Cats (Felis Silvestris Catus) Housed in Animal Shelters and Boarding Catteries. *Anim Welf*. 1999;8:259–267. doi: 10.1017/s0962728600021746
26. Wagner D, Hurley K, Stavisky J. Shelter Housing for Cats 2: Practical Aspects of Design and Construction, and Adaptation of Existing Accommodation. *J Feline Med Surg*. 2018;20:643–652. doi: 10.1177/1098612x18781390
27. Vitale Shreve KR, Udell MAR. Stress, Security, and Scent: The Influence of Chemical Signals on the Social Lives of Domestic Cats and Implications for Applied Settings. *Appl Anim Behav Sci*. 2017;187:69–76. doi: 10.1016/j.applanim.2016.11.011

Appendix A: Upper Respiratory Infection (URI) Scoring Matrix

Feline URI Scoring Chart

Symptoms	Score/Subtype	Movement/Adoptability
No URI signs seen during exam of animal for previous respiratory disease.	0	• No change needed.
Cats who are sneezing with or without active (not dried), serous (clear or watery), or mucoid (cloudy or grey) nasal discharge and/or mild congestion (audible only at close proximity).	1	• Approved for adoption in an appropriate URI area and approved for surgery.
Mild (minimal volume), active (not dried), and/or muco-purulent (colored) discharge with or without congestion.	2	• Approved for adoption in an appropriate URI area. • Hold back from surgery until URI score is 1 or 0. • Start antibiotic treatment per SOP.
Cats with moderate to severe (increased volume), active (not dried), and/or mucopurulent (colored) discharge and/or open mouth breathing.	3	• Hold back from adoption/surgery and house in an appropriate URI area. • Start antibiotic treatment per SOP.

*Hemorrhagic nasal discharge does not reflect severity of disease; however, because it may cause patron distress, these animals should be removed from the adoption floor until the hemorrhage resolves.