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Understanding pet owner decision-making: A discrete choice study on parasiticide purchases and use

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Abstract

Companion animal parasite prevention is important for animal and public health. However, recently, concern has grown over the negative environmental impact parasiticides may have. As owner engagement will be critical to achieving an effective 'one health' balance between these potentially competing considerations, an online owner-focused survey with a stated choice component was undertaken (n = 2,846 responses, December 2025 – January 2026). Analysis using choice models revealed that owners consistently preferred treatment over no treatment. Broad-spectrum protection was the strongest driver of choice amongst the non-monetary attributes. Environmental risk and impact influenced product choice, but these considerations were valued less compared to other attributes. This study suggests that companion animal parasiticide decisions are principally driven by effectiveness and ease of administration, with environmental considerations playing a secondary role. Understanding owner preferences can support veterinary decision-making and inform sustainable parasite-stewardship.

Keywords: Dog, Cat, Parasiticide, Discrete Choice Study, Decision-making

1. Introduction

In the UK, there are an estimated 10.6 million pet dogs and 10.8 million pet cats [1] that are at risk of external and internal parasitic infestation. These parasites can cause severe clinical disease and also pose a zoonotic risk to humans [2]. Therefore, effective parasite control is essential for both animal welfare and public health.

Parasitic infestations in pets are primarily controlled through the use of parasiticides, and routine, preventative administration of endo-parasiticide and ecto-parasiticide products is common. Data from the PDSA report that 84% of dog owners give worming treatment, and 81% of owners give their dog flea treatment. Regarding cat owners, 77% treat their cat for worms, and 83% provide flea treatment (PDSA, 2024), which suggests a strong desire amongst pet owners to prevent parasitic infestations.

Despite widespread use of parasiticides, adherence to recommended prevention protocols is often inconsistent. A review of the literature identified several factors that influence owner use and choice of parasiticides, including financial considerations, forgetfulness, and limited knowledge of parasite-associated disease. Additional barriers include misconceptions regarding parasite risk, such as the belief that animals kept indoors do not require preventive treatment, as well as lower levels of trust in veterinary recommendations [3]. These factors appear to influence treatment behaviours in practice,

with veterinary teams reporting that many owners do not follow currently recommended treatment schedules and instead purchase only one or two doses of flea treatment annually [4].

Compounding these compliance challenges is the extensive range of parasiticide products available. Currently, there are over 1,000 products authorised by the Veterinary Medicines Directorate (VMD) in the UK, and these are available with prescription from veterinary practices or online pharmacies, without prescription online or in pet stores, and also without prescription in supermarkets [5]. This abundance of options may be overwhelming for pet owners, particularly given a spectrum of action between products, varied application methods, and varied durations of efficacy.

Using a discrete choice methodology, a UK study of 160 dog owners examined a range of attributes to establish preferences for parasiticide products [6]. The results showed that parasite coverage is the most important driver of preference. Broad spectrum products were preferred over more targeted products; receipt of a recommendation from a veterinary professional was also a strong influence. While cost and less frequent administration (i.e. longer efficacy) were also important to owners, there was no preference towards method of administration or where the product was obtained [6]. Although the study provides important insights into owner preferences regarding parasiticide products, it does not address potential concerns about the environmental impact of parasiticide use, which is an increasingly important consideration in veterinary practice and responsible pet ownership [7–9]

The strongest evidence of environmental impact associated with use of parasiticides on pets concerns fipronil and imidacloprid entering wastewater and surface waters from bathing treated animals, washing pet bedding, washing owners' hands after contact, swimming, and runoff from treated pets [9,11,12]. The evidence supporting this contamination is growing, as multiple observational studies have now detected these compounds in a variety of settings. These concerns are now starting to translate into considerations for policy change; the UK's Veterinary Medicine Directorate (VMD) has recently announced a call for evidence for the impact of pet parasiticides on waterways with a view to potentially restricting the routes with which pet parasiticides could be purchased by owners [13]. The European Medicines Agency has also recently consulted on expanding environmental risk assessment requirements for companion animal ectoparasiticides [14].

However, although ensuring owner engagement and understanding of this complex area will prove vital for achieving a true 'one health' balance between animal, human and environmental health, little is known about how these considerations influence pet owner decision-making. Existing research has largely focused on environmental occurrence and exposure pathways, whereas owner attitudes towards environmental impact and the extent to which environmental considerations influence product choice

remain poorly understood. Understanding how owners value environmental attributes relative to others is important for informing veterinary policy and stewardship initiatives.

The aim of this owner-focused study was to conduct research on (real and hypothetical) purchasing behaviour and motivations regarding parasiticide products. This study aimed to reveal to what extent key factors such as cost, onset of action, convenience, ease of use, frequency of use, parasite coverage, or environmental impact, influence caregiver purchasing choices. Additionally, in a questionnaire, we explored external factors that may motivate owners to purchase parasiticides, including veterinary recommendation, desire to protect their pet, zoonotic risks, and marketing. This also allowed us to examine knowledge gaps related to parasite risks and parasite control measures.

2. Methodology

Ethical approval was granted by the Royal College of Veterinary Surgeons (RCVS) ethical review board under approval Ref: 2025-068 prior to the commencement of data collection.

The study was performed in accordance with the Declaration of Helsinki. Informed consent was obtained electronically from all participants before they commenced the survey, following provision of the participant information sheet.

The main focus is on a stated choice (SC) component, also known as discrete choice experiment (DCE), with the resulting data analysed using random utility models. This SC survey produced data allowing us to gain an understanding of pet owner preferences, alongside more traditional questions on motivations and concerns. We now describe these two components in turn.

2.1. Stated choice component

2.1.1. Attribute development

Attribute development and selection was undertaken using a narrative review of the literature and discussions with the IVC Evidensia Parasite Strategy Working Group (a cross-disciplinary working group representing key business and clinical areas within IVC Evidensia). We identified a list of attributes that may be important to dog and cat owners when purchasing parasiticides. We assigned various realistic levels to each attribute based on information from the product datasheets, scientific literature, and the current UK parasiticide market. The attributes initially included environmental impact, environmental risk, method of administration, where the product was obtained, frequency of administration, parasite coverage, onset of action, and cost.

Following development of the initial attributes, these were trialled in a draft survey using the Survey Engine platform with the IVC Evidensia Parasite Strategy Working Group and

external collaborators that included Vetoquinol Group, IDEXX, and The European Scientific Counsel Companion Animal Parasites (ESCCAP). Following several rounds of iterative feedback from the internal and external groups, the attributes, levels and wording of the survey were refined and subsequently piloted with ten non-clinical, dog or cat-owning team members within IVC Evidensia to obtain feedback on clarity, usability, and functionality of the survey. On the basis of this survey, onset of action was considered unlikely to meaningfully influence owner decision-making or generate sufficient discrimination within choice tasks, and was thus removed. Two attributes were also combined, namely treatment frequency and parasite coverage, to reflect realistic product options currently available and to improve ecological validity. This also reduced cognitive burden for respondents by simplifying the choice tasks.

2.1.2. Stated choice setting

The stated choice survey presented respondents with four separate sets of hypothetical treatment contexts for their pet. In the first, preventative, scenario, participants were asked to imagine that their pet showed no signs of parasite infection, but that treatment was overdue, and to select their preferred option. This was followed by three additional scenario contexts in which a parasite infestation was explicitly identified; one was noticing a flea on their pet, another was removing a tick attached to their pet, and the last scenario was observing worms in their pet's faeces. In each scenario, multiple choice tasks were deployed, with 8 tasks in the preventative scenario, and 2 in each of the scenarios where a parasitic infestation was identified, totalling 14 choice tasks per survey participant.

In each choice task, respondents were presented with two product alternatives and an opt-out ("no treatment / alternative treatment") option, and were asked to indicate which they would choose. (Figure 1). In the preventive scenarios, all possible treatment options formed part of the design. However, in the scenarios with a response to a specific parasitic infestation, only treatment options with coverage that included that particular issue were shown.

Imagine you have just noticed worms in 's faeces. Please indicate your preferred option

	Option 1	Option 2	No treatment / alternative treatment
Method	Tablet	Flavoured chewable	
Frequency	Once a month	Once a month	
Sale point	Online with veterinary prescription	From the veterinary clinic	
Coverage	Fleas, ticks, intestinal worms, lungworm	Fleas, ticks, intestinal worms	
Environmental risk	Small chance of product being released into the environment	Product is known to be released or washed off	
Environmental impact	Toxic to aquatic animals or invertebrates (e.g. insects)	Product degrades rapidly	
Annual cost	£151	£117	
Which would you choose?	○	○	○

Figure 1: Example choice task

2.1.3. Experimental design

The choice tasks were designed to examine preferences for parasiticide options for pets, with respondents asked to choose repeatedly between two hypothetical treatment alternatives and a third opt-out alternative representing no treatment or an alternative treatment not described in the experiment. This structure was intended to mimic realistic decision-making, where pet owners may compare available products but may also decide against any of the presented options.

For the preventative scenarios, an initial experimental design was generated in NGene using a multinomial logit D-efficient design without priors, with 80 choice situations segmented into 10 blocks. The levels used for the categorical attributes are shown in Table 1, while we discuss the levels for the continuous cost attribute in more detail below.

Table 1: Categorical refined attributes and levels used in the stated preference section

Attribute	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Method of administration	Tablet	Flavoured chewable	Spot-on directly to pet's skin	Injection	Collar	
Frequency of administration	Once a month	Once every three months	Once every seven months	Once a year		
Where product obtained	Online with veterinary prescription	Online without veterinary prescription	From a shop	From the veterinary clinic		

Parasite coverage	Fleas	Ticks	Fleas and ticks	Intestinal worms	Fleas, ticks, and intestinal worms	Fleas, ticks, intestinal worms, and lungworm
Environmental risk	Product remains confined to the animal	Small chance of product being released into the environment	Product is known to be released or washed off	No data on product breakdown post-application		
Environmental impact	Product degrades rapidly	Mild toxicity to aquatic animals or invertebrates (e.g. insects)	Toxic to aquatic animals or invertebrates (e.g. insects)	No environmental data or evidence available		

To ensure that the choice tasks reflected realistic parasite prevention options available to pet owners, several post-processing steps and design constraints were incorporated into the experimental design. Frequency of administration was derived from combinations of treatment method and parasite coverage to reflect clinically relevant treatment schedules, rather than being included as an independent attribute. Logical constraints were also imposed to exclude implausible combinations of attribute levels and ensure internal consistency between treatment characteristics, environmental attributes, and routes of administration. Separate experimental designs were generated for four pet size categories, with cost levels derived from reference market prices and adjusted according to treatment characteristics and point of sale. Examples of the reference costs used in the design are shown in table 2, where these varied by animal size (with cats being allocated to small) and full details of the design restrictions, frequency derivation, and cost construction procedures are provided in the Supplementary experimental design.

Table 2: Example reference costs (£) by pet size and method (Fleas & ticks). Cat

Small dog (under 10 kg) – example: Chihuahua, Pomeranian, Yorkshire Terrier

Medium dog (10–25 kg) – example: Beagle, Border Collie, Cocker Spaniel

Large dog (25–40 kg) – example: Labrador Retriever, German Shepherd, Greyhound

Extra-large dog (over 40 kg) – example: Mastiff, Great Dane, Saint Bernard

SIZE	TABLET	CHEWABLE	SPOT-ON	COLLAR	INJECTION
SMALL	10.5	12.5	5.5	37	165
MEDIUM	11	13	6	37	195
LARGE	11.5	13.5	7.5	37	195

EXTRA-LARGE	13	15	12	37	240

Equivalent matrices were defined for all parasite coverage categories (e.g. fleas only, ticks only, multi-parasite combinations), with some methods unavailable (coded as missing) for certain coverage types.

A key feature of the experimental design was the construction of realistic and internally consistent cost levels. Rather than specifying cost entirely in the NGene design, monetary values were generated during post-processing using a structured approach based on reference prices, channel adjustments, and scaling factors.

First, a set of reference costs was assembled for each combination of parasite coverage and method of administration, differentiated by pet size (small, medium, large, extra-large). These values reflect typical market prices and form the baseline for cost construction.

Second, these reference costs were adjusted using channel-specific multipliers to reflect differences in price depending on the point of sale. The multipliers applied were: online with veterinary prescription (0.95), online without veterinary prescription (0.90), from a shop (0.90), and from the veterinary clinic (1.00).

Third, frequency multipliers were applied to convert treatment prices into annual costs. These multipliers reflect the number of administrations per year implied by the treatment frequency: monthly (12), every 3 months (4), every 7 months (12/7), and annual (1).

Fourth, pivot multipliers were used to generate variation around the reference price levels. Five pivot values were defined: 0.70, 0.85, 1.00, 1.15, and 1.30. Each cost level from the NGene design corresponds to one of these multipliers, scaling the baseline cost downward or upward.

The final cost shown to respondents was constructed as: Cost = pivot × channel multiplier × reference cost × frequency multiplier. All resulting values were rounded to produce annual price figures.

This multi-stage construction generates a rich set of possible cost values. Across the four pet sizes, this procedure resulted in a wide but realistic spread of annual cost levels, ensuring sufficient variation for statistical identification while maintaining credibility for respondents.

A key distinction in these scenario-specific designs are restrictions on the parasite coverage attribute to exclude irrelevant options (e.g. tick-only treatments were excluded in the flea scenario, and vice versa), ensuring that all presented treatments were plausible options for the observed problem. In the preventative design, constraints were imposed to ensure realistic combinations of attributes and to maintain meaningful trade-

offs, specifically pairing narrower, issue-specific treatments with broader-spectrum alternatives. This approach ensured both behavioural realism and statistical efficiency across the different decision contexts.

2.2. Questions on motivations and concerns

A range of questions were designed to understand owner knowledge of parasites in the UK, and factors motivating parasiticide use. These consisted of multiple choice, Likert, and free text questions (Supplementary material survey questions). These were also piloted alongside the discrete choice study.

2.3. Sampling

UK dog and cat owners were recruited for the survey by distribution to a random selection of 4% of the IVC Evidensia clinic database between 12/12/2025 and 31/01/2026. Respondents had to be 18 years of age or older, and be UK-based owners of at least one dog or cat to be in scope. Additionally, the survey was shared via social media, through external collaborators, and via professional contacts. Following data cleaning, 2,846 respondents remained for analysis. Demographic information data can be found in supplementary respondent demographics.

3. Analysis methodology

Two separate analyses were carried out for the present study, namely a formal choice modelling analysis of the stated choice data, and a more descriptive analysis of the remaining questionnaire part. We now look at the approaches for these components in turn.

3.1. Choice model specification and estimation

The choice data were analysed using a nested logit model (cf. Train, 2009, chapter 4). estimated in Apollo. Each choice task presented respondent n with two treatment alternatives and a no-treatment alternative. The two active treatment alternatives were grouped within a common "treatment" nest, while the no-treatment alternative formed a separate branch. This specification allows for correlation in unobserved utility between the two active treatment alternatives while allowing the no-treatment option to remain behaviourally distinct.

A respondent in the survey sees 14 choice tasks split across four separate sets of experiments. Let s be an index of the experiment set, with $s = 1, \dots, 4$, where $s = 1$ corresponds to the preventive case, $s = 2$ to the fleas case, $s = 3$ the ticks case and $s = 4$ the worms case. Let T_s be the number of tasks for experiment s, where T_1=8, and $T_s = 2$ with $s = 2, \dots, 4$.

The utility of treatment alternative j, in choice task t_s for respondent n in experiment s is specified as:

$$U_{njt_s} = \mu_s V_{njt_s} + \varepsilon_{njt_s} \quad [1]$$

where V_{njt_s} is the observed component of utility, ε_{njt_s} is the stochastic error component, and μ_s is a scale parameter specific to experiment s. The main preventative scenario was used as the reference context, with its scale normalised to one, i.e. $\mu_1 = 1$. Separate scale parameters were estimated for the flea, tick, and worm scenarios in order to account for possible differences in error variance across stated-preference contexts.

The observed utility for the treatment alternatives includes the effects of administration method, point of sale, parasite coverage, environmental risk, and environmental impact, respectively. These were all treated as categorical variables, using dummy coding, i.e. setting the effect of one level to zero. Tablet administration was used as the reference administration method, veterinary clinic as the reference point of sale, and low environmental risk and low environmental impact as the reference environmental levels. The scale parameter for the main preventative scenario was also fixed to one. For parasite coverage, no normalisation was needed as the base is implicit in the no treatment alternative. Finally, cost entered utility linearly. A left-alternative constant was included to account for any residual tendency to select the first experimentally designed treatment option.

Observed preference heterogeneity was incorporated through systematic interactions between attribute coefficients and respondent characteristics. A generic coefficient specification can be represented as:

$$\beta_{nk} = \beta_k + \Sigma\, \delta_{kh}\, Z_{nh} \quad [2]$$

where Z_{nh} represents respondent-specific characteristics such as age group, income group, veterinary experience, geographic region, and pet type. Interactions were estimated for administration method, sale point, cost, and parasite coverage attributes. Additional interactions were included for the scenario-specific stated-preference tasks, allowing preferences for relevant parasite coverage levels to differ when respondents were asked to imagine having identified fleas, ticks, or worms.

The nested logit model grouped the two treatment alternatives within a treatment nest characterised by nesting parameter λ, while the no-treatment alternative remained outside the nest. The resulting probability of choosing alternative j can therefore be expressed as the product of the conditional probability of selecting alternative j within a nest and the marginal probability of selecting that nest.

All models were coded and estimated in Apollo v.0.3.7 (Hess & Palma, 2019). Model simplification was undertaken iteratively following estimation of the full specification. Interaction parameters with low statistical significance were sequentially fixed to zero using increasing absolute t-ratio thresholds. At each stage, the simplified model was re-estimated and compared against the previous specification using likelihood-ratio tests alongside the Bayesian Information Criterion (BIC) and adjusted ρ^2 measures. This process allowed the final specification to balance behavioural richness with parsimony.

Following estimation, the final model coefficients were used to derive willingness-to-pay (WTP) measures for key treatment attributes and attribute contrasts, calculated as marginal rates of substitution between each non-monetary attribute and the cost coefficient. For a given attribute comparison, WTP was computed as the negative ratio of the difference in utility coefficients to the individual-specific marginal utility of cost. This incorporated differences across individuals and across the four types of SP experiments. The heterogeneity linked to income, age, veterinary experience, region, and stated-preference scenario was averaged out, leading to summarised WTP measures for cat and dog owners within each stated-preference context (preventive, flea noticed, tick noticed, and worm noticed).

3.2. Analysis of other survey components

Survey data was analysed in R (version 4.4.2). Data were cleaned prior to analysis by removing missing data. Differences between dog and cat owners, the age of respondents, and veterinary experience were tested using chi-square tests, applied to contingency tables of selection frequencies.

Free-text responses were analysed using an inductive thematic approach. Responses were iteratively reviewed to identify recurring concepts, which were then grouped into broader themes reflecting relevance to the question. In the question “when making the choices between products in the first part of the survey, what do you think led you to make these decisions?”, the attributes were used as the main themes. The frequency of each theme was calculated to provide an indication of their importance.

4. Empirical results

4.1. Raw estimates from choice models

Our final model makes use of 101 parameters, and obtains a log-likelihood of -37,258.78, an adjusted ρ^2 of 0.1073 and a Bayesian Information Criterion (BIC) of 75,582.89. The estimation results are shown in Table 3 and will now be looked at it turn.

Table 3: Choice model estimation results

Parameter group	Parameter description	Estimate	Rob.t-ratio (0)
Constants	constant for the left treatment option, capturing any left-right preferences	0.0009	0.10
	constant for no treatment, normalised to zero as all treatments captured by coverage parameters	0	NA
Method of administration	main effect for tablet, normalised to serve as the base for administration method	0	NA
	main effect for chewable (tablet is base)	0.1029	5.28
	*interaction for **cats** (base is dogs)*	-0.1245	-3.70
	main effect for spot on (tablet is base)	-0.0657	-2.08
	interaction for respondents with vet experience	-0.2208	-2.34
	interaction for respondents aged 30-39 (base age group is 50-59)	-0.1222	-2.12
	*interaction for **cats** (base is dogs)*	0.8028	9.48
	main effect for collar (tablet is base)	-0.589	-10.98
	*interaction for **cats** (base is dogs)*	0.1528	2.36
	main effect for injection (tablet is base)	0.0261	0.55
	interaction for respondents aged 30-39 (base age group is 50-59)	-0.1273	-1.79
	*interaction for **cats** (base is dogs)*	0.4021	5.69
Sale point	main effect for online with prescription (vet clinic is base)	-0.1694	-6.90
	interaction for respondents aged 60 plus (base age group is 50-59)	-0.0928	-2.69
	main effect for online without prescription (vet clinic is base)	-0.2252	-8.64
	interaction for respondents aged 60 plus (base age group is 50-59)	-0.1369	-3.30
	main effect for shop (vet clinic is base)	-0.3456	-7.92
	interaction for respondents aged 30-39 (base age group is 50-59)	0.0906	1.84
	interaction for respondents aged 40-49 (base age group is 50-59)	0.1343	2.50
	interaction for respondents aged 60 plus (base age group is 50-59)	-0.1224	-2.39
	*interaction for **cats** (base is dogs)*	0.1051	2.91
	main effect for vet clinic, normalised to serve as the base for sale point	0	NA
Coverage	main effect for fleas only (base is no treatment)	1.2484	15.36
	interaction for respondents with vet experience	-0.4903	-3.17
	interaction for respondents aged under 30 (base age group is 50-59)	0.7466	4.60
	interaction for respondents aged 30-39 (base age group is 50-59)	0.6186	5.33
	interaction for respondents aged 60 plus (base age group is 50-59)	-0.2921	-3.28
	interaction for respondents not reporting age (base age group is 50-59)	-1.4071	-5.22
	interaction for respondents in East Midlands (base group is Scotland)	0.1173	1.81
	interaction for respondents in London (base group is Scotland)	0.2731	2.56
	interaction for respondents in Northern Ireland (base group is Scotland)	0.1954	1.73
	*interaction for **cats** (base is dogs)*	-0.5747	-6.86
	*interaction for SP experiments where they have noticed a **flea** (base is preventive)*	0.4592	8.25
	main effect for ticks only (base is no treatment)	1.3279	16.77
	interaction for respondents with vet experience	-0.5875	-3.73

Parameter group	Parameter description	Estimate	Rob.t-ratio (0)
	interaction for respondents aged under 30 (base age group is 50-59)	0.7991	5.01
	interaction for respondents aged 30-39 (base age group is 50-59)	0.5967	5.15
	interaction for respondents aged 60 plus (base age group is 50-59)	-0.216	-2.41
	interaction for respondents not reporting age (base age group is 50-59)	-1.4577	-5.53
	*interaction for **cats** (base is dogs)*	-0.7281	-8.01
	*interaction for SP experiments where they have noticed a **tick** (base is preventive)*	0.0757	1.82
	*additional three-way interaction for **cats** for SP experiments where they have noticed a **tick***	0.3171	3.91
	main effect for fleast and ticks (base is no treatment)	1.7621	21.42
	interaction for respondents with vet experience	-0.4624	-3.22
	interaction for respondents aged under 30 (base age group is 50-59)	0.8236	5.36
	interaction for respondents aged 30-39 (base age group is 50-59)	0.5902	5.30
	interaction for respondents aged 60 plus (base age group is 50-59)	-0.2879	-3.34
	interaction for respondents not reporting age (base age group is 50-59)	-1.447	-5.44
	interaction for respondents in London (base group is Scotland)	0.2214	2.52
	interaction for respondents in Nothern Ireland (base group is Scotland)	0.246	2.52
	*interaction for **cats** (base is dogs)*	-0.9053	-10.02
	*interaction for SP experiments where they have noticed a **flea** (base is preventive)*	0.1609	3.10
	*additional three-way interaction for **cats** for SP experiments where they have noticed a **flea***	0.2765	4.29
	*additional three-way interaction for **cats** for SP experiments where they have noticed a **tick***	0.3284	4.90
	main effect for intestinal worms only (base is no treatment)	1.4703	19.02
	interaction for respondents with vet experience	-0.5147	-3.41
	interaction for respondents aged under 30 (base age group is 50-59)	0.8497	5.17
	interaction for respondents aged 30-39 (base age group is 50-59)	0.7292	6.08
	interaction for respondents aged 60 plus (base age group is 50-59)	-0.2706	-3.05
	interaction for respondents not reporting age (base age group is 50-59)	-0.9173	-3.65
	interaction for respondents in East Midlands (base group is Scotland)	0.1617	2.12
	*interaction for **cats** (base is dogs)*	-0.678	-8.01
	*interaction for SP experiments where they have noticed a **worm** (base is preventive)*	0.4237	5.85
	main effect for fleas, ticks and intestinal worms (base is no treatment)	1.9238	22.35
	interaction for respondents with vet experience	-0.5153	-3.35
	interaction for respondents aged under 30 (base age group is 50-59)	0.8689	5.43
	interaction for respondents aged 30-39 (base age group is 50-59)	0.6999	6.05
	interaction for respondents aged 60 plus (base age group is 50-59)	-0.2742	-3.11
	interaction for respondents not reporting age (base age group is 50-59)	-1.0431	-4.17
	interaction for respondents in London (base group is Scotland)	0.3021	3.06
	interaction for respondents in Northern Ireland (base group is Scotland)	0.184	2.10
	interaction for respondents in South East (base group is Scotland)	0.1611	2.52
	*interaction for **cats** (base is dogs)*	-0.9004	-9.92
	*interaction for SP experiments where they have noticed a **flea** (base is preventive)*	0.1455	1.99

Parameter group	Parameter description	Estimate	Rob.t-ratio (0)
	*additional three-way interaction for **cats** for SP experiments where they have noticed a **flea***	0.2971	3.17
	*additional three-way interaction for **cats** for SP experiments where they have noticed a **tick***	0.2265	3.22
	*additional three-way interaction for **cats** for SP experiments where they have noticed a **worm***	0.1871	2.93
	main effect for fleas, ticks and intestinal worms and lungworm (base is no treatment)	2.0061	21.96
	interaction for respondents with vet experience	-0.4703	-3.09
	interaction for respondents aged under 30 (base age group is 50-59)	0.9727	5.75
	interaction for respondents aged 30-39 (base age group is 50-59)	0.6707	5.74
	interaction for respondents aged 60 plus (base age group is 50-59)	-0.2939	-3.29
	interaction for respondents not reporting age (base age group is 50-59)	-0.8769	-3.74
	interaction for respondents in London (base group is Scotland)	0.308	3.21
	interaction for respondents in South East (base group is Scotland)	0.1791	2.61
	*interaction for **cats** (base is dogs)*	-0.8198	-9.27
	*interaction for SP experiments where they have noticed a **flea** (base is preventive)*	0.2681	3.93
	*interaction for SP experiments where they have noticed a **tick** (base is preventive)*	0.1674	3.38
	*interaction for SP experiments where they have noticed a **worm** (base is preventive)*	0.2864	5.41
Environmental risk	main effect for low environmental risk, normalised to serve as the base for environmental risk	0	NA
	main effect for medium environmental risk (base is low risk)	-0.0252	-1.55
	main effect for high environmental risk (base is low risk)	-0.2053	-9.16
	main effect for unknown environmental risk (base is low risk)	-0.1189	-4.70
Environmental impact	main effect for low environmental impact, normalised to serve as the base for environmental impact	0	NA
	main effect for medium environmental impact (base is low impact)	-0.0738	-4.04
	main effect for high environmental impact (base is low impact)	-0.1845	-7.94
	main effect for unknown environmental impact (base is low impact)	-0.0251	-1.40
Cost	main effect for cost	-0.0039	-11.30
	interaction for income under 20K (base is 20K-40K)	-0.002	-3.29
	interaction for income unreported (base is 20K-40K)	-0.0017	-3.58
			Rob. t-ratio (1)
Model structure terms	nesting parameter	0.743	-4.65†
	scale parameter for main SP (normalised to 1)	1	NA
	scale parameter for fleas SP (base is main SP)	1.1146	2.31†
	scale parameter for ticks SP (base is main SP)	1.1188	3.09†
	scale parameter for worms SP (base is main SP)	1.218	3.62†

† t-ratio for nesting and scale parameters calculated against a value of 1

In what follows, we now interpret the results for the different parameters in turn. Our model is utility based, meaning that attributes of an alternative contribute to the utility that respondents perceive for that alternative, where they maximise utility by choosing whichever option is more attractive for them.

Constants

The constant for the left alternative is positive, but not different from zero, indicating an absence of any left-right bias between the two treatment options. The constant for no treatment is fixed to zero given the estimation of parameters for all levels of coverage.

Method of administration

Tablet administration is used as the reference level. To aid readers to understand the results, we provide more details for one specific comparison. In particular, relative to tablets, chewable treatments are preferred for the base group (i.e. positive effect), indicating that respondents generally favour this administration method. However, the interaction for cat owners is sufficiently negative (-0.1245) to reverse this preference, implying that cat owners prefer tablets over chewables (as the sum of 0.1029 and -0.1245 becomes negative). Spot-on treatments are associated with a significantly lower utility for the base group (-0.0657), with this negative effect becoming stronger for respondents with veterinary experience and those aged 30–39. In contrast, the positive interaction for cat owners is large enough to overturn the average effect, indicating that cat owners prefer spot-on treatments relative to tablets. Collar treatments are associated with substantially lower utility than the tablets base group, although the negative effect is somewhat weaker for cat owners. Injection treatments do not differ significantly from tablets on average, but respondents aged 30–39 show lower preferences for injections, while cat owners exhibit significantly more positive preferences, resulting in injections being preferred to tablets within this subgroup.

Coverage

All parasite coverage options are associated with positive utility relative to no treatment for the reference respondent group, indicating that respondents generally prefer some form of parasite protection over no treatment. However, the strength of these preferences varies substantially across respondent groups and stated-preference contexts, with some combinations of interaction effects reducing or overturning the base preference for specific subgroups.

Across all coverage levels, preferences were lower among cat owners, respondents aged over 60 years, those not reporting age, and respondents with current or previous veterinary experience, whereas younger respondents generally demonstrated stronger preferences. The specific parasite scenarios increased preferences for the corresponding treatment options and cat owners exhibited stronger increases in preference these.

Environmental risk and impact

For the environmental attributes, respondents generally prefer treatments associated with lower environmental risks and impacts. Relative to low environmental risk, medium environmental risk is associated with a small reduction in utility, with the null hypothesis

of no difference being rejected at the 94% confidence level in a one-sided statistical test (t-ratio), suggesting weak evidence that respondents prefer lower-risk products. In contrast, both high environmental risk and unknown environmental risk are associated with substantially lower utility and are significant. The larger negative coefficient for high environmental risk indicates strong aversion towards products known to enter the environment and potentially affect non-target species, while the negative effect for unknown risk suggests that respondents also dislike uncertainty regarding environmental consequences.

A similar pattern is observed for environmental impact. Relative to low environmental impact, medium environmental impact reduces utility, although the magnitude of the effect is smaller than for high impact. High environmental impact is associated with a substantial reduction in utility, indicating that respondents dislike products associated with persistent environmental toxicity or harm to aquatic organisms and invertebrates. Unknown environmental impact is also associated with a negative coefficient, with the null hypothesis of no effect being rejected at approximately the 92% confidence level in a one-sided test. This suggests weaker but still noticeable evidence that respondents prefer treatments with clearly established low environmental impacts over products where environmental consequences are uncertain.

Cost

The cost coefficient is negative and rejects the null hypothesis of no effect at a very high level of confidence, indicating that respondents prefer lower-cost treatments, as expected. Additional heterogeneity is observed across income groups. Respondents with household incomes below £20,000 display greater cost sensitivity (i.e. a more negative parameter), as do respondents who did not report their income. No significant differences in cost sensitivity are retained for respondents in higher income categories, suggesting that preferences among middle- and higher-income respondents are relatively similar once other factors are controlled for.

Model structure

The estimated nesting parameter is positive, below one, and rejects the null hypothesis of equality to 1 at high level of confidence. This provides evidence in favour of the nested logit specification relative to a standard multinomial logit model, indicating the presence of correlation in unobserved utility between the two active treatment alternatives (a nesting parameter of 1 indicates no correlation, i.e. MNL, while a nesting parameter below 1 implies heighted substitution). In behavioural terms, respondents appear to view the two treatment options as closer substitutes to each other than to the no-treatment alternative. This has important policy/business implications as it implies that pet owners are more likely to change from one treatment option to another than they are to change from non-treatment to treatment or treatment to non-treatment.

The scale parameters for the parasite-risk stated-preference scenarios are all greater than one relative to the preventative scenario and reject the null hypothesis of equality at a very high level of confidence. This indicates lower unobserved variance, or greater choice consistency, in the flea-, tick-, and worm-specific contexts compared with the preventative context. The largest scale effect is observed for the worm scenario, suggesting that respondents make the most deterministic choices when asked to imagine having observed worms in their pet's faeces. Overall, these findings imply that explicitly identifying a parasite-related threat increases the salience of the decision context and leads respondents to express more consistent preferences.

4.2. WTP

The WTP results for method of administration indicate substantial differences in preferences across treatment formats, with collars generally emerging as the least preferred option. Respondents were often willing to pay considerable additional amounts for alternative administration methods relative to collars, although the magnitude of these valuations differed between cat and dog owners and across stated-preference contexts (Table 4). While owners were willing to pay more for low environmental risk or impact products, the differential was lower than for other preference comparisons,

suggesting a relatively lower cost preference for environmentally conscious products compared to coverage or administration method. For more detailed information see supplementary material WTP.

Table 4: Willingness-to-pay (WTP) results. These show the additional amount of money respondents are willing to pay compared to the base levels. Cells in black relate to unavailable options. Only comparisons against the base are shown, and as the base changes across scenarios, cells in grey relate to cases where the base in that row of the table does not apply.

	Cat				Dog			
Label	**Preventive**	**Flea noticed**	**Tick noticed**	**Worm noticed**	**Preventive**	**Flea noticed**	**Tick noticed**	**Worm noticed**
WTP tablet vs collar (£)	98.54				132.55			
WTP chewable vs collar (£)	93.66				155.71			
WTP spotOn vs collar (£)	255.48				109.75			
WTP injection vs collar (£)	189.01				133.29			
WTP tablet vs chewable (£)				4.88				
WTP spotOn vs chewable (£)				161.82				
WTP tablet vs spotOn (£)								22.80
WTP chewable vs spotOn (£)								45.96
WTP vet clinic vs online with prescription (£)	42.82				44.66			
WTP vet clinic vs online without prescription (£)	57.57				60.31			
WTP vet clinic vs shop (£)	48.87				77.28			
WTP fleas vs no treatment (£)	183.42	287.18			295.28	398.64		
WTP ticks vs no treatment (£)	159.12		247.87		308.53		325.58	
WTP fleas & ticks vs no treatment (£)	222.16	320.98	296.35		408.56	444.77	408.56	
WTP intestinal worms vs no treatment (£)	216.00			311.73	349.24			444.59
WTP fleas, ticks & intestinal worms vs no treatment (£)	272.41	372.42	323.58	314.68	454.78	487.53	454.78	454.78
WTP fleas, ticks & intestinal worms and lungworm vs no treatment (£)	309.66	370.23	347.47	374.36	471.86	532.20	509.53	536.32
WTP low vs medium environmental risk (£)	5.70				5.67			
WTP low vs high environmental risk (£)	46.38				46.19			
WTP low vs unknown environmental risk (£)	26.87				26.76			
WTP low vs medium environmental impact (£)	16.68				16.61			

WTP low vs high environmental impact (£)	41.69	41.53
WTP low vs unknown environmental impact (£)	5.68	5.66

4.3. Additional questions

Respondent were also directly asked about what factors influenced their choices. These answers can at times differ from the behavioural findings of the choice models. When asked “when making the choices between products in the first part of the survey, what do you think led you to make these decisions?”, respondents most commonly believed that cost (26.7%), followed by the method of administration (25.1%), were the main drivers of their choice; 8.7% of respondents felt that environmental concerns influenced which products they chose (Figure 2).

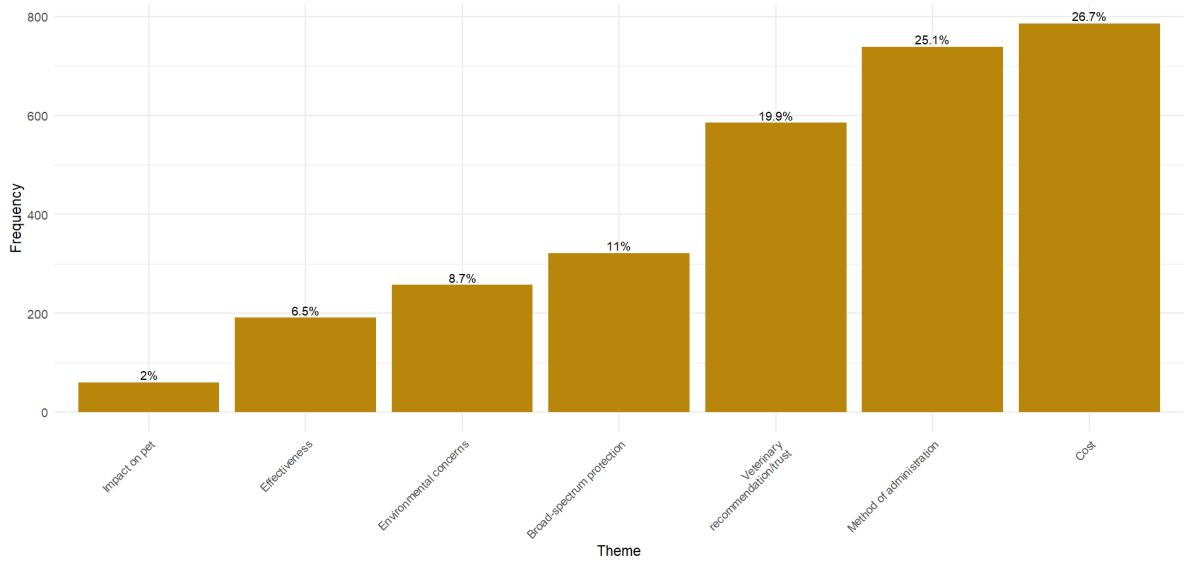


Figure 2. Quantification of qualitative analysis of themes from “when making the choices between products in the first part of the survey, what do you think led you to make these decisions?”

When asked about what motivated owners to protect their pet from parasites, 76.2% of cat owners and 81.4% of dog owners said they were extremely motivated to purchase parasite products because of the risk of them catching disease from parasites. Similarly, 75.4% of cat owners and 76% of dog owners were extremely motivated to use parasite products from seeing fleas and ticks in the home. Fewer cat (42.3%) and dog owners (49.4%) were extremely motivated from the risks to children, with 24.9% of cat owners and 18% of dog owners reporting being not at all motivated to purchase parasiticides because of the risks affecting children. Regarding the risk of parasites affecting the respondent or other household members, 56.8% of cat owners and 60.6% of dog owners were extremely motivated to be influenced by this (Figure 3).

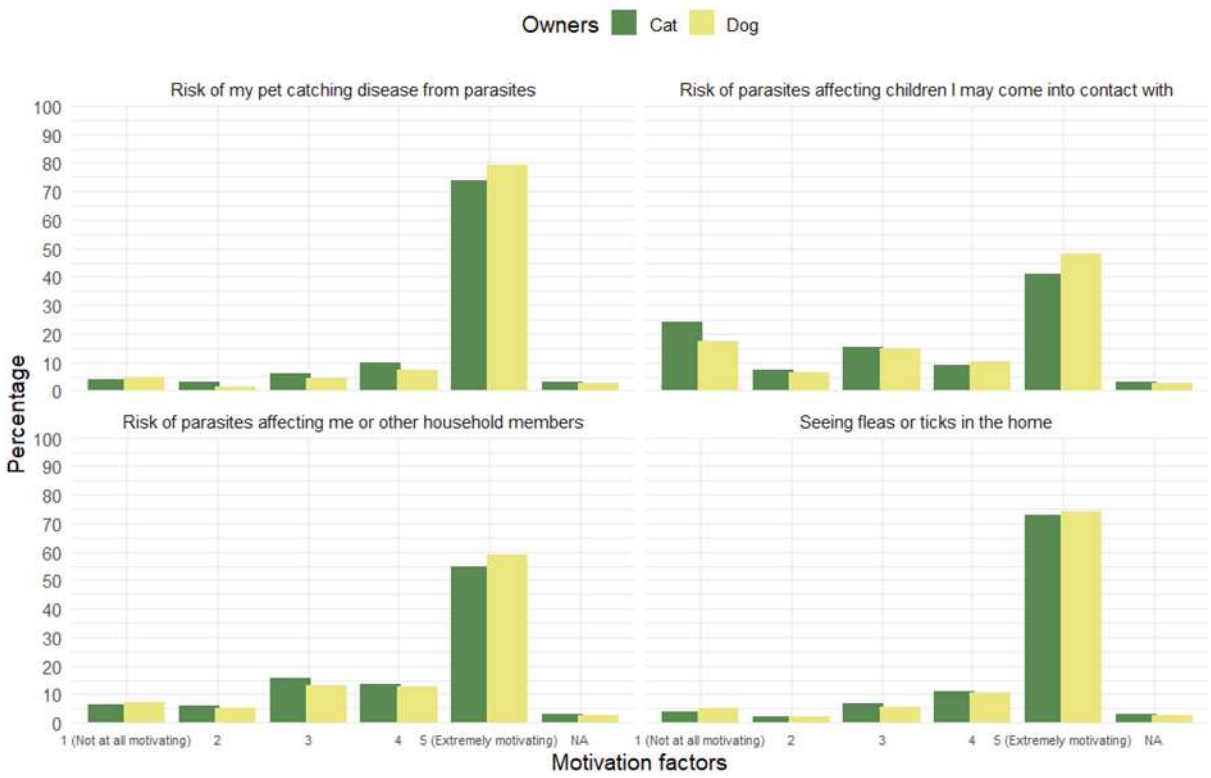


Figure 3. Likert scale responses for "What motivated owners to protect their pet from parasites?"

Results for all other survey questions can be seen in supplementary additional survey results.

5. Discussion

5.1. Stated preference study

The discrete choice study and questionnaire provides evidence of dog and cat owner preferences for parasite prevention and treatment. The findings suggest that dog and cat owners primarily prioritise attributes associated with coverage and practical utility, with environmental considerations having a secondary influence in the decision-making process.

Across all scenarios (preventative and presence of parasites), respondents preferred treatment over no treatment, and utility increased monotonically with increasing parasite coverage. This is consistent with the results of another study using a discrete choice method in which protection from ticks, fleas, intestinal worms, and lungworm compared to ticks and fleas only was the most preferred quality of a product [6]. It may be that owners perceive value in the comprehensiveness of protection, as this is more efficient and provides added reassurance of broad coverage. However, the principle of least effort may also apply here. This theory purports that people favour strategies that minimise the

cognitive and practical burden associated with selecting and administering multiple products [15]. In the context of parasiticides, broad-spectrum products may be perceived as a more convenient and efficient approach to parasite management. Clinically, a broad-spectrum preference can help prevent parasite-associated disease by reducing the likelihood of gaps in protection across a range of parasite species. However, this preference may result in animals receiving treatment for parasites to which they are at minimal risk, reducing or negating clinical benefit. This is particularly relevant where parasite risk is context-dependent in terms of lifestyle and geographic location.

Cat owners showed lower utility for all coverage levels compared to dog owners, suggesting a different risk perception or need for treatment. This may reflect differences in lifestyle (e.g., indoor cats) or a belief that their cat may not come into sufficient contact with other animals to present a meaningful risk of parasitic infestation. Lower rates of routine veterinary attendance in cats may further contribute to this finding, with fewer clinical interactions potentially reducing opportunities for parasite prevention recommendations [16]. This is consistent with cats being treated less often for parasites compared to dogs, [17] and may highlight an underestimation of the risk of parasites in cats amongst owners or lower owner engagement towards cats. This hypothesis is additionally supported by the willingness to pay estimates in the current study, where dog owners were willing to pay more for broad-spectrum coverage compared to cat owners. Veterinary knowledge-sharing strategies that highlight parasite risk in feline patients (including those perceived to be lower risk) can help ensure patients needing preventive care or treatment receive appropriate advice.

Additionally, an expressed preference for purchasing at the veterinary clinic highlights the importance of veterinary professionals in influencing decision-making. Products obtained through veterinary clinics were consistently preferred over online or shops, suggesting that veterinary advice is important to owners, despite the increasing accessibility of alternative purchasing options. This shows the importance of veterinary consultations in discussing parasite risk and prevention for facilitating knowledge sharing and protecting both animal and public health.

Preferences in method of administration also varied by species, with cat owners showing preferences for spot-on treatments and injections, and dog owners preferring flavoured chewables compared to cats. This likely reflects practical challenges associated with the administration of oral medication in cats [18]. Although flavoured chewables were the most preferred option overall, the lower preferences in cat owners highlights the importance of having species-specific considerations when developing new products.

Environmental impact and risk had an influence on product choice; respondents were less likely to select products associated with higher environmental risk or impact. However, despite evidence to suggest that certain topical pet parasiticides may have a negative impact on the environment (Perkins et al., 2024, 2025), when it comes to

purchasing decision-making, owners appear to prioritise attributes such as coverage and practicality over environmental considerations. This finding corresponds with a well-established theoretical framework known as the intention-behaviour gap or intention-action gap [20,21], where the expressed environmental concern does not translate into actual behaviour change [22]

These findings are also supported by respondents' reported influencers on decision-making. When directly asked which factors influenced their parasiticide choices, cost (26.7%) and method of administration (25.1%) were most frequently reported to be drivers of choice, whereas fewer respondents (8.7%) indicated that environmental considerations influenced their decision-making. This may suggest that although environmental concerns are recognised, they have lower weight in real-world decision-making contexts, and environmental considerations may act as a secondary influence, rather than as a primary driver of choice [22].

Further, while attributes such as parasite coverage, method of administration, and cost provide direct immediate actions and consequences for the owner, environmental impacts could be considered comparatively indirect, temporally distant, and not directly observable by the user. Consequently, environmental risk may carry lower decision salience [23], despite owners tending to express pro-environmental views. It may be that respondents unintentionally select the most immediate, observable and potentially marketed attributes, rather than the arguably nebulous benefits of minimising or avoiding environmental harm.

This may impact how environmental stewardship is approached and policy development within the veterinary profession surrounding parasiticide prescribing. Although the environmental impact of parasiticides administered to pets is an increasing concern, the comparatively low weight given to this attribute by respondents suggests that these concerns are not fully embraced or prioritised by pet owners. This raises important questions regarding how meaningful behaviour change can be achieved. Reliance on owner-led behaviour change alone may have limited impact unless environmental risks are communicated in ways that are accessible to owners and veterinary consultations may present an opportunity to contextualise environmental considerations alongside risk when discussing parasite control options and the potential for anti- parasitic resistance [24].

The challenge for environmental stewardship does not necessarily arise from individual veterinary clients alone. Companion animal parasiticides are available through multiple access routes with varying levels of professional oversight and opportunity for stewardship interventions. Furthermore, increasing regulatory scrutiny of the environmental fate and effects of veterinary pharmaceuticals in the UK and internationally [13,14] is likely to place greater emphasis on approaches that extend to multiple stakeholders. Future stewardship approaches such as reformulation of

products, regulatory restrictions, or changes to the range of products available can promote behaviour change by ensuring environmental considerations are provided within the choices available to owners. However, this must be carefully balanced against the potential for increased product costs or reduced accessibility, which could inadvertently compromise treatment and widen inequalities in accessing parasite prevention. Moving forward, a multidisciplinary approach involving environmental scientists, regulatory bodies, pharmaceutical companies, and the veterinary profession will be essential to provide the stakeholder insight needed to ensure responsible use of companion animal parasiticides. To ensure a One Health approach, collaborative action across these sectors will be critical to developing strategies that balance effective parasite control with environmental sustainability, product accessibility, and evidence-based decision-making.

5.2. Secondary questionnaire

An interesting discrepancy was found between respondents' self-reported perceptions of decision-making and the attribute preferences identified through the discrete choice study. Respondents believed that cost and method of administration were the primary factors influencing their choices, whereas the stated preference analysis identified parasite coverage as the attribute most consistently associated with product choice rather than method of administration. This likely reflects the limitations of conscious self-reporting in complex decision-making contexts, where individuals may not be fully aware of the underlying trade-offs in their choices [25]. As previously discussed, more immediate salient attributes such as cost and method of administration may be more readily recalled by respondents. This finding highlights the value of the discrete choice methodology in comparison to more traditional survey or interview-based study designs.

Similarly, owner-reported motivations for purchasing parasiticides appear to be influenced by immediately observable risks, such as threats to pet health and visible signs of parasites. In contrast, motivations related to zoonotic risk were more variable and a up to one quarter of owners reported being "not at all motivated" by the risk of parasites affecting children. Respondents were more motivated to protect themselves or other household members from the risk of parasites, which may suggest that public health messaging on zoonotic risk is insufficient, particularly about children, who may be at greater risk [26].

5.3. Conclusion

Overall, this study provides new insight into dog and cat owner preferences for companion animal parasiticide products and demonstrates that decisions are primarily driven by coverage and practical utility. Although this may support improved parasite control by reducing gaps in protection, it also raises considerations regarding risk-based prescribing, particularly where broad-spectrum treatment may be unnecessary for a low-

risk individual. Differences between dog and cat owners suggest species-specific perceptions of parasite risk and reinforce the importance of tailored veterinary knowledge sharing strategies. Environmental risk influenced choice to an extent, but consistently was less important compared to coverage, administration method, and cost. Collectively, these findings highlight the need for a One Health approach to companion animal parasite control, integrating effective clinical protection with environmental stewardship and owner engagement.

5.4. Limitations

Some limitations need to be considered when interpreting these findings. The sample was predominantly recruited through distribution to IVC Evidensia veterinary clients. By responding to the survey, these respondents were likely to be more engaged with veterinary services and preventative healthcare compared to the wider pet-owning population. While the authors did attempt to mitigate this through social media advertisements, a bias may have been introduced nonetheless. Additionally, as the surveys were cross-sectional, the data captured preferences at a single time point and may not have detected any seasonal variation in parasite risk perception or changes in owner behaviours. Finally, while stated preference (SP) methods are well established across fields, their hypothetical nature of cause raises the possibility of various biases, and future work should investigate the use of revealed preference (RP) data alongside SP.

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