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How pet owners choose antiparasitic treatments for their dogs: A discrete choice experiment

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ABSTRACT

Background: External and internal parasites can cause significant pathology to pets, posing distress to their owners. Antiparasitic treatment is complex because there are many antiparasitic products and dog owners have a limited understanding of parasiticides. The aim of this study was to investigate the characteristics of antiparasitic treatments available at veterinary offices to help veterinarians understand what pet owners value when selecting parasiticides for their dogs.

Methods: Discrete choice experiment (DCE) methodology was used. A list of important treatment attributes was developed based on semi-structured interviews with six dog owners with a total of nine dogs and six veterinarians. The questionnaire including 12 choices between pairs of hypothetical products defined according to treatment attributes was developed. The questionnaire was administered to UK dog owners recruited through an internet panel. It was tested in a pilot study with 17 dog owners, and then was completed by 160 dog owners in the main study.

Results: The selected treatment attributes were price, spectrum of action, veterinarian recommendation, treatment schedule, mode of administration, and place of obtention. The main analysis showed the first four of these attributes significantly influenced the preferences of dog owners for antiparasitic treatments. The most important factor was spectrum of action; most owners expressed a preference for products treating multiple parasites. The influence of price was comparable to that of spectrum of action. Pet owners were more likely to choose a product recommended by their veterinarian. Willingness-to-pay estimates were £11.22 [€12.68; $15.38] for extending protection from fleas and ticks only to intestinal worm and lungworm and £7.21 [€8.14; $9.87] for recommendation from veterinarian.

Conclusions: A broad spectrum of action, veterinarian recommendation, and price are key drivers for choosing antiparasitic products among dog owners. These results may help veterinarians with recommendations of antiparasitic treatment for pet owners based on the key drivers pet owners value.

1. Background

External and internal parasites can cause significant pathology to pets, posing distress to their owners (ESCCAP, 2017, 2018). Therefore, effective protection against and treatment for parasites are essential for pets and their owners. Fleas, ticks, lice and mites are considered by the European Scientific Counsel Companion Animal Parasites (ESCCAP) as the most important groups of ectoparasites (ESCCAP, 2018). In addition, lungworm is considered as a parasite of concern in the UK, due to increasing prevalence, and poor prognosis, with report mortality rates up to 25 % (Battersby, 2015).

Ectoparasiticides are active against external parasites, endoparasiticides are active against internal parasites, and endectoparasiticides are active against both types of parasites. The most recently developed

Abbreviations: DCE, discrete choice experiment; DIC, deviance information criterion; MNL, multinomial logit; WTP, willingness-to-pay.

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class of ectoparasiticides – isoxazolines, which include afoxolaner, fluralaner, lotilaner, and sarolaner – protect against a broad spectrum of fleas, ticks, and mites. Additionally, combining isoxazolines with endoparasiticides increases the number of products and adds to the complexity of treatment selection.

In veterinary medicine, dog owners are actively taking part in the decisions related to parasiticide prevention. They can choose from the wide array of products available both at the veterinary and at pet stores. On the other hand, dog owners have a limited understanding of antiparasitic treatments for dogs. Some do not provide protection against all parasites to their dogs (Little and Duncan, 2019; Boost et al., 2017) and others use effective doses less frequently than recommended (Lavan et al., 2017, 2018). Reports from the literature suggest that dog owners are often not aware of the importance of antiparasitic treatment; they may not know how it should be used or may not think their dog is at risk (Boost et al., 2017).

Because dog owners have a limited understanding of antiparasitic products, veterinarians are expected to recommend treatments. Apart from considering the dog's lifestyle and risk of parasitic infection, veterinarians also take the dog owners preference into consideration. To make appropriate recommendations, veterinarians need insight into the treatment characteristics that are important to owners. We applied methods commonly used in measuring preferences in human healthcare to help veterinarians understand what pet owners value when selecting parasiticides for their dogs. A discrete choice experiment (DCE) is an established quantitative method used to elicit preferences and derive values for specific characteristics of a product. DCEs are frequently used in human medicine and healthcare to measure patients', caregivers' or healthcare providers' preferences for new treatments (Ryan, 2004). They allow for investigation of trade-offs between product characteristics and their translations to monetary value. The indirect preference elicitation methods include scenarios of budget constraints and trade-offs; therefore, they are believed to be more reliable than asking individuals directly for their attitudes towards the products (Pfarr et al., 2014).

2. Methods

2.1. DCE methodology and study overview

The DCE methodology was used to assess dog owners' preferences regarding antiparasitic treatments defined by several characteristics, or attributes. For each attribute, multiple options, or levels, can be considered. A profile is a hypothetical antiparasitic treatment described using the predeveloped attributes.

Participants were asked to choose between the profiles of two hypothetical products for multiple questions. The premise of a DCE is that choices are driven by the values attached to different levels of attributes that define the profiles (Hauber et al., 2016). The outcomes are the marginal utility values attached to attribute levels. These values indicate which levels of an attribute are preferred, and can also be compared between attributes, to determine which of the characteristics contribute more than others to preferences between alternative product profiles.

The study was conducted in two steps: (1) qualitative research, in which relevant attributes of antiparasitic preventative treatments for dogs were identified based on a review of product characteristics and interviews with veterinarians and dog owners; (2) a survey, first tested on a small number of respondents (i.e., dog owners) and later delivered online to a larger number of respondents, which quantified dog owners' preference towards the attributes.

2.2. Attribute development

First, six veterinarians and six dog owners were interviewed by telephone using a semi-structured discussion guide. The respondents were selected to represent adults with experience with various antiparasitic treatments for dogs. During the interview, veterinarians talked about their experience with recommending antiparasitic treatments and dog owners about choosing and administering treatment to their dog(s). Desirable and undesirable characteristics of the antiparasitic treatments were discussed. Respondents were asked to name the characteristics that were important for them and rank them in order of importance. Veterinarians were also asked to name and rank characteristics which in their perception, are important for the dog owners. Summaries of the interviews were reviewed. The characteristics which were mentioned most often as most important to dog owners were considered potential attributes in the DCE. Then, a review of existing antiparasitic treatments was performed to determine the range of possible treatment characteristics. Based on the review, levels of the attributes were defined to best reflect the range of existing products. A cost attribute was considered because it is likely to influence the choices of a dog owner between products. Furthermore, the inclusion of the cost attribute in the DCE makes it possible to estimate the importance of different attributes relative to cost, in other words, to quantify the importance of different attributes in terms of willingness-to-pay (WTP).

2.3. Survey of dog owners

The DCE was conducted in the form of an online survey. Respondents were recruited through an online consumer panel representing all regions of the United Kingdom. The survey invitation was sent to all panel participants in the United Kingdom who previously declared having at least one dog. The recruitment was closed after the planned number of answers was collected. The following inclusion criteria were used: aged 18 years or older, ownership of at least one dog, and at least one visit to the veterinarian with the dog(s) in the past. The last criterion was chosen to limit the respondents to dog owners who are willing to offer medical care to their dog(s). Respondents were offered incentives for participation in the study; however, they did not know the name of the study sponsor, and their answers were anonymous.

The questionnaire for the online survey consisted mainly of a set of choice tasks. It was preceded by screening questions to ensure eligibility of respondents for the study and followed by questions meant to characterize the sample of participants. The latter part included sociodemographic characteristics of the owner, characteristics of the dogs, and experience with the use of antiparasitic treatments. Each choice task included two possible profiles, and an opt-out ensuring the possibility for participants to choose neither of the two proposed treatments. It was not feasible to present choices involving all possible combinations of attributes to respondents because of a large number of such combinations. Therefore, only a sample of possible choice tasks was presented to respondents. The choice tasks were designed using experimental design methods to ensure that utility values (measuring the degree of preference for the attributes' levels) can be estimated with precision and without systematic bias. (Reed Johnson et al., 2013)

The main survey was preceded by a pilot study during which a small sample of dog owners assessed survey questions adequacy. For the pilot study, we used an orthogonal balanced design of choice questions, i.e., each level of each attribute appears equally and there is no correlation between attributes (the fact that an attribute is at a given level in a scenario is independent of the levels of other attributes). There were 24 choice tasks divided into two blocks. Each block was presented to 50 % of respondents; the two blocks were assigned alternately as respondents enrolled in the survey. The design was generated using Ngene 1.2.1 software (ChoiceMetrics, Sydney, Australia). For the main study, we used a D-efficient design with priors, estimated based on results from the pilot study, to obtain the best precision around utility values. Overall, 24 newly designed tasks were included in the survey (in two blocks). Additionally, two choice tasks in which one of the profiles was strongly dominating the other were submitted to respondents, to test respondents' careful reading and understanding of the tasks. Follow-up interviews (cognitive debriefing) were performed with a sample of

pilot survey respondents to verify if the survey questionnaire was easily understandable, in particular, if the instructions to the choice tasks were clear and the attributes' descriptions were well understood. The choice of attributes and levels were also confirmed in the cognitive debriefing interviews.

The questionnaire used in the survey is provided as supplemental material to this article (Additional file 1).

2.4. Statistical analysis

Descriptive statistics were calculated for respondent characteristics. The analysis of responses to choice tasks was performed using multinomial logit (MNL) models (Chen and Kuo, 2001). The results of the analysis were the estimates of relative preference of each level within an attribute in comparison to the baseline level of that attribute (marginal utilities). We tested fixed-effects (assuming independence between all choices from the same respondent) and random-effects (assuming responses from one individual are not independent) models. The cost variable was entered either as a continuous or discrete variable. When it was entered as a continuous variable, a linear relationship between the utility of a product and cost was assumed. The models were estimated using Bayesian methods. The best model was selected by minimizing the deviance information criterion (DIC) (Spiegelhalter et al., 2002). The standard deviations and 95 % credible intervals for the marginal utility estimates were calculated to present the variability of results.

WTP expresses the degree of preference for an attribute level as the amount of money that dog owners would be willing to pay for a product with this characteristic rather than another. It was derived from marginal utility estimates. WTP estimates were calculated in GBP and presented also in USD ($1=£1.37) and EUR (€1=£1.13), using exchange rate on Feb 3, 2021. The statistical analysis was performed using the SAS 9.4 software (SAS Institute Inc., Cary, NC, USA).

3. Results

3.1. Attributes development

In total, six dog owners were interviewed (three lived in urban areas and three in rural areas). Five owners had one dog, one owner had four dogs. The nine dogs were of various sizes (range, 2–32 kg) and ages (range, 3 months to 13 years). Four interviewees had also other animals. All dogs were treated against parasites at the time of the interview, with fluralaner (Bravecto®, Merck & Co., Inc., Madison, NJ, USA), selamectin (Revolution®/Stronghold®, Zoetis, Parsippany, NJ, USA), imidacloprid (Endectrid®, MiPet, Norfolk, UK), praziquantel + milbemycin oxime (Interceptor Plus®, Elanco, Greenfield, IN, USA), and sarolaner (Simparica®, Zoetis, Parsippany, NJ, USA). Two dogs had previously experienced parasite infestations, two dogs had allergies, and seven dogs had no health issues. In addition, six veterinarians were interviewed. They had been practising veterinary medicine for a median of 12.5 years (range, 3–33). They took care of a median of 50 dogs a week (range, 40–120) from both urban and rural regions. They prescribed preventative parasiticides to a median of 57.5 % of dogs they looked after (range, 25–90 %). Table 1 presents the traits of the antiparasitic treatments reported most often as important to dog owners in the interviews with dog owners and veterinarians.

Table 1
Antiparasitic treatment characteristics in order of perceived importance to dog owners according to dog owners and veterinarians.

Rank	Dog owners	Veterinarians
1	Effectiveness	Formulation/Ease of administration
2	Cost	Cost
3	Ease of administration	Effectiveness
4	Treats several types of parasites	Safety
5	Safety of the dog/Safety of others	Treatment schedule
6	Treatment schedule	Purchase channel
7	Purchase channel	Treats several types of parasites
8	Recommended by the veterinarian	Available dosage

The top attributes were included in the DCE. Availability of various doses (including very small and very large doses) was important to the veterinarians as it made managing the treatment easier. Effectiveness was represented by the different types of parasites for which a product would provide effective protection. It was considered the category of the recommendation made by a veterinarian, despite not being mentioned by the pet owners as a preference driver. Knowing the effectiveness of a drug, a veterinarian can tailor treatment to fit with a patient's specific needs based on a risk exposure assessment. The levels of the attributes were based on the characteristics of antiparasitic products available in the veterinarian's office, including over the counter products. The list of the attributes and their levels used in the DCE is presented in Table 2.

3.2. Survey of dog owners

The pilot study performed on 17 dog owners confirmed that respondents understood the choice tasks and the descriptions of the attributes included in the survey. One respondent was excluded from the analysis after verification of consistency of preference. Minor modifications were introduced to the survey wording. An example of the choice question used in the survey is presented in Fig. 1.

The survey was completed by 160 dog owners. It took on average 8.1 min (range, 4.3–265.3). Of all records, 25 were not included due to failure on both dominant choice tasks. A total of 135 responses were included in the analysis. The majority (56.3 %) of participants were female, 77.8 % lived in urban or suburban areas, 90.4 % had given an antiparasitic treatment to their dog before, and 45.9 % had obtained an antiparasitic treatment for their dog at the veterinarian's office in the past 6 months. The detailed characteristics of respondents are available in the supplemental materials (Additional file 2). The most frequently used brand names of antiparasitic treatments were Frontline®, Advocate®, and Drontal® (Fig. 2).

The Bayesian MNL model with random effects and continuous cost attribute was selected as the best model based on the DIC criterion. The results of the model showed that the spectrum of action is the most important driver of preference. Products against ticks and fleas were chosen as a baseline category, due to being the most common type of product on the market (ESCCAP, 2013). Protection from ticks, fleas, intestinal worms, and lungworm rather than ticks and fleas only was the most preferred quality of a product (marginal utility of +2.3 [95 % CI, 1.7–2.8]). Protection against ticks, fleas, and intestinal worms was also

Table 2
List of attributes and levels used in the main study.

Attribute	Level
Type of parasites the product treats	Ticks, fleas, intestinal worms, and lungworm
	Ticks, fleas, and intestinal worms
	Tick and fleas
	Fleas
Treatment schedule	Given every 8–12 weeks
	Given once a month
Veterinarian recommendation	Recommended by your veterinarian
	No recommendation from your veterinarian
Where the treatment can be obtained	Only available through a veterinarian
	Available through a veterinarian and other channels
Mode of administration	Chewable tablet must be given at or around time of feeding
	Chewable tablet given at any time with or without food
	Spot-on to be applied on dog's skin
Cost per administration	£40
	£13
	£6
	£3

Imagine you must choose between two anti-parasitic treatments for your dog(s), Treatment A and Treatment B, as described in the table below.

Take a moment to review the characteristics of each treatment, and then indicate which treatment you would choose at the bottom of the table. You can also answer that you would not choose any of the presented treatments.

	Treatment A	Treatment B
Type of parasites that the product treats	Treats ticks, fleas and intestinal worms	Treats ticks, fleas, intestinal worms and lungworm
Treatment schedule	Given once a month	Given once a month
Veterinarian recommendation	Recommended by your veterinarian	No recommendation by your veterinarian
Where the treatment can be obtained	Available through a veterinarian and other channels	Only available through a veterinarian
Mode of administration	Chewable tablet given at any time with or without food	Spot-on to be applied on dog's skin
Cost per administration	£ 6	£ 13
	I prefer treatment A □ I prefer treatment B □ I would not use any of these treatments for my dog □	

Fig. 1. Example of choice question presented to the respondents.

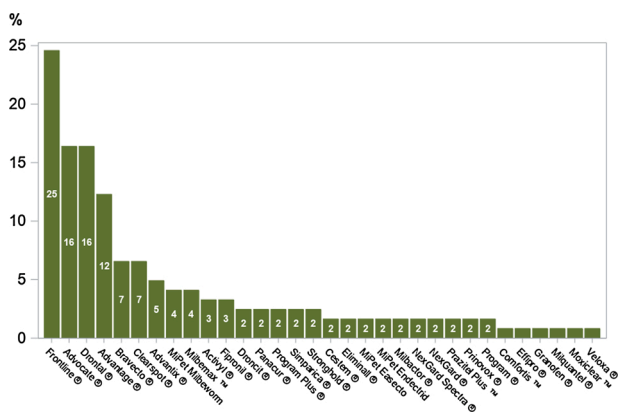

Fig. 2. Antiparasitic drugs purchased by dog owners during 6 months preceding the study (multiple choice question). N=96.

significantly preferred over protection against ticks and fleas only (+1.0 [95 % CI, 0.7–1.4]). Protection against fleas only was significantly inferior to protection against fleas and ticks (–1.5 [95 % CI, −1.9 to −1.0]). Recommendation of the product by the veterinarian was also strongly preferred treatment characteristic (+1.4 [95 % CI, 1.0–2.0]) in comparison to not giving any recommendation. The treatment schedule was a factor taken into consideration when deciding on treatment too. Administration of the treatment every 8–12 weeks was preferred over administration once a month (+0.5 [95 % CI, 0.3−0.8]). Each additional £1 [€1.13; $1.37] of price per administration lowered the utility of the treatment by 0.2 (–0.2 [95 % CI, −0.3 to −0.2]). The study showed no significant preference towards any mode of administration of the treatment (spot-on or chewable tablet) or the supply route (availability only at the veterinarian office or also elsewhere). The preference estimates are shown in Fig. 3; the detailed results are presented in Additional file 3.

Dog owners were willing to pay £11.22 (95 % CI, £7.88–15.98) [€12.68 (95 % CI, €8.91−18.06); $15.38 (95 % CI, $10.80−21.90)] more for a product protecting from ticks, fleas, intestinal worms, and lungworm than for a product protecting from ticks and fleas only. Respondents would pay £4.97 (95 % CI, £3.05–7.53) [€5.61 (95 % CI, €3.45−8.51); $6.81 (95 % CI, $4.18−10.31)] more for a product protecting from ticks, fleas, intestinal worms in comparison to a product protecting from ticks and fleas only. Protection from only fleas makes the product worth £7.23 (95 % CI, £4.74–10.48) [€8.17 (95 % CI, €5.35−11.84); $9.91 (95 % CI, $6.49−14.36)] less than products with protection from ticks and fleas in respondents' opinion. Dog owners were willing to pay an additional £7.21 (95 % CI, £4.45−10.86) [€8.14 (95 % CI, €5.03–12.27); $9.87 (95 % CI, $6.10–14.88)] for a product recommended by their veterinarian and an additional £2.69 (95 % CI, £1.24–4.46) [€3.04 (95 % CI, €1.40−5.04); $3.68 (95 % CI, $1.70−6.11)] per administration for a product given every 8–12 weeks in comparison to products given every month. The detailed WTP results are presented in Table 3.

4. Discussion

The results of this study indicate that despite a recommendation from the veterinarian is an important factor when choosing the antiparasitic treatment for the dog, the dog owners also take other factors (like price or treatment schedule) into consideration. It was shown that four factors significantly influence the preference of dog owners for antiparasitic treatments: the spectrum of action, a recommendation from the veterinarian, treatment schedule, and price. The most important factor was the spectrum of action. Pet owners preferred combination products offering protection against multiple parasites. This may be for convenience, ease of use and peace of mind but the reasons were not explored. Importance of price was comparable to the importance of types of parasites that the treatment protected against. Assuming the range between the average cost of one administration of the least and the most expensive product available at the veterinarian's office is £19 [€21.47; $26.03], the difference in utility between products with minimum and maximum prices on the market, all other characteristics equal, would be 3.8. This was similar to the difference in utility of 3.7 between products protecting against fleas, ticks, intestinal worms, and lungworm compared to fleas only. Pet owners were more likely to choose a product that was recommended by their veterinarian; this was the second most important factor after the spectrum of action, putting the price aside. WTP estimates were £11.22 [€12.68; $15.38] for extending protection to intestinal worm and lungworm and £7.21 [€8.14; $9.87] for veterinarian recommendation (i.e., dog owners would pay an additional £7.21

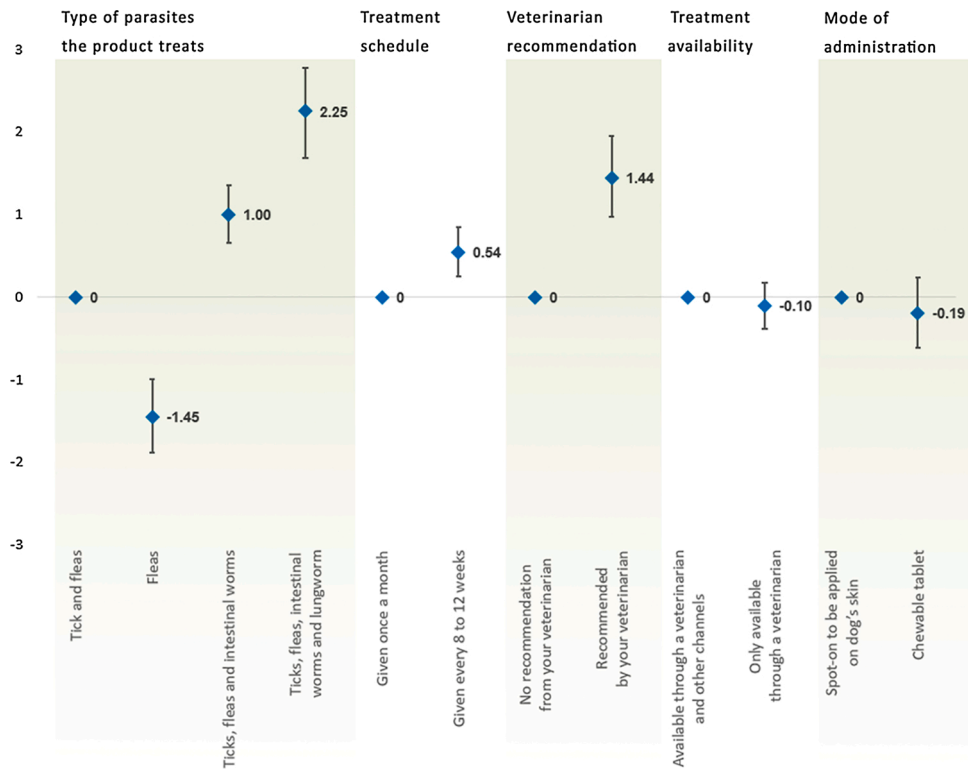

Fig. 3. Estimates of relative preference (marginal utilities) of treatment characteristics.

Table 3
Additional amount dog owners are willing to pay for treatment characteristics (WTP results).

Attribute	Level	WTP	95 % CLL	95 % CLU
Type of parasites covered	Ticks, fleas, intestinal worms, and lungworm	£11.22[a]; €12.68; $15.38	£7.88; €8.91; $10.80	£15.98; €18.06; $21.90
	Ticks, fleas, and intestinal worms	£4.97[a]; €5.61; $6.81	£3.05; €3.45; $4.18	£7.53; €8.51; $10.31
	Fleas	–£7.23[a]; −€8.17; −$9.91	–£10.48; −€11.84; −$14.36	–£4.74; −€5.35; −$6.49
	Tick and fleas	£0 (reference)	—	—
Treatment schedule	Given every 8–12 weeks	£2.69[a]; €3.03; $3.68	£1.24; €1.40; $1.70	£4.46; €5.04; $6.11
	Given once a month	£0 (reference)	—	—
Veterinarian recommendation	Recommended by your veterinarian	£7.21[a]; €8.14; $9.87	£4.45; €5.03; $6.10	£10.86; €12.27; $14.88
	No recommendation from your veterinarian	£0 (reference)	—	—
Where the treatment can be obtained	Only available through a veterinarian	–£0.50; −€0.57; −$0.69	–£1.83; −€2.07; −$2.51	£0.92; €1.04; $1.26
	Available through a veterinarian and other channels	£0 (reference)	—	—
Mode of administration	Chewable tablet	–£0.94; −€1.06; −$1.28	–£3.11; −€3.51; −$4.26	£1.19; €1.35; $1.64
	Spot-on/topical to be applied on dog's skin	£0 (reference)	—	—

CLL, Lower Confidence Limit; CLU, Upper Confidence Limit; WTP, willingness-to-pay.
[a] Result is statistically significant.

[€8.14; $9.87] for a product recommended by a veterinarian, everything else equal).

The DCE methodology is seldom used in the veterinary field (Widmar et al., 2020). This study illustrates the potential of this method, which is becoming increasingly important in human and veterinary medicine. It involves hypothetical decisions, which respondents may not have experienced before and which include only a limited number of factors, but it proves to be helpful in predicting real-life health-related behaviour (Quaife et al., 2018). One of the limitations of the study is that it has not compared the results of the DCE to real-life choices of dog owners. This needs to be further investigated in a separate study. A strength of this study is its performance in accordance with methodological

guidance for DCEs in human healthcare, ISPOR Task Force reports (Bridges et al., 2011; Reed Johnson et al., 2013; Hauber et al., 2016). Various measures, such as elicitation of attributes in the target population, testing the attributes and the choice questions in the pilot study and using opt-out, were taken to ensure the validity and reliability of the estimated preferences. The survey technique has the advantage of avoiding any bias due to the perception of different brands as it refers to treatment characteristics without mentioning any brand names.

The study has limitations, some being linked to observations made during the study and others to the study design itself. Some interviewees noted that side effects could be added as an attribute, as side effects also constitute an important factor when choosing antiparasitic treatment. However, all products evaluated in this study were approved by regulatory agencies and are considered safe by healthcare professionals. Additionally, the survey results and the interviews with the veterinarians indicated that the dog owners' knowledge of antiparasitic treatment was superficial; some were basing their opinions on their experience and veterinarian recommendation. It was thought by researchers that respondents would not be able to make choices between product profiles, including several types of adverse events with different probabilities and levels of severity, because of the high level of complexity of this task. Determining the levels of this attribute based on the existing evidence regarding the safety of the antiparasitic dog treatments would also be a challenge for respondents.

After collection of the surveys, 25 respondents who did not select any of the two dominated treatment alternatives in both test choices were excluded. This is a frequent problem in online DCEs (Tervonen et al., 2018). These 25 respondents may have entered the survey primarily for the offered incentive instead of a desire to express their preferences about the antiparasitic treatments for dogs. It is generally debated whether respondents with seemingly irrational answers should be excluded, as we may not fully understand the reasoning behind their answers. However, the sensitivity analysis of the sample including these respondents showed similar results, confirming the robustness of the findings.

5. Conclusions

The key drivers for choosing antiparasitic products among dog owners are: a broad spectrum of action (targeting intestinal worms and lungworm in addition to fleas and ticks), veterinarian recommendation, and price per administration. These findings may be important for veterinarians to consider when recommending antiparasitic treatments to owners of dogs. They may also be helpful to the animal health pharmaceutical industry for product development.

Ethics approval and consent to participate

Consent was obtained from the dog owners to participate in the study.

Consent for publication

Not applicable.

Availability of data and materials

The data supporting the conclusions of this article is included within the article and its additional files.

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Authors' contributions

MB: supervised the field activities, participated in data analysis, drafted the manuscript. AW: was a major contributor to study conceptualization and data interpretation, oversaw the methodology and field activities, revised the manuscript. MG: participated in study conceptualization, supported the field activities, revised the manuscript. DRD: participated in study conceptualization, supported the field activities, contributed to data interpretation, revised the manuscript. GH: contributed to data interpretation, revised the manuscript. EG: supported the field activities, contributed to data interpretation, revised the manuscript. SA: participated in study conceptualization, supervised data analysis, drafted the manuscript. All authors read and approved the final version of the manuscript.

Declaration of Competing Interest

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.prevetmed.2021.105493.

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