The frequency and distribution of canine leishmaniosis diagnosed by veterinary practitioners in Europe

M.J. Mattin, a,*, L. Solano-Gallego, b, S. Dhollander, c, A. Afonso, c, D.C. Brodbelt a

a Department of Production and Population Health, The Royal Veterinary College, University of London, Hawkshead Lane, North Mymms, Hatfield, Hertfordshire AL9 7TA, UK
b Departament de Medicina i Cirurgia Animal, Facultat de Veterinària, Universitat Autònoma de Barcelona, Edifici V, 08193 Bellaterra, Spain
c European Food Safety Authority, Via Carlo Magno 1°, 43126 Parma, Italy

ARTICLE INFO

Keywords:
Canine
Dog
Epidemiology
Leishmaniosis
Prevalence

INTRODUCTION

Leishmaniosis is endemic in parts of Europe, where the causal agent is almost exclusively Leishmania infantum (Ready, 2010) and the main reservoir host is the domestic dog (Alvar et al., 2004; Baneth et al., 2008; Quinnell and Courtenay, 2009). The parasite can cause severe, potentially fatal disease in humans (Desjeux, 2004) and dogs (Solano-Gallego et al., 2009), presenting both public health and animal welfare concerns.

In recent years, a northward spread of leishmaniosis in Italy has been documented (Maroli et al., 2008; Baldelli et al., 2011). This has been attributed to changes in vector distributions, possibly as a result of climate change. Increased travel and movement of infected dogs may also contribute to the changing epidemiology of the disease within and between countries (Teske et al., 2002; Menn et al., 2010). Shaw et al. (2009) identified a number of clinically apparent canine leishmaniosis (CanL) cases in the United Kingdom (UK), which had been imported from or travelled to CanL endemic countries. A number of these dogs were re-homed shelter dogs, which may be at a higher risk of developing seropositivity to L. infantum than owned dogs in endemic countries (Paradies et al., 2006; Schallig et al., 2013).

However, clinically apparent cases represent the minority of infected dogs in endemic regions (Moreno and Alvar, 2002; Solano-Gallego et al., 2009; Schallig et al., 2013), so dogs with sub-clinical infection that appear healthy may also be imported from endemic regions. Further, an association between the area a dog originated from and the course of infection has been found in a cohort of dogs exposed to natural L. infantum infection (Quinnell et al., 2003), suggesting that the likelihood of infection may be different in dogs visiting and inhabiting endemic areas. These issues relating to the spread of CanL make it particularly pertinent to evaluate the current prevalence and distribution of the disease.

Routine collection of veterinary data from companion animals is limited and there have been few large scale epidemiological studies on clinically apparent CanL in the European Union (EU). National surveys of CanL in veterinary clinics across France estimated a disease prevalence of 0.41% and suggested that CanL was endemic along the Mediterranean coast and in the South-East of the country (Bourdeau et al., 2010). The Veterinary Journal (2014), doi: 10.1016/j.tvjl.2014.03.033

* Corresponding author. Tel.: +44 1707 667168.
E-mail address: maddylj@hotmail.com (M.J. Mattin).

http://dx.doi.org/10.1016/j.tvjl.2014.03.033
1090-0233/© 2014 Published by Elsevier Ltd.
et al., 2004, 2011). In 2009, the true prevalence of CanL infection in dogs attending veterinary clinics across Portugal was estimated to be 6.31% (Cortes et al., 2012). The apparent prevalence of infection was reported to be 19.4% in a study of clinically normal dogs attending veterinary clinics in mainland Greece (Athanasioiu et al., 2012). Other CanL epidemiological studies were mostly seroprevalence surveys conducted in limited geographical areas, often in southern parts of Western European countries (Trotz-Williams and Trees, 2003).

Many factors will influence prevalence estimates of L. infantum infection and disease, including the source population, the characteristics of diagnostic tests used and the tissue sampled (Solano-Gallego et al., 2001; Fernández-Bellon et al., 2008; Morales-Yuste et al., 2012). Sampling techniques, diagnostic test cut-off values and the time of year the study is conducted can also influence estimates (Morales-Yuste et al., 2012), making direct comparison of studies difficult.

Recently, disease surveillance techniques using search engine query data have been developed to complement more conventional methods (Eysenbach, 2006; Carneiro and Mylonakis, 2009). Google, an internet search engine, has developed Google Trends (GT) (Google Trends, 2013), a tool that captures data based on the number of Google web searches for user-specified search terms. This tool has been used to track internet interest in several diseases including influenza (Eysenbach, 2006), West Nile virus, Respiratory syncytial virus (Carneiro and Mylonakis, 2009), Lyme disease (Seifert et al., 2010) and otolaryngological conditions (Braun and Harréus, 2013). In addition to using English terms, disease tracking with GT has been explored using French (Pelat et al., 2009) and Spanish (Valdivia and Monge-Corella, 2010) search terms. To our knowledge, GT has not been used to explore trends in search terms relating to leishmaniosis.

The objectives of this study were: (1) to collect data on prevalence and management of CanL as diagnosed by veterinary practitioners in France, Greece, Italy, Portugal and Spain; (2) to compare the geographical distribution and frequency of the cases in France with data collected from a benchmarking company; and (3) to explore GT as a tool for monitoring CanL trends. This work was done as part of a project funded by EFSA (European Food Safety Authority) that evaluated the impact of CanL in the EU.

Materials and methods

Three data sources were evaluated to estimate the frequency and spatial distribution of CanL in France, Greece, Italy, Portugal and Spain: an online questionnaire, benchmarking data and Google Trends. The project received ethical approval from the Royal Veterinary College Ethics and Welfare Committee (URN 2012 1188).

Online veterinary questionnaire

An online questionnaire for veterinarians asked respondents to estimate the total number of confirmed CanL cases seen at their clinic within the last 12 months, the number of new (incident) cases diagnosed within this period and their weekly canine caseload (see Appendix A, Supplementary material). The total annual number of cases included dogs with CanL that had attended the clinic within the previous 12 months, irrespective of when the original diagnosis was made (both newly diagnosed incident cases and pre-existing cases were included). CanL cases confirmed by any diagnostic method were included. Other questions related to the frequency with which different CanL preventative measures and treatments were used in respondents' clinics and the perceived impact of the economic crisis on veterinary services relating to CanL. The questionnaire was translated into the relevant languages and promoted to veterinary practitioners working in France, Greece, Italy, Portugal and Spain. Member organisations of the FVE (Federation of Veterinarians of Europe) and companion animal veterinary associations promoted the questionnaire to their members via email or their websites.

Data collected from the online veterinary questionnaire were cleaned and analysed using Microsoft Excel. Period prevalence (the proportion of practice-attending dogs with a confirmed veterinary diagnosis of CanL within a 12-month period) was calculated at the national and NUTS (Nomenclature of Territorial Units for Statistics) levels 2 (larger regions within a country) and 3 (smaller areas, e.g. department or province within a region) using the following equation:

\[
\text{Prevalence} = \frac{\text{annual number of leishmaniosis cases (existing and new cases)}}{\text{annual number of dogs attending clinics}}
\]

The estimated number of dogs seen per week was multiplied by the average annual number of working weeks to derive the annual number of consultations involving dogs. The annual number of working weeks was calculated by subtracting the average collectively agreed paid annual leave for each country from the number of weeks per year. To account for multiple visits per dog, the annual number of consultations was divided by the reported mean number of times a dog attends a clinic per year (P. Mercader, T. Richard, personal communication). Incidence risk was calculated by dividing the number of incident cases (newly diagnosed with CanL within the previous year) by the number of dogs attending the clinics annually. The mean and median NUTS 2 level prevalence estimates and 95% confidence intervals (CI) were calculated using standard methods (Kirkwood et al., 2003). The number of questionnaire responses, prevalence estimates and associated standard errors were presented as NUTS 3 level choropleth maps in ArcGIS 9 (ESRI, 2013), using shape-files downloaded from a database of global administrative areas (GADM, 2013). In some instances, NUTS 3 regions were combined to become compatible for joining to shape-files.

Benchmarking data

Data were requested from a French benchmarking company (Panelvet), which extracts clinical and financial data from the practice management systems (accounting and clinical record computer systems) of primary-care veterinary clinics in France. Prevalence was defined as the proportion of benchmarking company subscribing practice-attending dogs invoicing treatment for or euthanasia with CanL annually. Data at the NUTS 3 (department) level were available including the number of veterinary clinics and the number of dogs attending clinics in each department that contributed data. The latter figure was used as the denominator population for the prevalence estimates.

CanL cases were defined as dogs whose electronic patient records contained invoices for treatment specific for CanL (allopurinol, meglumine antimoniate, miltefosine; Solano-Gallego et al., 2009), or dogs which were tested or treated (but not vaccinated) and euthanased within 60 days of the last test or treatment prescribed. Duplicate records of the same animal were excluded. Data were analysed using Microsoft Excel and exported to ArcGIS 9 (ESRI, 2013) to create maps as described for the online questionnaire.

Google Trends

Temporal trends for Google queries for ‘leishmaniosis’, ‘canine leishmaniosis’, ‘rabies’ and ‘babesiosis’ between April 2007 and April 2013 were compared within each studied country when possible. Each search term was translated into the relevant language and entered into GT on 18 April 2013 to explore the relative web interest in the different veterinary diseases. The results of the queries were displayed as search volume index graphs generated by GT. News headlines relating to the search terms were also indicated on the graphs whenever Google detected a peak in Google News stories relating to a search term (Carneiro and Mylonakis, 2009). Queries for ‘leishmaniosis’ and ‘dog’ were entered into GT to generate maps showing the geographical differences in web interest for these terms. The latter term was included to account for regional differences relating to interest in dogs or canine populations.

Results

Online veterinary questionnaire

In total, 1231 questionnaires were completed by veterinary practitioners between January and May 2013: 625 came from France, 369 from Spain, 57 from Portugal, 67 from Italy and 113 from Greece. Thirteen questionnaires were not analysed as they were completed by veterinary practitioners working outside the studied countries or not currently in employment. The number of responses per

---

1 See: http://www.google.co.uk/trends/explore


4 See: http://www.gadm.org/

5 See: http://www.panelvet.fr/
area varied within countries, especially in France where more responses were received from Southern departments (Fig. 1).

The national prevalence estimates of veterinary-diagnosed CanL (percentage of practice-attending dogs with a confirmed veterinary-diagnosis of CanL) ranged from 0.71% in France to 7.80% in Greece (Table 1). This represented a median of one CanL case seen by the responding veterinarian over the previous year in France and a median of eight cases annually. Generally, prevalence estimates were highest in the Mediterranean regions (Fig. 2) and standard errors of these estimates were smaller in parts of France and Spain where number of respondents were higher, compared with the other countries (Fig. 3). Differences between the national and average regional (NUTS 2) prevalence estimates were particularly marked for France (Tables 1 and 2).

The most common CanL preventative measures used in practice-attending dogs were repellents and insecticides applied to the dog (Fig. 4). In addition to the preventative measures specified in the questionnaire, some veterinarians recommended keeping dogs indoors overnight, using environmental insecticides and using drugs typically used to treat CanL as prophylaxes (allopurinol, meglumine antimoniate and miltefosine). Allopurinol was the most frequently prescribed treatment for CanL, although meglumine antimoniate and miltefosine were used relatively frequently in some countries (Fig. 5). In addition, some veterinarians used treatments not specified in the questionnaire including antibiotics, corticosteroids, levamisole, complementary therapies, immunotherapy, nutraceuticals, ACE inhibitors, anthelmintics and autovaccination.

Generally, veterinary practitioners responding to the online questionnaire thought that the economic crisis was most likely to have a moderate to high impact on the use of prophylactic measures and

---

Table 1

<table>
<thead>
<tr>
<th>Country</th>
<th>Cases per veterinarian Incident All cases</th>
<th>Dogs per week (Median (range))</th>
<th>Consults per year (Median (range))</th>
<th>Dogs seen per year (Median (range))</th>
<th>National prevalence % 95% CI</th>
<th>National incidence per 1000 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>1 (0–150) 1 (0–190)</td>
<td>50 (0–600) 2350 (0–28,200)</td>
<td>783 (0–9400)</td>
<td>0.71 (0.69–0.73)</td>
<td>4.6 (4.5–4.8)</td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>20 (0–200) 25 (1–350)</td>
<td>30 (2–250) 1422 (95–11,850)</td>
<td>474 (32–3950)</td>
<td>7.80 (7.58–8.03)</td>
<td>56.3 (54.3–58.2)</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>5 (0–100) 8 (0–250)</td>
<td>25 (3–150) 1160 (139–6960)</td>
<td>387 (46–2320)</td>
<td>4.33 (4.16–4.50)</td>
<td>22.6 (21.0–24.3)</td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>5.5 (0–80) 8 (0–80)</td>
<td>20 (1–100) 938 (47–4688)</td>
<td>313 (16–1563)</td>
<td>2.92 (2.71–3.13)</td>
<td>23.1 (21.3–25.0)</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>6 (0–220) 8 (0–220)</td>
<td>30 (0–209) 1406 (0–9798)</td>
<td>469 (0–3266)</td>
<td>3.71 (3.63–3.79)</td>
<td>25.2 (24.5–25.9)</td>
<td></td>
</tr>
</tbody>
</table>

* Incident, new canine leishmaniosis cases diagnosed within the last 12 months.

† Prevalence, percentage of practice-attending dogs with a confirmed veterinary diagnosis of canine leishmaniosis.

---

Please cite this article in press as: M.J. Mattin, L. Solano-Gallego, S. Dhollander, A. Afonso, D.C. Brodbelt, The frequency and distribution of canine leishmaniosis diagnosed by veterinary practitioners in Europe, The Veterinary Journal (2014), doi: 10.1016/j.tvjl.2014.03.033
Fig. 2. Veterinary estimates of the percentage of practice-attending dogs diagnosed with canine leishmaniosis (pre-existing and incident cases) in France, Greece, Italy, Portugal and Spain over a 12-month period (2012–2013).

Fig. 3. Standard errors of the estimated percentage of practice-attending dogs diagnosed with canine leishmaniosis (pre-existing and incident cases) in France, Greece, Italy, Portugal and Spain over a 12-month period (2012–2013).
the diagnosis and treatment of dogs with CanL (Fig. 6). The responses relating to the impact of the economic crisis on euthanasia decisions were more diverse.

Benchmarking data

In total, 97 clinics located in 52 French departments contributed data relating to approximately 180,000 dogs each year between August 2010–August 2011 and August 2011–August 2012. Up to seven practices per department contributed data (Fig. 7). A mean of 844 dogs were under the care of each full-time veterinary practitioner annually.

Table 2
Regional estimates of the percentage of practice-attending dogs with a confirmed veterinary diagnosis of canine leishmaniosis attending veterinary clinics over a 12-month period (2012–2013) in France, Greece, Italy, Portugal and Spain.

<table>
<thead>
<tr>
<th>Country</th>
<th>Mean</th>
<th>Median</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>0.43</td>
<td>0.05</td>
<td>0.01–3.51</td>
</tr>
<tr>
<td>Greece</td>
<td>9.05</td>
<td>7.41</td>
<td>3.80–21.57</td>
</tr>
<tr>
<td>Italy</td>
<td>3.61</td>
<td>2.85</td>
<td>0.00–11.18</td>
</tr>
<tr>
<td>Portugal</td>
<td>2.78</td>
<td>3.12</td>
<td>0.97–6.66</td>
</tr>
<tr>
<td>Spain</td>
<td>2.87</td>
<td>2.95</td>
<td>0.31–6.15</td>
</tr>
</tbody>
</table>

NUTS, Nomenclature of Territorial Units for Statistics.

Fig. 4. Veterinary estimates of the proportions of all dogs attending their clinic that receive preventative measures for canine leishmaniosis in France, Greece, Italy, Portugal and Spain. The Y axis represents the percentage of respondents per country indicating that level of measure use.

Fig. 5. Frequency of treatments used for canine leishmaniosis in veterinary clinics France, Greece, Italy, Portugal and Spain. The Y axis represents the percentage of respondents per country indicating that level of treatment use.

Please cite this article in press as: M.J. Mattin, L. Solano-Gallego, S. Dhollander, A. Afonso, D.C. Brodbelt, The frequency and distribution of canine leishmaniosis diagnosed by veterinary practitioners in Europe, The Veterinary Journal (2014), doi: 10.1016/j.tvjl.2014.03.033
During the first and second 12 months of the study period, 415 (0.23%) and 735 (0.41%) dogs attending these clinics were tested for *Leishmania* infection. The majority of invoices (59.3%) did not specify the type of test used. Of the specified tests, the most commonly used were serological rapid tests (39.6%). Less than 1% of *Leishmania* tests were specified as PCR tests. Ninety-four and 83 dogs were treated for CanL or euthanased with CanL between August 2010–August 2011 and August 2011–August 2012, respectively. The vast majority related to invoice data for treatment (91.0%) with only 16 (9.0%) euthanased. This equated to 0.052% (95% CI: 0.047–0.057%) and 0.046% (95% CI: 0.041–0.051%) of practice-attending dogs being treated for or euthanased with CanL in each 12-month period. The apparent prevalence at the department-level ranged from 0 to 0.83% (Fig. 8), with higher levels of disease generally found in the South-Eastern departments.

A total of 565 (0.31%) dogs were vaccinated against *Leishmania* infection between August 2011 and August 2012. The median proportion of dogs receiving the vaccine per department was 0.01% and ranged from 0 to 9.53%. The pattern of vaccination administration largely reflected the disease distribution.

**Google Trends**

Google generated graphs and maps reflecting web search volumes for ‘leishmaniosis’ in France, Italy, Portugal and Spain. There were insufficient numbers of web queries for this term for analysis in Greece.
Generally, web searches for leishmaniosis were more frequent than searches for babesiosis, but less frequent than for rabies (Fig. 9). Regional web searches for ‘dog’ were generally more homogenously distributed than for ‘leishmaniosis’, especially in France and Spain (Fig. 10), where searches for ‘leishmaniosis’ broadly followed the disease distribution identified from the veterinary questionnaire (Fig. 2).

**Discussion**

This study highlights the greatest estimates of veterinary-diagnosed CanL in the Mediterranean in Greece, whereas France had the lowest perceived burden of disease and Italy, Portugal and Spain had intermediate estimates. The geographical distribution of disease based on the questionnaire data was broadly consistent with the patterns identified from two novel data sources, namely, veterinary benchmarking data and GT.

The national prevalence of disease seen in France was 0.71% (proportion of practice-attending dogs with a diagnosis of CanL over a 12-month period; 95% CI: 0.69–0.73%), whereas the mean regional prevalence was 0.43%. The national prevalence in the current study was higher than that observed by Bourdeau et al. (2004) (0.41%). The difference in national prevalence estimates may be due to differing methodologies, temporal changes in diagnostic test availability or accuracy, an increased awareness of CanL or a true increase in CanL prevalence over time. In both studies, greater numbers of responses were received from departments in South-East France, where CanL was observed to be most prevalent. Consequently, the national estimate of 0.71% may be an overestimate and the mean regional estimate was likely to represent a better estimate of the burden of disease. Furthermore, the large difference between the regional median and mean prevalence estimates reflects that the regional prevalence estimates of CanL were highly skewed, with the majority of regions in France experiencing very low levels of disease.

The benchmarking data estimated that 0.05% of practice-attending dogs were treated for or euthanased with CanL in France. This was based on invoice data relating to CanL treatments or euthanasia following testing and was much lower than the estimates calculated from the online questionnaire. This case-finding method would not have detected CanL cases prescribed treatments other than allopurinol, meglumine antimoniate and miltefosine or therapies sold and dispensed that were not entered onto the clinics’ practice management systems. Moreover, dogs receiving treatment purchased from human or online pharmacies that were not invoiced via the participating practice would not have been included as cases. Despite this limited sensitivity, the geographical distribution of cases followed a similar pattern to the questionnaire data.

Veterinary-diagnosed CanL was observed to have a relatively high prevalence in dogs attending practices in all responding regions in Greece. However, there were low numbers of responses from regions outside of Athens resulting in imprecise estimates. In Italy, the regions of Sicily, Piedmont and Liguria had the highest prevalence of CanL, whereas the North-East regions had low levels of disease. Previous studies on owned dogs in coastal and Southern Italy generally reported higher CanL seroprevalence estimates (Zaffaroni et al., 1999; Cringoli et al., 2002; Rossi et al., 2008) compared with a study conducted in Northern continental regions (Maroli et al., 2008). In contrast to the results in the current study, Ferroglio et al. (2005) detected a low prevalence of CanL infection in the region of Piedmont. The prevalence of CanL in Portugal appeared to be highest in parts of Central Portugal and lowest in the north consistent with the results of a recent national survey (Cortes et al., 2012). The frequency of CanL cases was highest in the South-East and lowest in
the North and West of Spain, largely compatible with existing seroprevalence studies (Morillas et al., 1996; Amusategui et al., 2004; Alonso et al., 2010).

The online questionnaire estimates were based on veterinary-diagnosed cases of CanL seen at private veterinary clinics. Due to different clinical approaches, specific criteria for the case definition (e.g. specific clinical signs, serology results exceeding a certain titre) were not specified in the questionnaire. The local prevalence estimates would have depended on factors including the clinical acumen of the veterinary practitioners, the proportion of sus-

---

Please cite this article in press as: M.J. Mattin, L. Solano-Gallego, S. Dhollander, A. Afonso, D.C. Brodbelt, The frequency and distribution of canine leishmaniosis diagnosed by veterinary practitioners in Europe, The Veterinary Journal (2014), doi: 10.1016/j.tvjl.2014.03.033
pected cases that underwent investigations and the characteristics of the diagnostic techniques adopted.

The travel history of the dogs with CanL was not collected, so it was not possible to speculate where the infections were acquired. Further, although it is likely that a high proportion of veterinary case-loads consist of client-owned dogs, the living conditions of the dogs were not recorded; the prevalence of CanL in client-owned dogs may differ to that of stray dog populations. In order to calculate the number of dogs seen annually, it was assumed that a dog attended a clinic three times per year based on data from benchmarking companies in France and Spain (P. Mercader, T. Richard, personal communication). It was assumed that this figure would be similar for all the studied countries. If the mean number of annual visits per dog was under- or overestimated for a country, this would have impacted on the prevalence estimate. Furthermore, the generalisation of these estimates to the wider dog population will depend on the proportion of the entire dog population that attend veterinary clinics in each country.

Generally, the impact of the economic crisis on the use of CanL prophylaxis, diagnostics and treatments was considered to be higher in Spain, Greece and Portugal than France and Italy, consistent with the reported magnitude of economic hardship of the respective countries. If disease control measures were relaxed or treatment plans were suboptimal, this may have both animal welfare and public health implications.

The frequency of Google searches for CanL followed the pattern of searches for leishmaniosis. Peaks in Italy appeared to correspond to news headlines and follow a seasonal pattern. The term ‘leishmaniosis’ rather than ‘canine leishmaniosis’ was selected to generate maps showing the spatial distribution of web interest, as a greater number of searches were performed for the more general term than for the canine-specific term. Although a proportion of these searches may have been relating to the human form of the disease, the levels of web interest in the two search terms appeared to be correlated. The geographical distribution of web search interest in France, Italy and Spain broadly followed the patterns identified by the online questionnaire and the benchmarking data. Although GT normalises the data to compensate for differences in population size, to be effective, a large population of Google users is necessary (Carneiro and Mylonakis, 2009). The relatively small populations in Portugal and Greece may explain why limited and no regional results were generated for these countries respectively.

Conclusions

CanL was a relatively common clinical diagnosis in veterinary clinics in many regions of France, Greece, Italy, Portugal and Spain. CanL had a heterogeneous spatial distribution as evidenced from veterinary questionnaire data, French benchmarking data and internet web interest. The current economic climate may have an adverse impact on the prevention and treatment of CanL, which could subsequently influence the future epidemiology of the disease. There is therefore a major need for the routine collection of epide-


miological data from companion animals in the EU to be able to measure and respond to changes in disease frequency.

**Conflict of interest statement**

None of the authors of this paper has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

**Acknowledgements**

The authors would like to acknowledge the European Food Safety Authority (EFSA) for funding this work and EFSA scientific staff, Claire Wylie, Solenne Costard, Luis Espejo and Francisco Zagmutt for their valuable input. The authors would like to thank Nancy De Brinny for her help distributing the online veterinary questionnaire to FVE member associations. The authors are grateful to the following veterinary associations for promoting the questionnaire to their members: SNVL and AFAC (France), HCACS and HVA (Greece), PNOVI and SCIAC (Italy), OMV and APMEAC (Portugal) and CGCVC and AMVAC (Spain). The authors would also like to thank all the veterinary practitioners who responded to the survey and the following people who translated the questionnaires into the local languages: Aris Polyviou, Maria Ferrara, Alex Mattin, Ana Pascual, Luís Cardoso and João Sucena Afonso. The authors also acknowledge Thibault Richards for providing the benchmarking data and Pere Mercador for information relating to trends in Spanish practice attending animals. This manuscript has been approved by the Royal Veterinary College’s publications approval system in order to comply with Good Research Practice Policy on Publications (manuscript number PPH_00629). Dr. Laia Solano-Gallego holds a Ramón y Cajal senior researcher contract awarded by the Spanish Ministry of Economy y Competitividad and the European Social Fund.

**Appendix A: Supplementary material**

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.tvjl.2014.03.033

**References**

Alonso, F., Gimenez Font, P., Manchon, M., Ruiz de Ybanez, R., Segovia, M., Berriatua, ., 2011. Epidemiological data from companion animals in the EU to be able to measure and respond to changes in disease frequency.

**Conflict of interest statement**

None of the authors of this paper has a financial or personal relationship with other people or organisations that could inappropriately influence or bias the content of the paper.

**Acknowledgements**

The authors would like to acknowledge the European Food Safety Authority (EFSA) for funding this work and EFSA scientific staff, Claire Wylie, Solenne Costard, Luis Espejo and Francisco Zagmutt for their valuable input. The authors would like to thank Nancy De Brinny for her help distributing the online veterinary questionnaire to FVE member associations. The authors are grateful to the following veterinary associations for promoting the questionnaire to their members: SNVL and AFAC (France), HCACS and HVA (Greece), PNOVI and SCIAC (Italy), OMV and APMEAC (Portugal) and CGCVC and AMVAC (Spain). The authors would also like to thank all the veterinary practitioners who responded to the survey and the following people who translated the questionnaires into the local languages: Aris Polyviou, Maria Ferrara, Alex Mattin, Ana Pascual, Luís Cardoso and João Sucena Afonso. The authors also acknowledge Thibault Richards for providing the benchmarking data and Pere Mercador for information relating to trends in Spanish practice attending animals. This manuscript has been approved by the Royal Veterinary College’s publications approval system in order to comply with Good Research Practice Policy on Publications (manuscript number PPH_00629). Dr. Laia Solano-Gallego holds a Ramón y Cajal senior researcher contract awarded by the Spanish Ministry of Economy y Competitividad and the European Social Fund.

**Appendix A: Supplementary material**

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.tvjl.2014.03.033

**References**

Alonso, F., Gimenez Font, P., Manchon, M., Ruiz de Ybanez, R., Segovia, M., Berriatua, ., 2011. Epidemiological data from companion animals in the EU to be able to measure and respond to changes in disease frequency.