REVIEW

Epidemiology and management of foodborne nematodiasis in the European Union, systematic review 2000–2016

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ABSTRACT

Background: Foodborne nematodiasis are caused by the ingestion of food contaminated by helminths. In Europe, these diseases are present in all countries.

Objectives: To review the available data on epidemiology and management of foodborne nematodiasis in the European Union, detect any trends and determine the possible causes of the observed changes.

Methods: A review of available literature published between 2000 and 2016 was conducted.

Results: Out of 1523 cases described in the literature, 1493 cases were autochthonous and 30 cases were imported. The detected parasites were *Toxocara spp* (34.7%), *Ascaris lumbricoides* (27.1%), *Trichinella spp* (21.9%), *Anisakis spp* (15.5%) and *Angiostrongylus cantonensis* (0.8%).

Conclusions: Foodborne nematodiasis remains a public health challenge for the European Union. Autochthonous cases of nematodiasis present the greatest health risk within the European Union. Foodborne nematodes due to lack of hygiene in food processing are diseases that can be avoided by increasing

KEYWORDS

Foodborne; nematodiasis;
Europe; zoonosis

Introduction

Foodborne nematodiasis infections affect millions of people each year and are a major global concern [1]. Globalization has introduced new eating habits resulting in new fresh foods being consumed. Therefore, the import of foods is now necessary to satisfy consumer demands for exotic meats, vegetables, and fruits. Transportation and new methods of cooking are a risk to public health. Asymptomatic carriers and the zoonotic potential of some parasites contribute to the spread of pathogens and misdiagnoses of parasitic infections are very common [2].

Foodborne nematodiasis are infections acquired following the consumption of raw or improperly cooked food, such as meat, snails, seafood, freshwater fish and aquatic invertebrates containing various nematodes in an infective stage [3]. Contaminated water and various kinds of aquatic vegetation may also contain nematodes [1]. The consumption of raw or undercooked cooked food is commonplace in many parts of the developing world, while in developed countries the consumption of such foods has steadily increased [1].

There are concerns about these infections in the European Union, due to possible cases of imported infections, local infections that may have been acquired from tainted imported foodstuff and infections acquired within the European Union due to the presence of

infected intermediate hosts imported from endemic areas [4].

The purpose of this review is to provide information on imported and local cases of foodborne nematodiasis in the European Union between 2000–2016: number of detected cases, country of diagnosis, main symptoms, date of publication, first author field of activity, diagnosis, treatment and case diagnosis certainty.

Nematodes are probably one of the most abundant and widespread of all animal groups, occurring in the sea, freshwater, and soil and as parasites of vertebrates, invertebrates and plants [5]. The chosen organisms for this study are various species nematodes in the genera *Anisakis* (Dujardin, 1845), *Trichinella* (Raillet 1895), *Angiostrongylus* (Kamensky 1905), *Toxocara* (Werner 1782) and *Ascaris* (Linnaeus 1758).

Anisakis spp

Anisakiasis is caused by the ingestion of larval nematodes of the Anisakidae family. Humans acquire the infection by eating raw, salted, marinated or undercooked seafood. Human infection is accidental and humans are not suitable hosts for these parasites. No multiplication occurs in human [6].

Avoiding the consumption of raw or undercooked fish can prevent Anisakiasis. Sushi, ceviche, and sashimi

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should be consumed from fish that has undergone inspection for infective larvae. Cooking fish to an internal temperature of 60°C for 1 minute or 65°C for 30 seconds or freezing at –20°C or below for at least 60 hours can destroy this larva [7].

Trichinella spp

Trichinella spp is one of the most important parasites of this study; it is associated with the ingestion of game meats and sausages that are not properly cooked.

Trichinellosis is both a public health and economic problem. *Trichinella* may live in a very wide variety of host species however, only humans are clinically affected [8]. Apart from its effects on human health, it seriously affects the porcine agricultural industry due to the fact that the domestic pig is the most important source of human infection worldwide. In recent outbreaks in Europe, horses and wild boars have also played significant roles as sources of infection [9]. The spread of Trichinellosis may be avoided by eliminating the feeding of pigs using infected or possibly infected meats. The increased movement of both people and livestock to appease the currents demands of globalization exacerbates the risk of disease dissemination [9].

According to the Commission Implementing Regulation (EU) 2015/1375 of 10 August 2015, this disease can be prevented by the thorough cooking of meats to an internal temperature of 60°C or higher. Freezing times and temperatures depend on the thickness of the product. The temperature of freezing must never be less than –15°C for 20 days when the thickness of the piece is less than 15cm or –15°C for 30 days if the thickness is between 15 and 50 cm.

Angiostrongylus cantonensis

Angiostrongylus cantonensis can normally be found in rat lungs. Both rats and humans may become infected the same way, by eating contaminated foods such as snails or uncooked vegetables [10].

Diagnosis is difficult and involves a history of exposure in an endemic area. An elevated cerebrospinal fluid (CSF) eosinophilia along with serologic testing will confirm infection.

Avoidance of uncooked or undercooked snails and transport hosts is the best way to prevent infection, as well as washing or cooking all food items that may have been contaminated by slug secretions [2].

Toxocara spp

Toxocariasis caused by either *Toxocara canis* or *Toxocara cati* can be found worldwide. The most common way for humans to become infected is by

consuming contaminated plants or invertebrates that live in contaminated soils [2]. The normal source of contamination is dog or cat feces. The consumption of infected chickens, cattle and sheep may also lead to infection but this transmission is much less frequent [2].

Children are the main infected group. Behaviors common in children such as geophagia or poor personal hygiene as well as close contact with young dogs increases the risk of infection [11].

Ascaris lumbricoides

Ascaris lumbricoides has a direct life-cycle, inhabiting the intestinal tract as adults and producing eggs that are voided to the external environment with the feces. It is transmitted passively within the egg, being ingested by the host as a result of fecal contamination of food or lack of hygiene. The occurrence of *Ascaris lumbricoides* usually peaks in childhood or early adolescence. Infection may produce some degree of impaired cognitive function in children [12].

Methods

A review of the indexed literature on foodborne nematodiasis observed in the European Union and published during the period 2000–2016 was conducted.

This study follows a methodology similar to previous studies [4] but our study covers a larger number of parasites and clinical cases. A literature search was performed first to identify articles possibly apt for inclusion. This was followed by a screening process to assure selected articles met all inclusion criteria. Data was then extracted from the articles for analysis and discussion.

In addition, this paper informs about the current situation of the recent epidemiological data of foodborne nematodes in the European Union.

The investigation covered the 28 current member states of the European Union, namely Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom.

Search

The following search strategy was adopted in PubMed, SciELO, Google Scholar and PLOS: (Angiostrongyl* OR Anisakis* OR Ascaris* OR Toxocar* OR Trichinell* OR Nematod*) AND (Austria OR Belgium OR Bosnia OR Bulgaria OR Croatia OR Cyprus OR Czech Republic OR Denmark OR Estonia OR Finland OR France OR Germany OR Greece OR Hungary OR Ireland OR Italy

OR Latvia OR Lithuania OR Luxembourg OR Malta OR Netherlands OR Poland OR Portugal OR Romania OR Slovakia OR Slovenia OR Spain OR Sweden OR United Kingdom OR Europe) AND (Humans[Mesh] AND ("2000/01/01"[PDAT]: "2016/10/31"[PDAT])). **Figure 1** shows the Search Strategy.

Selection

The authors screened articles found by electronic search and evaluated their appropriateness based on title and abstract according to the established exclusion criteria. Exclusion criteria were: 1) studies concerning the wrong agent (for example helminthiasis but not nematodiasis or not the selected nematodes); 2) reviews, letters or editorials without original data; 3) studies concerning animals only; 5) studies of European investigator outside the continent; 6) duplicated data.

Extraction

Data from epidemiological studies were summarized, while data from case reports and case series were extracted using a standardized electronic form in which the main characteristics of study, clinical and epidemiological features of subjects with foodborne nematodiasis were recorded. The form included all the information needed to ascertain whether cases satisfied the definition of definitive, probable or possible case (reported below).

Cases of food-borne nematodiasis retrieved by the search were classified according to the following definitions:

- Definitive or probable case of food-borne nematodiasis. Definitive cases were defined as those where the clinical manifestations of the patient fit with nematodiasis and nematodes were observed

in a biological sample taken from the patient. Probable cases were defined as those where nematodes were not able to be observed in biological samples but were diagnosed as nematodiasis due to the clinical presentation of the patient.

- Autochthonous case (case diagnosed in a subject without a history of travel to or living in high endemic regions) or imported case (case diagnosed in a subject with a history of travel or long stay in an endemic region (Latin America, Asia or Africa)).

Results

The flow diagram in **Figure 2** shows the number of papers identified in each database and the review process. Out of 134-screened documents, 94 were included. Out of 1523 cases described in the 94 papers included in the analysis, 1493 cases were autochthonous and 30 cases were imported.

Table 1 shows the cases detected in this study of the nematodiasis in the European Union. The main countries involved in this parasitosis are Estonia, Romania, Poland and Spain.

Angiostrongylus cantonensis

Information on angiostrongyliasis originated from 5 papers. No cases were reported in the period between 2000 and 2005. All detected cases [12] in the European Union were imported, either from Cuba, the Philippines, Thailand or Samoa. Five (41.6%) cases were diagnosed only by the clinical history meaning a probable diagnostic [13]; the rest were diagnosed by serology (41.67%) [14,15] and Polymerase Chain Reaction (PCR) (16.66%) [16]. Clinical manifestations develop between 2 to 35 days after the ingestion of larvae [14]. Patients may

Figure 1. Flow diagram showing the search strategy of the study.

Figure 2. Flow diagram showing the number of papers identified in each database and the review process.

present neurologic symptoms as photophobia or diffuse paraesthesia in the arms and legs [13,16]. Table 2 shows the results for this parasite.

Anisakis spp

A total of 236 cases were detected, all of them autochthonous and definitive diagnostic.

In 62 patients the authors explicitly specified that the infection was produced by ingesting anchovy (*Engraulis encrasicolus*). In the rest of the cases, this data was not available. The country with the highest number of cases was Spain with 158 (6.9%) [17,18] and the second was Italy with 67 (28.4%) cases [19,20].

Table 1. Autochthonous and imported cases of Foodborne nematodiasis in the European Union by country of diagnosis (2000–2016).

Number of cases	Autochthonous 1493/1523 (98.03%)	Imported 30/1523 (1.97%)
Country of diagnosis		
Austria	3	-
Belgium	28	1
Bulgaria	16	-
Croatia	2	-
Cyprus	1	-
Czech Republic	8	-
Denmark	79	3
Estonia	299	-
Finland	1	-
France	11	5
Germany	19	4
Greece	-	2
Hungary	57	-
Ireland	-	1
Italy	71	2
Latvia	45	-
Lithuania	1	-
Luxembourg	84	-
Malta	-	-
Netherlands	-	2
Poland	211	-
Portugal	8	-
Romania	260	-
Slovakia	1	-
Slovenia	67	-
Spain	212	-
Sweden	-	9
United Kingdom	9	1

One of the outbreaks was originated by the consumption of Peruvian food 'ceviche' [21]. Serology is the most common diagnosis method (86.44%) but some patients are diagnosed by exploratory laparotomy (2.97%) [22,23] or gastroscopy (10.17%) [24,25]. Table 3 shows the results for this parasite.

Ascaris lumbricoides

Only six (1.46%) imported cases were detected of ascariasis [26,29] compared to 406 autochthonous cases (98.54%). Patients may present gastrointestinal bleeding [30] and intestinal necrosis [31]. The main symptom is abdominal pain (43.47%) [28,32,35]. The

Table 2. Selected studies reporting autochthonous and imported cases of angiostrongyliasis in the European Union (2000–2016, [13,14,15,16, 55]).

	- Undercooked snails or slugs - Vegetables contaminated - Paratenic host (freshwater shrimp and crab)
Origin of the infection	
Number of cases	12
Autochthonous/Imported	Imported 12/12 (100%)
Date of publication	
2000–2005	-/12 (0%)
2006–2011	7/12 (58.33%)
2011–2016	5/12 (41.67%)
First author field of activity	
Tropical Medicine	5/12 (41.66%)
Microbiology	3/12 (25%)
Neurology	2/12 (16.67%)
Travel Medicine	2/12 (16.67%)
Case diagnostic certainty	
Definitive	7/12 (58.33%)
Probable	5/12 (41.67%)
Main symptoms	
Headache	10/28 (35.71%)
Paresis	8/28 (28.57%)
Photophobia	6/28 (21.43%)
Fever	4/28 (14.29%)
Diagnosis	
Serology	5/12 (41.67%)
Medical History	5/12 (41.67%)
PCR	2/12 (16.66%)
Treatment	
Anthelmintic	12/12 (100%)

Table 3. Selected studies reporting autochthonous and imported cases of anisakiasis in the European Union (2000–2016, [17,18,19,20,21,22,23,24,25,54,60,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81]).

Origin of the infection	Raw or undercooked fish
Number of cases	236
Autochthonous/Imported	Autochthonous 236/236 (100%)
Date of publication	
2000–2005	65/236 (27.54%)
2006–2011	151/236 (63.98%)
2012–2016	20/236 (8.48%)
First author field of activity	
Parasitology	86/236 (36.44%)
Surgery	60/236 (25.42%)
Dermatology	49/236 (20.76%)
Allergy	10/236 (4.24%)
Infectious Diseases	10/236 (4.24%)
Gastroenterology and Endoscopy	10/236 (4.24%)
Family Medicine	4/236 (1.71%)
Epidemiology	3/236 (1.27%)
Cardiology	2/236 (0.84%)
Pathology	1/236 (0.42%)
Radiodiagnosis	1/236 (0.42%)
Case diagnostic certainty	
Definitive/Probable	Definitive 236/236
Main symptoms	
Pruritus	92/250 (36.8%)
Abdominal pain	83/250 (33.2%)
Cutaneous	59/250 (23.6%)
Vomit	7/250 (2.8%)
Diarrhea	5/250 (2%)
Chest pain	2/250 (0.80%)
Fever	2/250 (0.80%)
Diagnosis	
Serology	204/236 (86.44%)
Gastroscopy	24/236 (10.17%)
Exploratory laparotomy	7/236 (2.97%)
PCR	1/236 (0.42%)
Treatment	
Symptomatic	131/236 (55.50%)
Surgical	103/236 (43.65%)
Surgical+Symptomatic	2/236 (0.85%)

coprological examination is the most important tool for diagnosis (66.5%).

The countries with more cases detected were Romania (41.01%) [36] and Luxembourg (20.38%) [37]. Table 4 shows the results for this parasite.

Toxocara spp

The species included in this nematodiasis are not clarified, in the 55.5% of the papers the infection was caused by *Toxocara canis*, in the rest of the papers (44.5%), the authors did not specify the species of *Toxocara*.

All the cases detected were autochthonous. The country with the highest prevalence of the parasite infection was Poland with 190 (35.9%) cases detected [38], followed by Denmark (14.9%) [39] and Slovenia (12.6%) [40]. Table 5 shows the results for this parasite.

Trichinella spp

The species of *Trichinella* analyzed were *Trichinella britovi* in 17.9% of cases, *Trichinella spiralis* in 7.8% and *Trichinella pseudospiralis* in 1.2%. For the rest of the cases (73.1%), the authors did not specify the species of *Trichinella*.

Table 4. Selected studies reporting autochthonous and imported cases of ascariasis in the European Union (2000–2016, [26,27,28,29,30,31,32,33,34,35,36,37,57,58,82,83,84,85,86,87,88,89]).

Origin of the infection	Food or water contaminated with fecal matter containing eggs
Number of cases	412
Autochthonous	406/412 (98.54%)
Imported	6/412 (1.46%)
Date of publication	
2000–2005	6/412 (1.45%)
2006–2011	8/412 (1.95%)
2012–2016	398/412 (96.6%)
First author field of activity	
Pharmacy	169/412 (41.02%)
Veterinary	129/412 (31.31%)
Microbiology	84/412 (20.39%)
Tropical Medicine	13/412 (3.16%)
Family Medicine	7/412 (1.7%)
Surgery	4/412 (0.97%)
Gastroenterology and Endoscopy	3/412 (0.73%)
Radiodiagnosis	2/412 (0.48%)
Infectious Diseases	1/412 (0.24%)
Case diagnostic certainty	
Definitive/Probable	410/412 (99.51%)
Probable	2/412 (0.49%)
Main symptoms	
Abdominal pain	10/23 (43.47%)
Vomit	4/23 (17.39%)
Asymptomatic	3/23 (13.04%)
Weight loss	2/23 (8.7%)
Fever	2/23 (8.7%)
Diarrhea	2/23 (8.7%)
Diagnosis	
Coprological examination	274/412 (66.50%)
Serology	127/412 (30.82%)
Gastroscopy	3/412 (0.73%)
Exploratory Laparotomy	3/412 (0.73%)
CT findings	3/412 (0.73%)
Colonoscopy	2/412 (0.49%)
Treatment	
Anthelmintic	412/412 (100%)

Twelve (3.6%) cases were imported from: Spain (eight cases) [41], Montenegro (two cases) [42] Poland (one case) [43] and Bosnia and Herzegovina (one case) [44]. The rest of cases were autochthonous (96.4%).

The autochthonous cases (96.4%) were distributed among twelve countries. The main countries were Romania with 91 (28.3%) cases[45], Hungary with 57 (17.7%) cases[46], Spain with 46 (14.3%) cases [47], Germany with 17 (5.3%) cases[48] and Bulgaria with 16 (5%) cases[49]. 7.4% of cases were asymptomatic[47]

In 35 (10.48%) patients the diagnostic included a PCR of food sample [41,48,50,52]. Table 6 shows the results for this parasite.

Discussion

This review has more cases of parasitism detected than other previous similar studies[4] and contains current information.

Table 5. Selected studies reporting autochthonous and imported cases of toxocariasis in the European Union (2000–2016, [11,38,39,40,90,91,92,93,94,95,96,97,98,99,100,101,102]).

Origin of the infection	Food or water contaminated with fecal matter containing eggs
Number of cases	529
Autochthonous/Imported	Autochthonous 529/529 (100%)
Date of publication	
2000–2005	76/529 (14.36%)
2006–2011	87/529 (16.45%)
2012–2016	366/529 (69.19%)
First author field of activity	
Parasitology	154/529 (29.11%)
Veterinary	145/529 (27.41%)
Pediatrics	103/529 (19.47%)
Infectious Diseases	84/529 (15.88%)
Tropical Medicine	28/529 (5.29%)
Microbiology	8/529 (1.51%)
Ophthalmology	3/529 (0.57%)
Surgery	2/529 (0.38%)
Neurology	1/529 (0.19%)
Family Medicine	1/529 (0.19%)
Case diagnostic certainty	
Definitive/Probable	Definitive 529/529 (100%)
Main symptoms	
Eye injury	79/171 (46.2%)
Abdominal pain	33/171 (19.3%)
Atopy	23/171 (13.45%)
Headache	13/171 (7.6%)
Fever	12/171 (7.02%)
Asymptomatic	5/171 (2.93%)
Vomit	2/171 (1.17%)
Cough	2/171 (1.17%)
Weight loss	1/171 (0.58%)
Diarrhea	1/171 (0.58%)
Diagnosis	
Serology	528/529 (99.81%)
Endoscopy	1/529 (0.19%)
Treatment	
Anthelmintic	529/529 (100%)

Also, we have detected more cases of parasitism in the last years in Spain than previous studies in larger countries such as the USA in the same period of time [1].

Advances in the diagnosis of these diseases could explain the increase in cases detected [53,54] although we also suggest that the globalization of exotic food and changes in eating habits may have an important effect [21].

We have found the results of our findings of the epidemiology of foodborne nematodiasis in Europe suggest that these diseases are high risk and have an important impact on public health. Migration and travel do not appear to be particular risk factors for most of the investigated diseases as most cases found were autochthonous. However, all cases of nematodiasis by *Angiostrongylus cantonensis* were imported so therefore for this particular parasitosis, migration and travel do seem to play an important role.

Angiostrongylus cantonensis is endemic in Southeast Asia and the Caribbean. In Europe, this disease does not appear unless it is imported. Globalization has increased the number of European

Table 6. Selected studies reporting autochthonous and imported cases of trichinellosis in the European Union (2000–2016, [41,42,43,44,45,46,48,49,50,51,52,61,103,104,105,106,107,108]).

Origin of the infection	Raw or undercooked meat
Number of cases	334
Autochthonous	322/334 (96.4%)
Imported	12/334 (3.6%)
Date of publication	
2000–2005	67/334 (20.06%)
2006–2011	238/334 (71.26%)
2012–2016	29/334 (8.68%)
First author field of activity	
Parasitology	171/334 (51.2%)
Infectious Diseases	53/334 (15.87%)
Family Medicine	51/334 (15.27%)
Veterinary	27/334 (8.08%)
Epidemiology	17/334 (5.09%)
Pathology	8/334 (2.39%)
Neurology	4/334 (1.2%)
Microbiology	2/334 (0.6%)
Surgery	1/334 (0.3%)
Case diagnostic certainty	
Definitive/Probable	Definitive 334/334 (100%)
Main symptoms	
Fever	164/620 (26.45%)
Myalgia	137/620 (22.1%)
Oedema	126/620 (20.32%)
Asthenia	117/620 (18.87%)
Asymptomatic	46/620 (7.42%)
Diarrhea	24/620 (3.87%)
Headache	5/620 (0.81%)
Abdominal pain	1/620 (0.16%)
Diagnosis	
Serology	299/334 (89.52%)
Serology + PCR of food sample	35/334 (10.48%)
Treatment	
Anthelmintic	334/334 (100%)

tourists attracted by distant and exotic countries [16] where parasites, such as *A. cantonensis* are endemic. This is why we suggest that the number of cases imported into Europe of this parasite has increased. When the infection appears in children, it is usually associated with the child eating or playing with the intermediate host [13].

This helminth is responsible for the majority of eosinophilic meningitis cases worldwide [55]. *A. cantonensis* meningitis may be suspected if the patients has consumed possibly contaminated foods and by the patient's clinical presentation [14]. Eosinophilic pleocytosis of the cerebrospinal fluid can also aid in the diagnosis [14].

Toxocara spp is the parasite with the highest number of cases in our study, with the highest geographical prevalence in Poland [11,38]. More than half of the cases are in children and the infection of this parasite is attributed to lack of hygiene along with contact with the intermediary hosts. The diagnosis of human toxocariasis is confirmed through the assessment of clinical symptoms and the detection of blood eosinophilia and circulating immunoglobulin G (IgG) antibodies to *Toxocara* excretory–secretory antigens [56].

Ascaris lumbricoides infection affects 25% of world population [57]. In the case of *Ascaris lumbricoides*, more than 40% of the cases occur in children [36,58] and it is a parasite which exhibits monoxenous

development and in which the infection occurs only due to lack of hygiene. Diagnoses are made by coprological identification, serology, CT findings and clinical history. Incidental diagnosis occurs when the host passes a worm in the stool or vomit [29].

Because of the worldwide popularization of exotic food, the traditional Asian fish dishes are served in restaurants and prepared by consumers. These recipes include raw fish and are a risk of infection. Anchovies are a fish that produces many infections [59]. Also, consumption of marinated anchovies in the European Union should be cautioned, in Italy, is the main source of anisakiasis [60].

Trichinella spp is the most important parasite of this study from a public health point of view. It is a parasite that causes a very aggressive clinical picture and can cause the death of the host. Its transmission would be avoidable if the current European legislation regarding meat processing was adhered to. Outbreaks of this parasitic infection occur when meat from hunted animals is consumed [41] or when corresponding laws are not complied with [61]. As shown in Table 6, trichinellosis does not decrease over the years and the detected cases oscillated; therefore, it is not a controlled disease. To avoid the presence of *Trichinella* in meat intended for human consumption, areas, where wildlife and livestock holdings coexist, should be subject to a strict monitoring program.

When analyzing the results of this study, the limitations present must be taken into consideration. First, it is possible to not have included all available relevant literature that met the inclusion criteria in the study, mainly due to a lack of accessibility given that the search was restricted to studies published in English or Spanish available through PubMed, SciELO, Google Scholar and PLOS. Publication bias may also be one of the limitations of this study since it is believed that studies with positive results are more widely distributed than those without significant results or negative ones.

Conclusion

Considering both autochthonous and imported cases, parasitologists, pharmacists, veterinary and podiatrist were the most often involved professionals in the treatment and care of people with foodborne nematodiasis in Europe. The large number of different specialists involved suggests the need for knowledge in different settings in order to properly manage foodborne nematodiasis.

Travel Medicine is specialized in the detection of these cases. It is of great importance the clinical history in the diagnosis of non-endemic parasitosis since without it the symptomatology can lead us to a wrong diagnosis.

The data collected in this study show the set of number of cases of foodborne nematodiasis. Changes in eating habits and the effect of globalization may increase infected patients. For good management of these nematodiasis infections it is necessary to increase the control of food processing and to respect the laws that control food. Foodborne nematodes due to lack of hygiene in food processing are diseases that can be avoided by increasing the information to consumers. The high number of cases collected and the description of medical cases are an excellent tool for clinicians and doctors responsible for the diagnosis and treatment of these currently underdiagnosed diseases.

The methods used for this study could be adapted to estimate the proportion of illnesses attributable to other helminthiasis and the estimates from this study can be used to help direct policy and interventions and conduct other analyses.

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