

ORIGINAL ARTICLE

Human *Trichinellosis* in Italy: an epidemiological review since 1989

G. TROIANO, N. NANTE

Department of Molecular and Developmental Medicine, University of Siena, Italy

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Summary

Objectives. *Trichinellosis* is a worldwide zoonosis caused by a nematode of the genus *Trichinella* that can pose a risk to human health. Among the species of *Trichinella*, *T. Spiralis* is the most common represented. The main source of human infection is the consumption of raw or undercooked meat (especially from pigs, wild boars and horses). Infection with *Trichinella* was one of the most frequent parasitic diseases in Italy until 1959 when obligatory screening for these parasites in slaughtered swines was introduced. As the last review on this topic was performed in 1989, the aim of our study was to describe the epidemiology of *Trichinellosis* in Italy from 1989 to 2017.

Study design. We performed a systematic research in Pubmed (MEDLINE).

Methods. We included in our review studies that were published in the peer reviewed literature using the MESH terms “*Trichinellosis*” and “Italy”. The only restrictions were the language (articles should be in English, Italian, Spanish or French) and the date of publication: from 1989 to March 2017. We excluded all the articles which referred to *trichinellosis* in the animals or which

focused only on molecular biology of *trichinella* or on diagnostic techniques.

Results. We found 56 studies, but only 8 were considered eligible. During the study period, 764 cases of *Trichinellosis* occurred in Italy: 13.7% caused by *T. Britovi* and 84.4% by *T. spiralis*; in 14 cases the identification of the parasite was not performed. The outbreaks occurred in Umbria, Piedmont, Apulia (500 cases in 1990, by *T. spiralis*), Basilicata, Tuscany, Abruzzo, Emilia Romagna, Sardinia. In 2001 and in 2008 two outbreaks occurred in Lazio and Veneto respectively, but imported from abroad. The most important sources of infections were: horse meat (82.2%); wild boar meat (11.9%); pig meat (5.9%).

Conclusions. *Trichinellosis* is still present in Italy, but often forgotten by general practitioners and infectious diseases specialists. It's pivotal to improve awareness about this parasitic disease in Physicians and veterinarians. A strict surveillance, especially on meat products from endemic countries or from wild animals is necessary to considerably reduce the risk of acquiring the infection.

Introduction

Trichinellosis is a worldwide antrozoosis [1-3]; it is spread in a lot of Countries of Europe, South-East Asia, North and South America, New Zealand and North Africa. Outbreaks have been reported in 55 countries with an annual global average of 5,751 cases and five deaths [4]. According to the epidemiological data of the European Centre for Disease Prevention and Control (ECDC), *Trichinellosis* is most prevalent in eastern Europe but also in Italy and Spain where outbreaks have been reported in the past 10 years [5]. The parasite has a wide host spectrum due to its ability to virtually infect all mammals, birds and reptiles, depending on the involved *Trichinella* species [6]. *Trichinella spiralis* is the species that most adapted to domestic and wild swine but its life cycle could also include synanthropic rats. *T. spiralis* exhibits a wide and global distribution [7]. *Trichinella britovi* is the most widely distributed species within sylvatic life cycles of Europe, Asia, and Northern and Western Africa [8]. *T. spiralis* and *T. britovi* can also affect domestic pig populations mainly via extensive grazing

systems or feed with scraps or carrion originating from sylvatic carnivores. Zoonotically, *T. britovi* is the second-most common species of *Trichinella* that may affect human health [7].

The incubation period for *Trichinellosis* symptoms is 7-21 days. Although an infected person may be asymptomatic, ingestion of a higher parasite load usually correlates with a shorter incubation period and with more severe symptoms. If clinical symptoms appear, they usually begin with several days of mild, non-bloody diarrhea, nausea, vomiting and abdominal discomfort. From 2 to 8 weeks later, host's immunologic reaction to larval migration into tissues can result in persistent fever, sweating, chills, periorbital edema, urticarial rash and conjunctival or sub-nails hemorrhages. Long-term effects depend on parasite load and site of infection. Myalgia is often present, and cardiac manifestations (e.g. myocarditis) may rarely occur later especially in moderate and severe cases. Eosinophilia is often substantial and early appears in the infection [9].

The main source of human infection is the consumption of raw or undercooked meat, especially from pig,

wild boar and horse [10, 11]. However, recently published studies described possible cases of human *Trichinellosis* linked also to other kinds of meat, such as beaver meat [12]. Infection with *Trichinella* species was one of the most frequent parasitic diseases in Italy until 1959, when obligatory screening for these parasites in slaughtered swine was introduced [13]. The last Guidelines for the surveillance, management, prevention and control of *Trichinellosis* reported (in the section related to the epidemiology in Italy) that only the sylvatic cycle (*T. britovi*) occurs among wildlife (e.g. red fox [*Vulpes vulpes*], wolf [*Canis lupus*], badger [*Meles meles*], marten [*Martes martes*], wild boar [*Sus scrofa*]) and the parasite is seldom transmitted to backyard or free-ranging pigs [14]. In the last 58 years, 13 backyard pigs were detected positive at the abattoir or were the source of infection for humans. *Trichinella pseudospiralis* has been documented once in two birds. Infections in humans have been documented from the consumption of pork from wild boar (*Sus scrofa*) or backyard and free-ranging pigs and meat from the red fox (*Vulpes vulpes*); however, the most important source of infection was horse meat imported from abroad [14]. The aim of our review was to describe the epidemiology of *Trichinellosis* in Italy, in order to continue the last review published in 1989 by De Carneri et al. [15].

Methods

In January-March 2017, we performed a systematic search for original peer-reviewed papers in the electronic database PubMed (MEDLINE). The key search Mesh terms were: “*trichinellosis*” AND “Italy”. Abstracts and full-text papers were reviewed. The inclusion criteria considered to include articles in the review were:

- Type of article: original articles, but also letters to the editor if containing original data.
- Language: articles should be written in English, Italian, Spanish or French.
- Publication date: articles should be published in the period 1989-2017 (because the last review was written in 1989).

We excluded all the articles which referred to *Trichinellosis* in animals or which focused only on molecular biology of *Trichinella* or on diagnostic techniques.

When available, we collected data on: 1) laboratory methods used to identify the cases and the *Trichinella* species; 2) number of confirmed cases; 3) *Trichinella* species; 4) source of infection.

Studies were selected in a 2-stage process. Titles and abstracts from electronic searches were scrutinised by 2 reviewers independently (G.T. and N.N.) and full manuscripts and their citations list were analysed to retrieve missing articles and to select the eligible manuscripts according to the inclusion criteria. The level of agreement between the reviewers was high. Disagreements were resolved by consensus. Then, each

article was further reviewed to identify the manuscripts suitable for our systematic review. The authors then extracted the data from included studies and collected them in a database for a unique analysis.

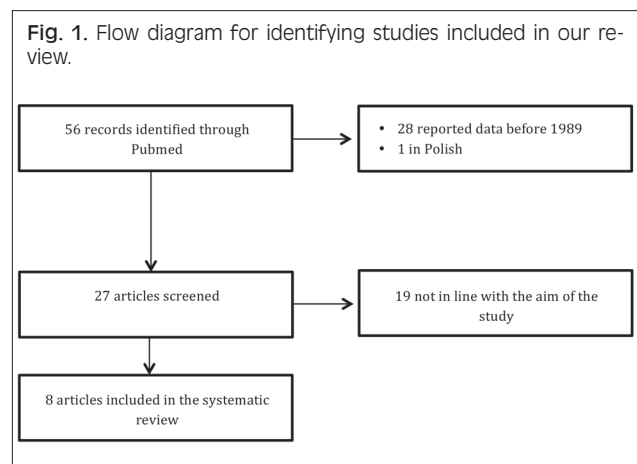
Results

The literature search yielded 56 publications. The titles, the abstracts and the full texts of these manuscripts were screened, resulting in 48 studies excluded because they didn't satisfy the inclusion criteria (28 because they reported data before 1989, 19 because they described animal cases of trichinellosis or were molecular biology studies about innovative techniques for the identification of the parasite; one was excluded because it was in Polish). Finally, we identified 8 manuscripts [10, 16-22] (Fig. 1). All the manuscripts reported data about human cases of trichinellosis, the geographical region and the year of the outbreak, and the source of infection. Two articles expressly reported the study design; 6 expressly reported the laboratory methods used to detect the parasite (ELISA or PCR).

The data collected from the 8 reviewed articles are shown in Table I (some original articles reported multiple data that we decided to report separately).

The total number of cases of human *Trichinellosis* in the last 25 years in Italy was 764 (Fig. 2).

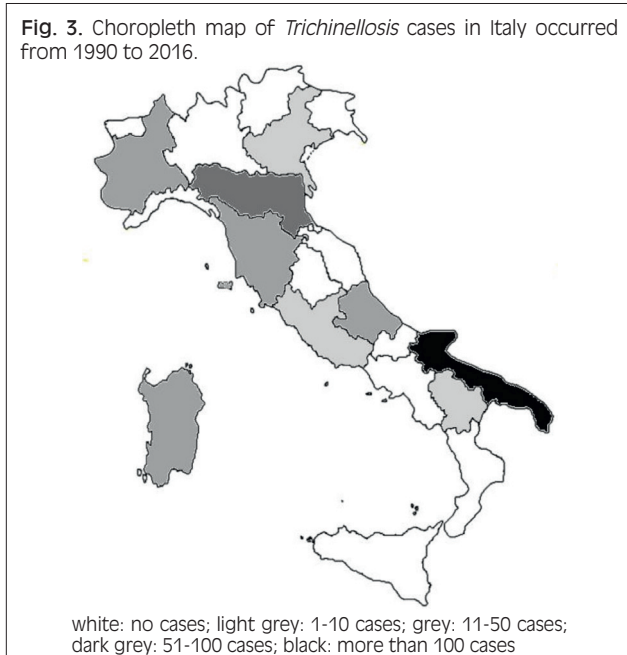
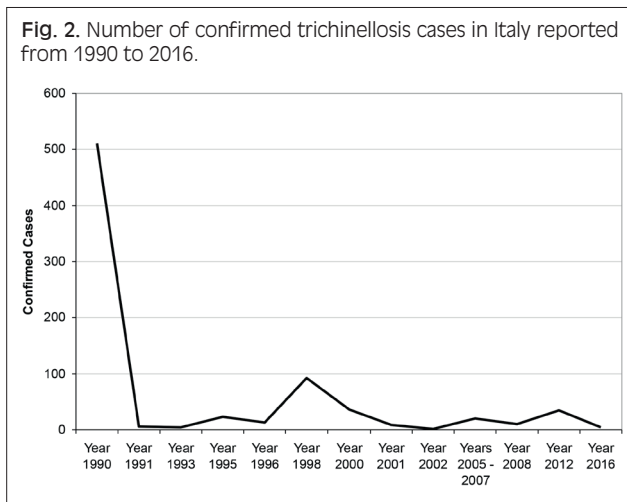
T. spiralis was responsible for 84.4% of the cases; *T. Britovi* was responsible for 13.7% of the cases, in 1.83% the laboratory identification of the parasite was not performed. The major sources of infections were: horsemeat (82.2%); wild boar fresh sausages (11.9%), meat from pigs slaughtered without any veterinary control (5.9%). The outbreaks occurred in Umbria, Piedmont, Apulia (500 cases in 1990, by *T. spiralis*), Basilicata, Tuscany, Abruzzo, Emilia Romagna, Sardinia. In 2001 and in 2008 two small epidemics happened in Lazio (N = 8) and Veneto (N = 4) respectively, but imported from abroad (Fig. 3).



Tab. I. Selected characteristics of the 8 studies included in the systematic review.

Period of outbreak	Place of outbreak	Diagnosis technique	Identification of <i>Trichinella</i> spp.	Source of infection	Infected toll (number of confirmed cases)	Source
1990	Piedmont	n/s	Spiralis	Wild Boar	11	[16]
1990	Apulia	n/s	Spiralis	Horse (imported)	500	[16]
1991	Basilicata	n/s	Britovi	Pig	6	[16]
1993	Tuscany	n/s	Britovi	Pig	4	[16]
1995	Abruzzo	n/s	Britovi	Wild Boar	23	[16]
1996	Abruzzo	n/s	Britovi	Wild Boar	10	[16]
1996	Basilicata	n/s	Britovi	Pig	3	[16]
1998	Emilia Romagna	n/s	Spiralis	Horse (imported)	92	[16]
2000	Apulia	n/s	Spiralis	Horse (imported)	36	[16]
2001	Lazio (imported)	ELISA	--	Pig	7+1	[21]
2002	Abruzzo	n/s	--	Wild Boar	2	[17]*
2005-2007	Sardinia	PCR/ELISA	Britovi	Pig	20	[18, 20]
2008	Veneto (Imported)	ELISA	--	Pig	4	[10]
2008	Piedmont	PCR/ELISA	Spiralis	Wild Boar	6	[19]
2012	Tuscany	PCR/ELISA	Britovi	Wild Boar	34	[17]
2016	Apulia	PCR/ELISA	Britovi	Wild Boar	5	[22]

n/s: not specified; *: unpublished data of Pozio et al. reported in the article.



Discussion

Our systematic review included 8 articles integrating all the available Italian data since 1990 till 2016 (the last published article on this topic, in 2017, reported data on an outbreak occurred in 2016) [22]. One of the most important limit of our review was the partially overlap between our results and those reported by Pozio et al. [16] that however was not a systematic review of the literature. According to our results, the number of reported cases of human *Trichinellosis* in the last 25 years in Italy was 764, but we can note a peak of incidence due to the outbreak in Apulia in 1990 (500 cases ascribed to horsemeat). *T. spiralis* was responsible for the 84.4% of the cases (but excluding the big epidemic occurred in 1990 this percentage dramatically falls), *T. Britovi* was responsible for 13.7% of the cases, in 1.8% the laboratory identification of the parasite was not performed. Scientific literature describes *T. britovi* as the most prevalent species, although cases from *T. spiralis* have also been reported [23]. In Italy, the most common etiological agent of infection is *T. Britovi*, which is maintained in nature by a sylvatic cycle in which the red fox (*Vulpes vulpes*) is the main reservoir [24]. The detection of specific anti-*Trichinella* antibodies in blood serum is of great diagnostic value and ELISA is the most commonly used approach for the detection of *Trichinella* infection in humans [7] whereas Real-time PCR is the most important and reliable assay for the identification of *Trichinella* species in muscle samples [25]. Only in some studies included in the review authors identified *Trichinella* species involved in the outbreak: this could be a limit for a complete epidemiological analysis of human *Trichinellosis* in Italy. It is known that cultural traditional habits of eating such foods play a key role in the spread of the disease and were responsible for past outbreaks [16]. Moreover, political and economic changes, could be responsible of increased prevalence and incidence (as described in

many former eastern European countries) especially because of a reduced efficacy of the veterinary control on susceptible production animals [7].

Our review has shown that the most important sources of infections were horsemeat (82.2%), wild boar fresh sausages (11.9%) and meat from pigs slaughtered without any veterinary control (5.9%), differently from that reported in the literature where the major source of infection is represented by insufficiently cooked pork products [26-31]. We have to consider that in our study 500 cases out of 764 was involved in Apulia-outbreak that was caused by horsemeat.

Our systematic review, therefore, adds some important information to the review of De Carneri et al. in 1989 [15]: before 1989, in Italy, the human infections were mostly caused by wild boar meat (11% of all cases) and by imported horse meat (43%), whereas the consumption of pork did not cause infection in men, as a result of a considerable reduction in foraging swine. Moreover *T. spiralis* was absent in Italy: only *Trichinella* species 3 (less pathogenic in men) was detected.

Our review demonstrated that after 1989, cases of pork-related *Trichinellosis* were identified, and that *T. Spiralis* resulted to be present in Italy (as demonstrated by the outbreaks occurred in 2008 [19], and in 1990 [16]).

The outbreaks occurred in Umbria, Piedmont, Apulia, Basilicata, Tuscany, Abruzzo, Emilia Romagna, Sardinia. In 2001 and in 2008 two small epidemics were described in Lazio and Veneto respectively, but imported from abroad. In 2001 the epidemics involved 7 immigrants from Eastern Europe who received a package containing smoked pork sausages as a present from their relatives. This unfortunate episode was similar to another one occurred in London among immigrants of another eastern European country after the consumption of infected sausages imported from their country of origin in December 1999 [21]. In 2008 a Romanian family living in Italy, during a visit to relatives and friends in Romania, ate ham produced from a pig slaughtered without any veterinary control [10]. As reported by R. Neghina in 2010, pork is the most frequent source of human *Trichinellosis* in Romania. "Pig's alms," a specific custom representing the thanksgiving meal offered to relatives, friends, or neighbors who participated in the slaughtering process may be a very good source of infection with *Trichinella* parasites, leading to unfortunate consequences, especially when animals are not veterinary tested [32].

Health education of the general population is one of the most important way to prevent *Trichinella* infection [33, 34]. It is important to remember that the necessary temperature to kill the larvae is 77°C and it is achieved when the meat is no longer pink. Freezing temperatures of -15°C for 20 to 30 days, -23°C for 10 to 20 days, and -29°C for 6 to 12 days are also effective, except for *T. nativa* which can infect for several days at these temperatures [35]. Non-commercial sources of pork, as from wild animals and small rural farms not using modern hog management practices, still represent a significant health problem.

In all the articles inserted in our review, in fact, the meat that caused the infection was not controlled by a vet, but in the study conducted by Fichi et al. [17], the pigs used to prepare the sausages have been slaughtered in an official abattoir and resulted negative for *Trichinella* by artificial digestion: in this case the wild boar meat (without a veterinary control) shuffled with pig meat to prepare the sausages was the real cause of infection. Our review demonstrates that the circulation of *Trichinella* parasite is not an extinguished problem and that it is impossible to define a region with a negligible risk of acquiring the infection. Health personnel and veterinarians should be regularly trained about this parasitic disease often forgotten by general practitioners and infectious diseases specialists. Differential diagnosis of *Trichinellosis* is especially difficult for isolated cases and atypical clinical courses, and physicians practicing in non-endemic countries are usually unfamiliar with the disease and may thus experience problems in diagnosing *Trichinellosis* [7].

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Conflict of interest statement

None declared.

Authors' contributions

GT had the idea of the study, collected data and wrote the article, NN provided support and suggestions.

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■ Correspondence: Gianmarco Troiano, Department of Molecular and Developmental Medicine, Area of Public Health, University of Siena, via A. Moro 2, 53100 Siena, Italy - Fax +39 0577 234090 - E-mail: gianmarco.troiano@student.unisi.it, gianmarco-89@hotmail.it