Retrospective study on *Trichinella*-infection incidence in pigs in Romania over the last two decades (1994-2013)

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Abstract. Trichinellosis is a food-borne parasitic zoonosis recognized for its importance to public health and for its economic impact, being one of the most common diseases in Romania. This study was conducted to evaluate the spatio-temporal trends related to the incidence of *Trichinella* infections in pigs raised in farms and in households in Romania, in order to obtain accurate information on the probability of occurrence for this parasite in pigs according to the raising system. Cumulative incidence-rates for *Trichinella* infections in pigs were determined for the 1994–2013 period and expressed as number of infected animals per 10,000 tested pigs. Between 1994 and 2013, in slaughterhouses supervised by local authority veterinary services, 49,076,180 muscle samples from pigs raised in farms were collected and analysed for *Trichinella* larvae. Out of them, 21,225 samples were positive, with an incidence-rate of 4.32/10,000 samples. At the same time, 22,259,233 samples from pigs raised in households were tested. For them, a twofold more incidence-rate (9.59 per 10,000 samples) has been recorded compared to that of the pigs raised in farms. The country-level incidence-rate for pigs originating from households was significantly higher than for the abattoir-slaughtered pigs.

Keywords: *Trichinella*; Incidence; Pigs; Farms; Households.

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Introduction

Trichinellosis is a parasitic zoonosis produced by nematode worms belonging to the genus *Trichinella*. *Trichinella* has a worldwide distribution, because it has been passively imported into most continents, with the exception of Antarctica, where the parasite’s presence was not registered (Pozio and Murrell, 2006; Oltean et al., 2012). The global distribution of *Trichinella*, correlated with different cultural eating habits, represent the main factors which make trichinellosis the most widespread parasitic zoonosis, in both industrialised and non-industrialised countries.
Domestic animals can become infected with some Trichinella species (T. spiralis, T. britovi, T. pseudospiralis, T. papuae and T. zimbabwensis) from the sylvatic environment, sometimes through synanthropic animals. So far, nine species and three genotypes of Trichinella have been worldwide described: T. spiralis, T. nativa, T. britovi, T. murrelli, T. nelsoni, T. pseudospiralis, T. papuae, T. zimbabwensis, T. patagoniensis, Trichinella T6, Trichinella T8 and Trichinella T9 (EFSA and ECDC, 2014).

Among primates, only humans have been naturally infected with Trichinella. Humans typically acquire the infection by eating raw or inadequately cooked meat containing infectious Trichinella larvae. The most common source of human infection is pig meat (EFSA and ECDC, 2014). Freezing of the meat minimises the infectivity of the parasite, although some Trichinella species/genotypes (T. nativa, T. britovi and Trichinella T6) have demonstrated resistance to freezing (EFSA and ECDC, 2013).

In spite of the efforts to control trichinellosis, the disease still continues to be one of the most common food-borne parasitic zoonosis in Eastern Europe and especially in Romania (Blaga et al., 2007). Annually scientific journals of the European Food Safety Authority (EFSA) and European Centre for Disease Prevention and Control (ECDC) noticed a high prevalence of human trichinellosis, the highest notification rates for 2012 being reported in Latvia (2.01 cases per 100,000), followed by Lithuania, Romania and Bulgaria (0.93, 0.70 and 0.41 cases per 100,000, respectively) (EFSA and ECDC, 2014).

This study was aimed to review the information about the occurrence of Trichinella infections in pigs according to the geographic region and based on statistic analyses to establish the trend of Trichinella-infection in pigs in different regions of Romania.

**Materials and methods**

Epidemiological information on Trichinella-infection in pigs was collected based on official reports of National County Sanitary-Veterinary Laboratories (1994-2013). These reports comprise information about Trichinella-infection in pigs raised both under controlled conditions (farms) and in households and slaughtered for own consumption. Also, a part of the epidemiological information originates from the Institute of Hygiene and Veterinary Public Health Bucharest, which is responsible for the centralization of passive surveillance data for Trichinella-infections in pigs received from the national county and private laboratories. These data were reported to EFSA.

For Trichinella, the control of pork has been conducted differently between 1994 and 2013 in Romania. Prior to the application of European Commission Regulation 2075/2005 for Trichinella inspection, Romanian legislation, respectively MAA Order no. 45/1995 and the Veterinary Sanitary Law 215/2004, was applied for the inspection of the meat originating from both farms and households. According to these normative acts, the meat was inspected by trichinoscopy method. Trichinoscopy was permitted to be used only during the transitional period until December 31st, 2009.

Since January 1st, 2010, according to the European Commission Regulation 2075/2005, all pigs slaughtered in the 27 Member States and intended for the E.U. market, should be tested for Trichinella spp. larvae, the recommended technique being the artificial digestion. Animals (both domestic and wild) slaughtered for own consumption are outside the scope of the mentioned Regulation, for these applying both artificial digestion and trichinoscopy methods. However, trichinoscopy may fail when the larval density is low or for not yet encapsulated larvae or larvae from non-encapsulated species, resulting in false-negative results. There are studies which have demonstrated that the sensitivity of the trichinoscopy method is lower than the artificial digestion method (Forbes and Gajadhar, 1999; Gamble, 1999).

In this study, the incidence of Trichinella-infection in pigs was analyzed depending on geographical regions, presuming that the incidence may vary depending on a specific
area. The study area included all Romania’s territory shared in seven geographical regions. A map of the geographical dividing of Romania is presented in figure 1.

The analyzed geographical areas in Romania were the following: the South-Western area (comprising Dolj, Olt, Vâlcea, Gorj and Mehedinți counties), the South area (comprising Bucharest and Argeș, Dâmbovița, Prahova, Ialomița, Călărași, Giurgiu, Teleorman and Ilfov counties), the South-Eastern area (comprising Tulcea, Brăila, Constanța, Galați, Buzău and Vrancea counties), the North-Eastern area (comprising Vaslui, Bacău, Iași, Neamț, Botoșani and Suceava counties), the North-Western area (comprising Bihor, Bistrița Năsăud, Cluj, Satu Mare, Sălaj and Maramureș counties), the Western area (comprising Arad, Timiș, Hunedoara and Caraș-Severin counties) and the Centre area (comprising Alba, Brașov, Covasna, Harghita, Mureș and Sibiu counties).

Cumulative incidence-rates for *Trichinella* infections in pigs were determined for the 1994–2013 period and expressed as number of infected animals per 10,000 tested pigs.

![Figure 1. Map of Romania’s territory – seven geographical regions – for the epidemiologic study of trichinellosis](image)

### Results

The incidence-rates of *Trichinella* infections in pigs raised in farms and in households, according to the geographical region of Romania, are presented in table 1. Between 1994 and 2013, in slaughterhouses supervised by local authority veterinary services, 49,076,180 samples from pigs raised in farms were collected and analysed for *Trichinella*. Out of them, 21,225 samples were positive, with an incidence-rate of 4.32 per 10,000 samples. At the same time, 22,259,233 samples from pigs raised in households were tested, in this situation being recorded a twofold more incidence-rate (9.59 per 10,000 samples).
compared to that of the pigs raised in farms. The country-level incidence-rate for pigs originating from households was significantly higher than for the abattoir-slaughtered pigs (table 1).

**Discussions**

*Trichinella*-positive findings in pigs raised in farms in South-Western, Southern and South-Eastern areas of Romania accounted 81.80% of all positive samples. A similar situation has been also recorded for pigs raised in households and slaughtered for own consumption (72.02% of all *Trichinella*-positive findings). This aspect could be correlated with the agricultural specificity of these areas, respectively the intensive cultivation of cereals mainly accompanied by the existence of large numbers of rodents. In such farms and even more in households, *Trichinella*-infection in pigs could occur due to the breakdown of the biosecurity barriers, allowing the introduction of *Trichinella*-infected rodents.

The lowest incidence-rate for *Trichinella*-infected pigs raised in farms (0.22 positive findings per 10,000 samples) has been recorded in North-Western area of Romania, whereas for households-raised pigs, the lowest incidence-rate was recorded in the North-Eastern area of Romania (2.31 positive findings per 10,000 samples) (table 1).

The incidence-rates of *Trichinella* infections in pigs raised in farms

In most of the regions in Romania, there was recorded a pick of *Trichinella*-infections incidence in pigs originating from farms during the 1998-2001 period. Although most of the cases were recorded in South-Western and South-Eastern regions, an increase of *Trichinella* incidence-rate was observed also in North-Eastern, Western and Centre regions. Significant differences were remarked between the North-Western area and the other analyzed regions, this part of the country showing the lowest *Trichinella*-infections incidence rate (figure 2).

Generally, the *Trichinella* incidence-rate recorded an important decrease during the 2002-2005 period in most of the regions. A particular situation was observed in South-Western area, where a significant decrease was noticed between 2006 and 2009. The Southern region showed a medium incidence-rate, which however has remained at a high level for a long period, a pronounced decrease being recorded in the last period, respectively during the 2010-2013 period. This relatively stationary trend could be the result of the maintenance of some reservoirs of infection, such as the transmission of infection between the domestic (synanthropic) and wildlife (sylvatic) cycles (Malakauskas et al., 2007). Similarly, pigs exposed to infected rodents rapidly acquire infection (Schad et al., 1987; Leiby et al., 1990).

However, populations of rodents living in and around pig farms often serve as bystanders rather than primary reservoirs (Pozio, 2000).

**Table 1.** Cumulative incidence-rates of *Trichinella* infections in pigs according to different regions of Romania (1994–2013)

<table>
<thead>
<tr>
<th>Geographical region of Romania</th>
<th>Pigs raised in farms</th>
<th>Pigs raised in households</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slaughtered (no.)</td>
<td>Infected with <em>Trichinella</em> (no.)</td>
</tr>
<tr>
<td>West</td>
<td>8,834,559</td>
<td>1,186</td>
</tr>
<tr>
<td>South-West</td>
<td>2,924,214</td>
<td>2,495</td>
</tr>
<tr>
<td>South</td>
<td>16,460,727</td>
<td>11,506</td>
</tr>
<tr>
<td>South-East</td>
<td>6,341,330</td>
<td>3,361</td>
</tr>
<tr>
<td>North-East</td>
<td>5,017,047</td>
<td>1,100</td>
</tr>
<tr>
<td>North-West</td>
<td>3,881,869</td>
<td>85</td>
</tr>
<tr>
<td>Centre</td>
<td>5,616,434</td>
<td>1,492</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>49,076,180</strong></td>
<td><strong>21,225</strong></td>
</tr>
</tbody>
</table>

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The last period of time (2010-2013) is characterized by a decrease of *Trichinella*-infections incidence-rate in pigs raised in farms, where probable through providing of control measurements and appropriate general farm hygiene the risk of exposure to this parasite has decreased. On the other hand, the high incidence observed in 1990s could be linked to the political, social, and economic changes that occurred in Romania in that period (Cuperlovic et al., 2005; Blaga et al., 2007).

The incidence-rates of *Trichinella* infections in pigs raised in households

In contrast to the incidence of *Trichinella*-infections in pigs originating from farms, where a decreasing trend is obvious, the incidence of *Trichinella*-infections in pigs raised in households, without control, has recorded in last period a worrying increase (figure 3).

Thus, 2002-2005 represents the period with the lowest *Trichinella*-infections incidence-rate in pigs, and starting with 2006 the incidence-rate recorded noticeable increase in almost all Romanian regions. A particular situation is observed in the North-Western area, where although in farms the level of incidence-rate was very low, in case of pigs raised in households the incidence-rate recorded the highest level, reaching 24.46 *Trichinella* positive findings per 10,000 tested pigs, in the last years (2010-2013). Overall, in last period, pronounced increases of *Trichinella*-infections incidence-rate in North-Western, South-Eastern and North-Eastern regions were recorded; the Western area showed a decreasing trend (figure 3). Findings reported during the past two decades in pigs raised in households, indicated that there are changing trends in *Trichinella*-infection in pigs in terms of the emergence of new outbreaks in these areas (Marincu et al., 2012).

Moreover, this aspect is important, given that the data include results from pigs originating from households, which are often raised with minimal biosecurity measures and are constantly at higher risk of contracting trichinellosis from sylvatic animals (Pozio and Zarlenga, 2005). Wild boars play a key role in the maintenance and spread of *T. spiralis* through the sylvatic cycle and it may pose a risk of transmission to household-raised pigs. Raising the pigs in small family farms, their feeding with food scraps or other forms of meat-containing waste, the access to rodents and wildlife represent a critical point in infection with *Trichinella*. These animals are, therefore, important indicators of the disease. Moreover, pigs raised in this manner are generally not sold through retail marketing channels, and therefore are not subjected to reliable methods of veterinary inspection, frequently applying for examination the trichinoscopy. This ascending trend of *Trichinella*-infection recorded in pigs...
raised for own consumption represents a worrying situation as long as the most important source of Trichinella infection for humans remains pork and its related products (FAO/WHO/OIE, 2007).

Overall, the temporal trend of Trichinella-infections incidence-rates in pigs in Romania, in the last period (2010-2013), is highly influenced by the number of infected pigs raised in households. In 2012, Romania accounted for 51.5% of all the Trichinella-positive findings in pigs recorded in European Union, all the positive findings originating from pigs raised in non-controlled housing conditions (EFSA and ECDC, 2014).

This high incidence of Trichinella-infections in pigs is closely correlated with the number of human Trichinella-infections, Romania being recognized for its high incidence (0.70 cases per 100,000 humans in 2012). Furthermore, in 2012 our country reported 49.5% of the confirmed cases of human Trichinella-infections in E.U., being noticed an ascending trend compared to the previous years (39.9% in 2011, 36.7% in 2010, and 35.3% in 2009) (EFSA and ECDC, 2011; 2012; 2013; 2014). In Romania, the highest number of human trichinellosis cases was recorded in 2008, respectively 75.3% of all human Trichinella-infections in E.U. Generally, human trichinellosis outbreaks involve individuals living in disfavoured communities, most of them being poor, illiterate and unemployed, living in unsanitary conditions and raising backyard pigs without any compliance with hygienic rules (Neghina, 2010; Ţăţulescu et al., 2010). In Romania, the increase of pigs' number infected with Trichinella (particularly pigs raised in households) represents a major threat to public health that has to be properly analyzed and evaluated.

Trichinella-infections in humans are related to cultural food practices, which include dishes based on raw or undercooked meat, especially pork. According to Neghina et al. (2010), who summarizes the evolution of trichinellosis in Romania over a 140-year period (1868–2007), 95% of human trichinellosis cases originate from specific cultural food practices involving pork consumption. The presence of the parasite in domestic and/or wild animals is not a sufficient risk in itself for transmission to human populations. For instance, in most of the European countries, Trichinella spp. frequently occur in wildlife and in some countries it occurs also in the domestic pigs populations; however, no infection has been documented in humans in these countries (e.g. Finland, Sweden, Switzerland), probably due to the practice of eating only well cooked meat, associated with organized farming systems and appropriate quality of veterinary services.
(Pozio, 1998). It is well-known that cultural traditions in food behaviour are not easily altered; therefore, this parasitic disease can be expected to remain a food-safety risk for the foreseeable future.

Taking into account all these aspects, we can conclude that Trichinella-infections in pigs have an endemic character in Romania, with serious implications to human health. Nevertheless, the provision of information to the consumers regarding the potential risks associated with consuming frequently untested pork from animals raised in households and the reassessment of meat control programs represent the key measures that can reduce the incidence of human Trichinella-infections.

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*** MAA Order no. 45/1995 approving the sanitary veterinary Norm regarding detection of trichinae in fresh meat of swine, game (bear, boar) and horse [Ordinul MAA nr. 45/1995 pentru aprobarea Normei sanitare veterinare privind decelarea trichinei în carnea proaspătă de porcine, vânat (urs, mistreţ) şi cabaline] [in Romanian]. MO 179/10.08.1995.