A 38-year study on *Trichinella* spp. in wild boar (*Sus scrofa*) of Latvia shows a stable incidence with an increased parasite biomass in the last decade

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**Abstract**

**Background:** *Trichinella* spp. are zoonotic parasites transmitted to humans by the consumption of raw or insufficiently cooked meat of different animal species. The most common source of infection for humans is meat from pigs and wild boar (*Sus scrofa*). The aim of the present work was to evaluate the incidence of *Trichinella* spp. infections in wild boar hunted in Latvia over a 38 year interval (1976 to 2013).

**Methods:** A total 120,609 wild boars were individually tested for *Trichinella* spp. by trichinoscopy and, in case of negativity, by artificial digestion of 25 g muscles, in the 1976–2005 period, and by artificial digestion of 25–50 g muscles in the 2006–2013 period. *Trichinella* spp. larvae were identified at the species level by multiplex PCR.

**Results:** In the study period, the overall prevalence of infected wild boar was 2.5%. *Trichinella britovi* was the predominant (90%) species. The incidence of *Trichinella* spp. infection in wild boar exhibited two different trends. From 1976 to 1987, the incidence of infected/hunted wild boar increased from 0.23% to 2.56%, then it decreased to 0.19 in 1994. Thereafter, the incidence fluctuated between 0.05% and 0.37%. A statistically significant (*P* < 0.05) correlation (*r* = 0.54; *p* = 0.0199) was found between the trend of *Trichinella* spp. incidence in hunted wild boar and the number of snow cover days from 1976 to 1993. From 1997 to 2013, the estimated wild boar population of Latvia increased by 4.9 times and the hunting bag by 9.7 times, with a stable incidence of *Trichinella* spp. in the population. It follows that the biomass of *Trichinella* spp. larvae and of *T. britovi*, in particular, increased.

**Conclusions:** The incidence trends of *Trichinella* spp. in wild boar could be related to the role played by the snow in reducing the thermal shock and muscle putrefaction which increases the survival of the larvae in muscle tissues of carrion in the 1976–1993 period; and, in the 1997–2013 period, to the increased biomass of *Trichinella* spp. due to the increased carnivore populations, which are the main reservoirs of these parasites.

**Keywords:** *Trichinella britovi*, Latvia, Wild boar, *Sus scrofa*, Incidence, Epidemiology, Biomass, Snow cover, Carnivore...
Background
Nematodes of the genus Trichinella are cosmopolitan parasites of carnivorous and omnivorous animals, which can be transmitted to humans by ingestion of raw or semi-raw meat and meat products of different animal origin [1]. The main source of infection for humans is meat from domestic pigs and wild boar (Sus scrofa) [2].

In Latvia, Trichinella spp. infections have been documented in wolves, wild boar and humans since 1960 [3]. From 1955 to 1985, trichinellosis was documented in 152 people who had acquired the infection for the consumption of meat, mostly from wild boar [4]. From 1986 to 2000, 150 cases of human trichinellosis due to the consumption of smoked or undercooked pork (72%), wild boar meat (23%), and unknown sources (5%), were gathered from [5]. Since 1992, human trichinellosis increased from 0.1-0.2 (1982–1991) to 3.75 (2000) cases per 100,000 inhabitants [6]. Then in the period 2000–2009, the average incidence of trichinellosis was 1.1 per 100,000 inhabitants of Latvia [2]. In the last fifteen years, there has been a marked reduction of human trichinellosis caused by the consumption of pork from domestic pigs in most countries of the European Union. In contrast, the number of infections caused by the consumption of meat from hunted wild boar has remained stable [2]. Among carnivore mammals of Latvia, Trichinella spp. has been detected in the lynx (Lynx lynx), red fox (Vulpes vulpes), raccoon dog (Nyctereutes procyonoides), wolf (Canis lupus), and pine marten (Martes martes) [7-10].

The aims of the present work were to evaluate by a retrospective analysis of longitudinal data, the relationship between the Trichinella spp. incidence in Latvian wild boar and its population growth during the past 38 years, to explore the cause(s), which could have affected the Trichinella spp. incidence in the wild boar population, and to identify the Trichinella species circulating in Latvian wildlife.

Methods
Source of information
The number of hunted wild boar tested for Trichinella spp. infection and the number of positive wild boar per district per year, were collected from the annual reports of the National Veterinary Laboratory for the period 1976–1990, was gathered from [11]. For the period 1991–2013, this information was downloaded from [12].

Data on the estimated raccoon dog and red fox populations were from [11] and from the State Forest Service (Jānis Ozoliņš, personal communication) for 2010. From 2005 to 2011, carnivore mammals (lynxes, raccoon dogs, red foxes, wolves, martens, domestic dogs, and domestic cats) hunted or killed by cars in Latvia were also screened to detect Trichinella spp. infection and to identify the etiological agents.

Detection of Trichinella infection
From 1968 to 2005 according to the Latvian Normative act Nr. 5-I0-960 of Latvian SSR Ministry of Agriculture of 9 October 1968, hunters delivered to veterinary services on a voluntary basis no less than 100 g of diaphragm muscle and 50 g of tongue muscle from hunted wild boar. Trichinella spp. larvae were searched in 28 small pieces about the size of a grain of rice from the diaphragm samples, by trichinoscopy. When trichinoscopy was negative, 25 g of muscle samples were individually digested by artificial gastric juice [13]. Briefly, 25 g from diaphragm and/or tongue muscles of each animal were cut into small pieces by scissors. Chopped meat was then placed on a bee sieve of 15 cm, which was placed in turn on a funnel containing the digestion fluid (1000 ml of warm water, 5 g of pepsin, 7 ml of HCl) covering the meat. The meat was incubated at 39°C for 18 h. Then 5 ml of the digestion fluid was run off from the bottom of the funnel in a conical tube. After 30 min sedimentation, 3 ml of supernatant were discharged and the remaining 2 ml were poured out in a 6 cm Petri dish. Larvae were searched under a stereomicroscope at 40× magnifications. The laboratory personnel were regularly trained on trichinoscopy and digestion methods with frequent observations of positive samples. When a positive wild boar was detected, the carcass was burned down in the presence of a veterinary inspector. From 1976 to 2005, the larval burden per gram of muscle was not evaluated and larvae were not collected for their identification at the species level.

From 2006 to 2013, muscle samples from wild boar (25–50 g) and carnivores (25 g) were individually tested by the magnetic stirrer method according to the Commission Regulation 2075/2005 (European Commission, 2005) [14]. The larval burden per gram of muscle was not evaluated but larvae were collected, washed in PBS, and then stored in 70%-96% ethyl alcohol for their identification at the species level by a molecular test. Information on Trichinella spp. isolates is available at the website of the International Trichinella Reference Centre [15].
Molecular identification of *Trichinella* spp. larvae

From 2005 to 2013, at least five single *Trichinella* spp. larvae isolated by artificial digestion from each positive animal, were identified at the species level by multiplex PCR analysis according to previously published protocols [16,17].

Potential factors influencing the *Trichinella* spp. prevalence in wild boar

The following factors were examined to evaluate their potential influence on the *Trichinella* spp. incidence in wild boar of Latvia in the period 1976–2013: 1) the number of *Trichinella* spp. infecting domestic pigs per year (Annual reports from 1976 to 1992 of the National Veterinary Laboratory; Annual reports from 1992 to 2006 of the Veterinary Medicine Diagnostic Centre; Annual reports from 2006 to 2011 of the National Diagnostic Centre and of the Institute of Food Safety, Animal Health and Environment BIOR), assuming the *Trichinella* spp. transmission from the domestic to the sylvatic cycle; 2) the estimated carnivore populations (red foxes and raccoon dogs) per year, since their carcasses left by hunters on the ground, can be the source of *Trichinella* spp. infections for wild boar; 3) the number of hunted wild boar per year for the reason cited in point 2; 4) the estimated wild boar population per year, since an increased population can result in a feed shortage favouring scavenging behaviour on carrions; 5) the air temperature and precipitation per year [18,19]; and 6) the number of snow cover days gathered from [20] for the period 1976–2004, and from the website (ftp://ftp.ncdc.noaa.gov/pub/data/gsod) for the period 2005–2013.

Statistical analysis

The proportion of infected wild boar was evaluated by the Chi-square for trend test. The prevalence of *Trichinella* spp. was calculated by dividing the number of infected wild boar by the number of hunted wild boar × 100. The Pearson’s Correlation Coefficient was used to compare the number of days with snow cover and the rate *Trichinella* sp. infected/hunted wild boar. *P* < 0.05 was considered significant. The statistical analysis was performed using the STATA 11.2 software.

Results

In the 38-year period (1976–2013), the estimated average number of wild boar in Latvia was 32,244 heads (range 13,775-74,107) per year (Table 1). The estimated wild boar population size fluctuated in the study period reaching a peak of 33,039 heads in 1992 and a new peak of 74,107 heads in 2013 (Figure 1). The number of hunted heads followed a similar fluctuation (average 15,496; range 3,962-38,723) and was proportional to the estimated wild boar population size (average 48%; range 22.5% - 72.5%) (Figure 1). From 1997 to 2013, the estimated wild boar population increased by 4.9 times and the hunting bag increased by 9.7 times. An average of 20% (range 0.54% - 60.9%) of the hunted wild boar were tested for *Trichinella* spp. and an overall prevalence of 2.5% was detected in the study period (Table 1). The number of tested wild boar and the number of *Trichinella* spp. positive animals varied among the years (Table 1, Figure 2). From 1976 to 1987, the incidence of infected/hunted wild boar increased from 0.23% to 2.56%, then it decreased to 0.19 in 1994. Thereafter, the incidence fluctuated between 0.05% and 0.37% (Figure 3).

A statistically significant correlation (*r* = 0.54; *p* = 0.0199) was found between the trend of *Trichinella* spp. incidence in wild boar and the number of snow cover days from 1976 to 1993 (Figure 3). In contrast, from 1994 to 2013, no correlation (*r* = 0.08; *p* = 0.7628) was observed between these two variables.

From 1990 to 2010, the estimated population size of raccoon dogs and red foxes increased by 288% and 317%, respectively (Figure 4). A correlation was detected between the increased carnivore populations and increased *Trichinella* spp. biomass in the wild boar population. No relationship was observed between the other investigated variables and the trend of *Trichinella* spp. incidence in the wild boar population (data not shown).

No correlation was detected between the incidence of *Trichinella* spp. infection in wild boar and their geographical origin, based on the 26 Latvian districts nor on the four main Latvian regions (Kurzeme, Latgale, Vidzeme and Zemgale) (data not shown). The overall prevalence for the 38 year period ranged from 0.8% in the Rezekne district up to 10.1% in the Preili district with the highest prevalence in the centrum and southeastern districts of Latvia (Figure 5).

*Trichinella britovi* was recovered from 90% of the *Trichinella* spp. isolates from wild boar hunted in 15 districts (Figure 5). *Trichinella nativa* was isolated from three (5.8%) wild boars killed in two districts; *T. spiralis* was detected in one (1.9%) wild boar and a

**Table 1 Estimated, hunted, tested and *Trichinella* spp. positive wild boar (*Sus scrofa*) in Latvia**

|                          | Average per year (range) | %     |
|--------------------------|--------------------------|-------|
| Estimated wild boar population | 32,244 (13,775-74,107)   |       |
| Hunted wild boar         | 15,496 (3,962-38,723)    | 48%   |
| Wild boar tested for *Trichinella* spp. | 3,174 (238-10,138) | 20%   |
| Wild boar positive for *Trichinella* spp. | 80 (6-369) | 2.5%  |

Data have been collected from 1976 to 2013.

* on estimated wild boar population.

* on hunted wild boar.

* on tested wild boar.
mixed *T. britovi*/*T. nativa* infection in another wild boar (Figure 5).

Overall, from 2005 to 2011, *Trichinella* spp. larvae were isolated from 179 carnivores. Larvae were identified as *T. britovi* (96%), *T. nativa* (2.8%) and *T. britovi*/*T. nativa* mixed infections (1.1%). *Trichinella britovi* was detected in 50 foxes, 43 lynxes, 43 raccoon dogs, 33 wolves, 1 marten, 1 domestic dog and 1 domestic cat; *T. nativa* in 3 wolves and 2 foxes; and mixed *T. britovi*/*T. nativa* infections in 1 wolf and 1 fox.

**Discussion**

We present valuable data here on the long term (38 years) trends in the incidence of *Trichinella* spp. in the hunted wild boar population of Latvia. They reveal an increase from 0.23% to 2.56% in the period 1976–1987, a decrease up to 0.19% in 1994, and then a fluctuation from 0.05% to 0.37% in the following years (Figure 3). This trend was not linked to the observed 4.9 fold growth of the host population in the country, with an average number of 1.14 heads per square kilometre in 2013.

A correlation (*r* = 0.54; *p* = 0.0199) between the incidence trend of *Trichinella* spp. in wild boar and the number of snow cover day trend during the period 1976–1993 has been observed in the present study (Figure 3). The higher the number of snow cover days, the higher the *Trichinella* spp. incidence in wild boar and vice versa. This suggests that snowfall favours the survival of *Trichinella* spp. larvae in decaying host muscles by preventing sudden changes of the carrion temperature (e.g., the action of the wind), and by maintaining a constant humidity. This correlation stresses the importance of the time spent by the larvae in the decaying muscle tissues when they are no longer protected by the host homeothermy. The muscle larvae...
have an anaerobic metabolism which supports their survival in decaying muscles over long periods of time, even though the striated muscle tissue develops an angiogenesis process around the muscle cell-larva complex [21]. Madsen [22] considered the ecological niche of the host carrion as the environment of the “free-living” stage, equivalent to the egg stage of most other nematode species. However, in the absence of snow cover, the carcass can be exposed to rapid decrease/increase of temperature, causing freezing and/or thawing of the muscle tissues which kill the larvae, and/or to a fast drying of the muscle tissues also resulting in the death of the larvae. However, further investigations are needed to evaluate the influence of the environment under the snow [23] on the survival of Trichinella spp. larvae in the host carcasses.

Since the Trichinella spp. incidence in the wild boar population of Latvia was quite uniform in the last 12 years (Figure 3), we can assume a significant increase of the parasite biomass in wild boar due to the growth of wild boar and carnivore populations (Figures 1 and 4). In Latvia, this increased parasite biomass is represented for 90% by T. britovi even if this species is not considered to be well adapted to swine (see below).

Trichinella britovi is largely the predominant Trichinella species circulating in Latvia where, in addition to wild boar, its prevalence in wild carnivores may vary from 21% to 50% in the raccoon dog, 17%-57% in the red fox, 69.6% in the wolf, 40%-90% in the lynx, and 46.1% in the pine marten [7-10]. Trichinella spiralis has been documented only in six foxes and in four domestic pigs [8], and in one wild boar (present work).
The enteral and parenteral niches of swine are not very favourable to *T. britovi*; a low worm burden and a short survival time in the muscles is typical [24-26]. Therefore, the overall prevalence of 2.5% in wild boar during the period 1976–2013 (1.4% in the last 12 years) should be considered very high. In European countries, where *T. britovi* is the prevalent species in wildlife, the prevalence of infection in wild boar is 0.3 in Estonia [8], 0.007 in Hungary [27], from 0.002 to 0.017 in Italy [28], 0.51 in Lithuania [8], and 0.06 in the Slovak Republic [29].

Carnivore mammals, canids in particular, are the most important reservoir species of *T. britovi* and *T. nativa* [30,31]. In some European countries, the increase of *Trichinella* spp. prevalence among wild boar has been related to a concomitant increase of the carnivore populations. In Poland, an increase in the fox population density has been linked with an increase in the prevalence of *Trichinella* spp. among wild boar [32,33]. In Mecklenburg–Western Pomerania (Germany), the increase of the *Trichinella* spp. prevalence in wild boar has been associated with the increasing raccoon dog population in the region [34]. In Spain, a decreasing trend of *Trichinella* spp. in the wild boar population during 1998 to 2009, was associated with an increase in fenced areas, which prevented the circulation of wild carnivores considered the most important reservoir of *Trichinella* spp. [35]. In Latvia, there has been a concomitant increase of the wild boar and carnivore populations. In 2010, the total estimated number of wild carnivores (lynx, raccoon dog, red fox, wolf, American mink, badger, pine and stone martens, and polecat, about 140,000 heads) [11], the main reservoir hosts for *T. britovi* [31], was two times higher than the number of estimated wild boar heads (about 67,000, Figure 1). The abundance of carnivores in which the prevalence of *Trichinella* spp. (96% *T. britovi*) was extremely high, allows the maintenance of a stable incidence of infection in the wild boar population in spite a 4.9 fold increase and the short survival time of *T. britovi* in this host species.

The increase of the carnivore and wild boar population size may have enhanced the common habit of hunters to leave animal carcasses in the field after skinning, or removing and discarding the entrails, which has been demonstrated to strongly increase the probability of *Trichinella* spp. transmission among wildlife [22,36-42], and to free-ranging and backyard pigs, particularly if the pig owner is a hunter [42].

In the period 1976–2005, the use of the trichinoscopy test in first instance and then, in the case of a negative result, of the digestion test of single animals, was driven to reduce the number of apparatuses needed to test these animals. The pooled sample digestion test was not used to reduce the need to identify the positive animal/s present in a pool considering an expected prevalence up to 40% in some districts (data not shown). The use of two, at least in part different, artificial digestion protocols between the 1976–2005 and 2006–2013 periods, does not seem to have influenced the test sensibility, since the incidence detected in the last eight years (2006–2013) was similar to the incidence of the previous eight years (1998–2005).

Conclusions

In most European countries including Latvia, but also elsewhere, the number of wild boar tested for *Trichinella* spp. larvae is always a percentage of the hunted animals (Figures 1 and 2). A high percentage of these animals are hunted for own consumption, do not enter into the official market, and escape the veterinary controls, thus causing infections in humans [43]. There is the need to educate hunters on the importance of the systematic examination for *Trichinella* spp. larvae of game intended for human consumption to prevent human infection. Furthermore, veterinary services should educate hunters not to spread game carcasses or their scraps and offal in the environment, and should organize a system for a proper collection and disposal of these biological samples.

Competing interests

The authors declare that they have no competing interests.

Authors’ contributions

Conceived and designed the laboratory tests: MK, EP. Performed the experiments: MK, GD, ZB, ZE, EB, AD, AZ, GM, IJ, AK. Analysed the data: AB, FG. Contributed reagents/materials/analysis tools: MK, GD, EP. Drafted the manuscript: MK, EP. All authors read and approved the final manuscript.
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References

1. Gottstein B, Pozio E, Nöckler K. Epidemiology, diagnosis, treatment, and control of trichinellosis. Clin Microbiol Rev. 2009;22:127–45.
2. Murrell KD, Pozio E. Worldwide occurrence and impact of human trichinellosis, 1986–2009. Emerg Infect Dis. 2011;17:2194–202.
3. Vikle AE. Epizootiological and epidemiological problems of trichinellosis in Latvia. Latv SSR, Wap Parazytol. 1976;16:72.
4. Ladzina MA, Nesaule VM. Occurrence of human trichinellosis in the Latvian S.S.R., 1955–1988. In: Vāldman EK, editor. Actual trends of parasitology in the Baltic States: XI Scientific Conference on Parasitology in the Baltic States Tallinn: Information Center of the State Agro-Industrial Committee of the Estonian SSR. 1989. p. 89 [in Russian].
5. Viksna L, Keidans P, Kruklite A, Keidane D, Kirjusina M, Ozolins J. Preliminary results on the prevalence of Trichinella spp. in experimentally infected pigs. Int J Parasitol. 2001;31:159–63.
6. Keidans P, Kruklite A, Keidane D, Kirjusina M, Lucenko I. Epidemiological study of the prevalence of Trichinella spiralis in experimentally infected pigs (Sus scrofa) and of the Council of 5 December 2005 laying down specific rules on official controls for Trichinella in meat. OFF J E C. 2005;L3860:82.
7. International Trichinellosis Reference Centre. http://www.isi.is/site/Trichinella/index.asp. Accessed 12 Jan 2015.
8. Pozio E, La Rosa G. PCR-derived methods for the identification of Trichinella parasites from animal and human samples. Methods Mol Biol. 2003;16:299–306.
9. Pozio E, La Rosa G. Trichinella. In: Liu D, editor. Molecular detection of foodborne pathogens. Boca Raton: CRC Press, Taylor & Francis Group; 2010. p. 851–63.
10. Lizuma L, Kļaviņš M, Briede A, Rodinov V. Long-term changes of air temperature in Latvia. In: Kļaviņš M, editor. Climate change in Latvia. Riga: LU Akadēmiskais āaugašs; 2007. p. 11–20.
11. Briede A, Līzuma L. Long-term variability of precipitation in the territory of Latvia. In: Kļaviņš M, editor. Climate change in Latvia. Riga: LU Akadēmiskais āaugašs; 2007. p. 35–44.
12. Dravenience A, Briede A, Rodinovs V, Kļaviņš M. Long-term changes of snow cover in Latvia as an indicator of climate variability. In: Kļaviņš M, editor. Climate change in Latvia. Riga: LU Akadēmiskais āaugašs; 2007. p. 73–85.
13. Despommier DD. How does Trichinella spiralis make itself at home? Parasitol Today. 1998;14:318–23.
14. Madsen H. The principles of the epidemiology of trichinellosis with a new view on the life cycle. In: Kim CW, editor. Trichinellosis. New York: Intext Educational Publishers; 1974. p. 615–38.
15. Paušni J, Zuckerberg B, Whiteman JP, Porter W. The subnubium: a deteriorating seasonal refugium. Front Ecol Environ. 2013;11:260–7.
16. Kapel CMO, Gamble HR. Infectivity, persistence, and antibody response to domestic and sylvatic Trichinella spp. in experimentally infected pigs. Int J Parasitol. 2000;30:215–21.
17. Kapel CMO. Sylvatic and domestic Trichinella spp. in wild boars; infectivity, muscle larva distribution, and antibody response. J Parasitol. 2001;87:309–14.
18. Nöckler K, Serrano FJ, Boireau P, Kapel CM, Pozio E. Experimental studies in pigs on Trichinella detection in different diagnostic matrices. Vet Parasitol. 2005;132:85–90.
19. Šzelž Z, Marucci G, Ludovisi A, Gómez-Moraes MA, Šrēter T, Pozio E. Spatial distribution of Trichinella britovi, T. spiralis and T. pseudospiralis of domestic pigs and wild boars (Sus scrofa) in Hungary. Vet Parasitol. 2012;183:93–96.
20. Gómez-Morales MA, Ludovisi A, Arnati M, Bandino E, Capelli G, Corrias F, et al. Indirect versus direct detection methods of Trichinella spp. infection in wild boar (Sus scrofa). Parasite Vectors. 2014;7:171.
21. Hamíková Z, Dubínkov P. Long-term survey on Trichinella prevalence in wildlife of Slovakia. Long-term survey on Trichinella prevalence in wildlife of Slovakia. Vet Parasitol. 2000;91:276–80.
22. Pozio E, Rinaldi L, Marucci G, Musella V, Galati F, Cringoli G, et al. Hosts and habitats of Trichinella spiralis and Trichinella britovi in Europe. Int J Parasitol. 2009;39:71–9.
23. Pozio E, Zarlanga DS. New pieces of the Trichinella puzzle. Int J Parasitol. 2013;43:983–97.
24. Balicka-Ramisz A, Grupiński T, Ramisz A, Pilarczyk B, Laurans L. Prevalence of Trichinella spp. in red foxes and wild boars in the northwestern part of Poland. Dorsch Tierarzt. Wochenschr. 2007;114:354–7 [in German].
25. Ramisz A, Grupiński T, Balicka-Ramisz A, Udala J, Laurans L. Prevalence of Trichinella sp. in red foxes and wild boars in the Western Pomerania Region. Bull Vet Inst Pulawy. 2011;55:199–201.
26. Pannwitz G, Mayer-Scholl A, Balicka-Ramisz A, Nöckler K. Increased prevalence of Trichinella spp., northeastern Germany, 2008. Emerg Infect Dis. 2010;16:936–42.
27. Boadella M, Barasona JA, Pozio E, Montoro V, Vicente J, Gortazar C, et al. Spatio-temporal trends and risk factors for Trichinella species infection in wild boar (Sus scrofa) populations of central Spain: a long-term study. Int J Parasitol. 2012;42:739–45.
28. Cironneau I. Trichinellosis in domestic and wild animals in Romania. In: Kim CW, editor. Trichinellosis. New York: In text Educational Publishers; 1974. p. 549–55.
29. Batkaev AI, Vakker VG. The role of conus fox in circulation of trichinelles in the Middle Irtysh territory. In: Proceedings of the 6th Scientific Conference on Trichinellosis, 12–14 May. Kirov, Moscow: Russian Academy of Sciences; 1992. p. 24–6.
30. Worley DE, Seseue FM, Zarlanga DS, Murrell KD. Attempts to eradicate trichinellosis from a wild boar population in a private game park (U.S.A.). In: Campbell CW, Pozio E, Bruschi F, editors. Trichinellosis. Rome: Istituto Superiore di Sanità Press; 1994. p. 611–6.
31. Pérez-Martín J, Serrano FJ, Reina D, Mora JA, Navarrete I. Trichinellosis in southern Spain. J Wild Dis. 2000;36:531–4.
42. Pozio E. Searching for Trichinella: not all pigs are created equal. Trends Parasitol. 2014;30:4–11.

43. Fichi G, Stefanelli S, Pagani A, Luchi S, De Gennaro M, Gómez-Morales MA, et al. Trichinellosis outbreak caused by meat from a wild boar hunted in an Italian region considered to be at negligible risk for Trichinella. Zoonoses Public Health. 2014. [in press].

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