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A DRAMATIC INCREASE IN THE INCIDENCE OF HUMAN TRICHINELLOSIS IN ROMANIA OVER THE PAST 25 YEARS: IMPACT OF POLITICAL CHANGES AND REGIONAL FOOD HABITS.

RADU BLAGA,* BENOIT DURAND, SILVIA ANTONIU, CALIN GHERMAN, CARMEN M. CRETU, VASILE COZMA, AND PASCAL BOIREAU

Agence Française de Sécurité Sanitaire des Aliments, Institut National de Recherche Agronomique, Ecole Nationale Vétérinaire d'Alfort, Université Paris XII Val de Marne, Joint Research Unit 956, Biologie Moléculaire et Immunologie Parasitaire et Fongique, Maisons-Alfort, France; Parasitology Unit, Faculty of Veterinary Medicine, University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Romania; Epidemiology Unit, Agence Française de Sécurité Santiaire des Aliments, Maisons-Alfort, France; Parasitology Unit, Faculty of Veterinary Medicine, University of Agronomical Sciences and Veterinary Medicine, Bucharest, Romania; Parasitology Unit, Faculty of Medicine, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania

Abstract. According to the International Commission on Trichinellosis survey in 2004, Romania has the most cases of trichinellosis in the world. Epidemiologic data for each county were collected and analyzed from two different time periods: before (1980–1989) and after (1990–2004) political changes. Data were analyzed separately for Transylvania and the rest of the Romanian counties. During the past 25 years, 28,293 human cases of trichinellosis were reported with an incidence of 51.0 cases per 10^6 persons per year. An important increase in the incidence was observed from 1980 to 1989 compared with the 1990–2004 period. For the entire period, the incidence rate obtained for Transylvanian counties (82.2 cases per 10^6 persons per year) was higher than the incidence rate obtained for the other counties (35.7 cases per 10^6 persons per year). Hypotheses and facts contributing to the heterogeneity of human trichinellosis cases are discussed.

INTRODUCTION

Zoonotic parasitic diseases are transmitted to humans either by ingesting the environmentally robust transmissive stages of the organism (spores, cysts, oocysts, ova, and larval and encysted stages) or by eating raw or undercooked meat containing infective tissue stages.[1] Human trichinellosis may be acquired through the consumption of undercooked meat (e.g., pork, horse and game meat) containing infective larvae of *Trichinella* spp. The global prevalence is difficult to evaluate, but as many as 11 million people may be infected worldwide.[2] No region has experienced a more marked change in the threat of trichinellosis than that of eastern Europe, which has accompanied the political and economic changes of the1990s.[3] The disastrous impact of war and population migration on this zoonosis is especially evident in countries of the former Republic of Yugoslavia,[4] and changes in pig production practices appear to account for much of the increase in human and pig infections in Russia and Lithuania during the 1990s.[5,6] Romania appears to be one of the most affected countries in southeastern Europe and in the world, accounting for 780 human cases of 3,109 cases reported worldwide in 2004.[4,7] Trichinellosis is the most important parasitic disease in Romania.[8,9]

We present an analysis of passive surveillance data of human trichinellosis in Romanian counties over the last 25 years. Two points are investigated: 1) differences in disease incidence before (1980–1989) and after (1990–2004) political changes, and 2) geographic variations of disease incidence in Transylvania compared with other Romanian counties that are separated by the Carpathian Mountains that divide Romania into two parts.

* Address correspondence to Radu Blaga, Agence Française de Sécurité Sanitaire des Aliments, Institut National de Recherche Agronomique, Ecole Nationale Vétérinaire d'Alfort, Université Paris XII Val de Marne, Joint Research Unit 956, Biologie Moléculaire et Immunologie Parasitaire et Fongique, 23 Avenue du Général de Gaulle, BP 67-94703, Maisons-Alfort CEDEX, France. E-mail: blecgec@yahoo.com

MATERIALS AND METHODS

Human data for trichinellosis incidence for the period 1980–2004. Census data were obtained online from the National Institute of Statistics, Bucharest, for 1977, 1992 and 2002, for each Romanian county.[10] Trichinellosis data (number of positive cases) were obtained from the National Institute for Medical Statistics (NIMS), Bucharest, which is responsible for centralization of passive surveillance data for such diseases, the notification of which is compulsory. Case inclusion criteria are based upon the clinical signs (high fever, periorbital or facial edema, and myalgia) and patient history (history of consumption of uninspected meat, culinary preparation). In addition, each case was confirmed by biologic testing (eosinophilia, leukocytosis, high levels of muscle enzymes in serum).

The NIMS does not collect data for clinical signs, patient history, and positive biologic tests results for positive cases. No immunologic or histologic confirmatory tests were performed. The collected data covered a 25-year period (1980–2004) for each county in Romania.

Descriptive and cluster analysis of human data for trichinellosis. Trichinellosis incidence rates are reported as the number of cases per 10^6 persons per year. For 1992 and 2002, census data were used. For other years (1980–1991 and 1993–2001), population data were linearly extrapolated from the 1977, 1992, and 2002 census data. For 2003 and 2004, data from the 2002 census were used. Trichinellosis incidence variations were then analyzed in time and space. Trichinellosis incidence figures for the period 1980–1989 were compared with those of 1990–2004. For both periods, data from the Transylvanian counties were also compared with data from the other Romanian counties. Statistical analyses were performed using R.[11]

A spatial cluster analysis was conducted using the SaTScan software.[12] This software enables the location and testing of the significance of clusters and computation of cluster-associated relative risks (RRs). It implements a cluster-detection test based upon a spatial scan statistic that may be used to detect area with high and low rates of trichinellosis.

TABLE 1
Cumulated trichinellosis incidence in Romania, 1980–1989 and 1990–2004

Area	Period	Cases	Population	Incidence* (95% CI†)
Transylvania	1980–1989	2,610	73,836,943	35.3 (34.0–36.7)
	1990–2004	12,381	108,549,279	114.1 (112.1–116.1)
	Whole period	14,991	182,386,222	82.2 (80.9–83.5)
Other counties	1980–1989	1,735	148,012,596	11.7 (11.2–12.3)
	1990–2004	11,567	224,883,050	51.4 (50.5–52.4)
	Whole period	13,302	372,895,646	35.7 (35.1–36.3)
Whole country	1980–1989	4,345	221,849,539	19.6 (19.0–20.2)
	1990–2004	23,948	333,432,329	71.8 (70.9–72.7)
	Whole period	28,293	555,281,868	51.0 (50.4–51.6)

* Cases per 10^6 persons-per-year.
† CI = confidence interval.

We used a procedure based on a Poisson model: circles of varying radii are sequentially centered on the centroid of each county and the ratio of cases to controls is computed for the areas inside and outside each circle.[13] The likelihood of the inside to outside ratio, assuming a Poisson distribution of cases, enables selection of the most likely cluster, which is the cluster less likely to have occurred by chance. The procedure is then repeated for detecting secondary clusters. The significance level of the clusters is computed using a resampling procedure (1,000 iterations). Only clusters for which $P > 0.05$ were retained for mapping. Cluster analysis was conducted separately on 1980–1989 and 1990–2004 data.

RESULTS

Between 1980 and 2004, 28,293 trichinellosis cases were reported in Romania. Taking into account census data, this figure corresponds to an incidence of 51.0 cases per 10^6 persons per year (Table 1). We analyzed separately 1) data from the pre-political (1980–1989) and post-political (1990–2004) periods of change and 2) data from Transylvania versus data from the other Romanian counties (Table 1). At the country level, an increase in the incidence rate was observed from the 1980–1989 period (19.6 cases per 10^6 persons per year) to the 1990–2004 period (71.8 cases per 10^6 persons per year), with an incidence ratio of 3.7. Additionally, for the entire period, the incidence rate obtained for Transylvanian counties (82.2 cases per 10^6 persons per year) was higher than the incidence rate obtained for the other counties (35.7 cases per 10^6 persons per year), with an incidence ratio of 2.3.

These two trends appear relatively independent of each other. The 1980–1989 versus 1990–2004 difference was observed in both Transylvania (incidence ratio = 3.2) and other counties (incidence ratio = 4.4). Similarly, the difference between Transylvania and other counties was observed in the 1980–1989 period (incidence ratio = 3.0) and the 1990–2004 period (incidence ratio = 2.2). These differences were statistically significant, as indicated by non-overlapping 95% confidence intervals (Table 1).

The yearly variations in the trichinellosis incidence rate show that the difference between the 1980–1989 period and the 1990–2004 period does not correspond to a global increase in the number of reported cases (Figure 1). After a slow increase in the incidence from 1986, a sharp peak was observed from 1990 to 1996, reaching a maximal value of more than 150 cases per 10^6 persons per year in 1993. The incidence then decreased to 20–30 cases per 10^6 persons per year. The incidence rate in Transylvania remained at a higher rate throughout the entire time period compared with the other non-Transylvania counties.

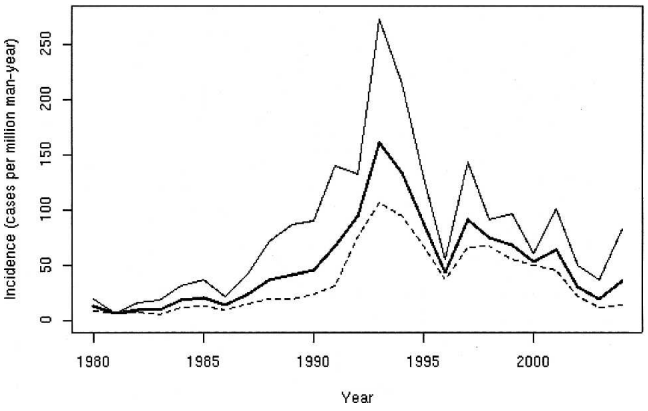

FIGURE 1. Yearly incidence rate of trichinellosis in Romania, 1980–2004 (thin line = Transylvania; dashed line = other counties; thick line = entire country).

Geographic variations of the incidence rate (Figure 2) confirm the difference in incidence between Transylvania and other counties. However, the incidence rate was heterogeneous, with higher values in two counties of western Transylvania (Caras-Severin and Hunedoara) and two Transylvanian counties in the center of the country (Brasov and Covasna). These geographic differences are observed both for the 1980–1989 and 1990–2004 periods. The incidence seems to have increased globally in 1990–2004 without marked changes in the geographic distribution of the incidence rates (Figure 2).

Trichinellosis case cluster analysis confirmed these geographic variations and showed convergent results for 1980–1989 and 1990–2004 period (Figure 3). The clusters identified were statistically significant and, unless otherwise specified, the P value for reported clusters was ≤ 0.001. For both periods, the most significant cluster was a high-rate area in the western part of Romaina, mainly in Transylvania (it includes Caras-Severin and Hunedoara). The associated RRs were 6.0 for 1980–1989 and 4.1 for 1990–2004. Moreover, the same high-rate secondary cluster was also obtained in Brasov and Covasna, with RRs of 6.5 for 1980–1989 and 4.3 for 1990–2004. Location of low-rate secondary clusters were also convergent for 1980–1989 and 1990–2004, in particular, in the same low-rate area in the northeastern part of the country. The corresponding RRs were 0.5 for the 1980–1989 and 0.2 for 1990–2004.

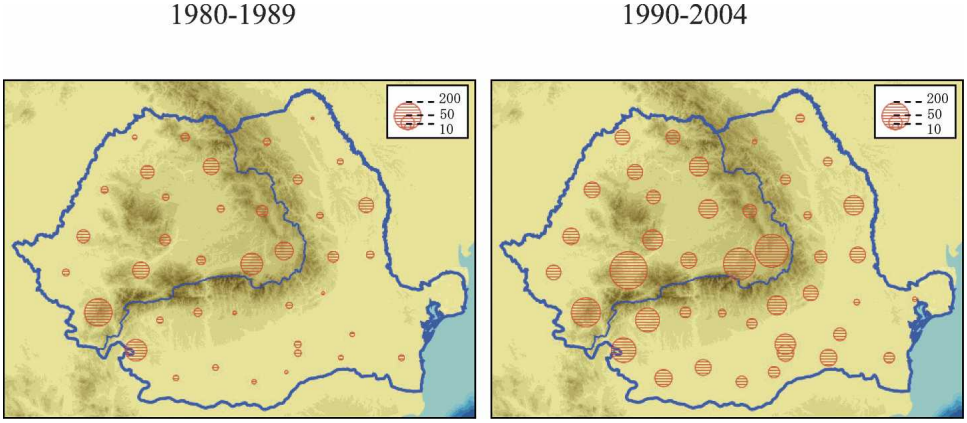

FIGURE 2. Cumulated incidence rate of trichinellosis in Romanian counties, 1980–1989 and 1990–2004 (cases per 10^6 persons per year). Thin blue line = Transylvanian border. This figure appears in color at www.ajtmh.org.

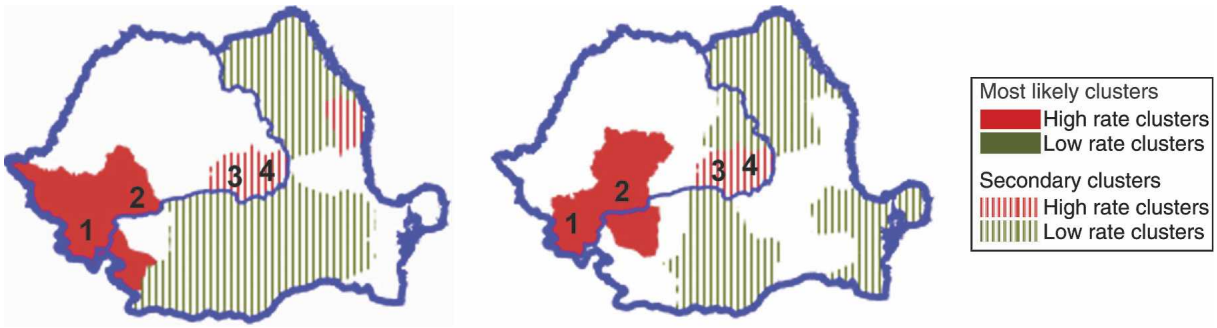

FIGURE 3. High-rate clusters and low-rate clusters of trichinellosis cases in Romania, A 1980–1989 and B 1990–2004. Counties: 1 = Caras-Severin; 2 = Hunedoara; 3 = Brasov; 4 = Covasna. Thin blue line = Transylvanian border. This figure appears in color at www.ajtmh.org.

DISCUSSION

The main outcome of our study is that between 1980 and 2004, 28,293 human trichinellosis cases were reported, which corresponds to an incidence of 51.0 cases per 10^6 persons per year (Table 1). Positive cases of human trichinellosis reported to NIMS are confirmed only by clinical signs, patient history, and positive biologic tests results. No confirmatory serologic or histologic tests are being routinely performed because they are too expensive. An overestimation might be possible, but the number of positive cases still remains extremely high compared with other countries.[4] If such an overestimation exists, it is the same in time and space; thus, differences we report still remain valid.

The average incidence indicates significant temporal and geographic variations. These include an increase in incidence from 1980–1989 (19.6 cases per 10^6 persons per year) to 1990–2004 (71.8 cases per 10^6 persons per year) and a higher incidence rate in Transylvanian counties (82.2 cases per 10^6 persons per year) when compared with the incidence rate in other counties (35.7 cases per 10^6 persons per year). In both cases, these differences may be analyzed using the same perspective, from animals to humans, with various factors involved. Variations in the *Trichinella* circulation level may exist in domestic and wild animal populations. In Romania, this animal population is the pig population. Cironeanu and Ispas[14] showed that 95% of human trichinellosis cases originate from pork consumption, with game meat playing a minor role in the epizootology of reported cases. Additionally, variations in the efficacy of food safety controls may exist. There may also be variations in the level of meat consumption or food habits, and the proportion of positive cases reported may vary.

Each of these factors may partially explain the increase in the incidence rate from 1980–1989 to 1990–2004. The parasite circulation level in pig herds probably increased at the end of the communist period, although there is no data available to confirm this. Closing of state production units after the change in the political regime resulted in the spread of infection and an increase in the contamination level of the meat and meat products.[8] Furthermore, the first years after the political changes were characterized by a chaotic state of veterinary services, with a decrease in the efficacy of food safety control. Before 1990, consumption of meat and meat products was restricted by use of a monthly card. With the new political regime, these restrictions disappeared and average consumption increased, which is similar to the increase in consumption and trichinellosis that has been observed in China.[15] Underreporting of trichinellosis cases probably occurred prior to 1990 because a clinical case was considered an unacceptable shame for the local county authorities.[14,16] Despite this factor, it can be assumed that the 1980–1989 to 1990–2004 increase in the observed incidence rate corresponds to an actual increase in the number of cases.

When analyzing the possible causes of the geographic variations in the trichinellosis incidence rate, with higher av-

erage rates observed in Transylvania compared with other counties, some of the factors reported earlier can be ruled out. Active surveillance data for 1997–2004 show that the prevalence of *Trichinella* infection was approximately half as much in home-slaughtered pigs and eight times lower in abattoir-slaughtered pigs in Transylvania when compared with the other non-Transylvania counties (Blaga R and others, unpublished data). No field data support a better efficacy of food safety controls in Transylvania, or a more accurate and exhaustive identification and declaration of human trichinellosis cases, because no significant discrepancy exists among the food safety and medical infrastructures of each of the 42 Romanian counties.

A better explanation for the higher trichinellosis incidence in Transylvania is based upon the food habits of the local populations. The natural barrier of the Carpathian Mountains chain) delimitating Transylvania from the rest of Romania confined the middle age colonization of Romania by populations of German origins only to this region. Since Transylvania was part of the Austrian-Hungarian empire until 1918, these populations have kept their customs, language and, in particular, their food habits (raw meat consumption), which are known to be risk factors for trichinellosis. Conversely, the rest of Romania was never colonized by foreign populations. The practice of eating raw pork does not exist in current or previous Romanian customs and cultures.[17] The location of these populations of German origin closely correspond to the convergent high-rate areas obtained in the 1980–1989 and 1990–2004 cluster analyses: Caras-Severin and Hunedoara in western Romania and the Brasov and Covasna in central Romania. This difference between Transylvania and other counties of Romania is valid in any of the years investigated, and is evidence for the major role of food habits in geographic variations in the incidence of trichinellosis.

With an trichinellosis incidence of 51.0 cases per 10^6 persons per year over a period of 25 years, *Trichinella* and trichinellosis are a major concern in Romania. The special eating habits of the local people, a major factor associated with severe human trichinellosis, combined with the overthrow of the social and political structures in the 1990s, explains the significant geographic and time variations in the human trichinellosis incidence rate in this country.

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Authors' addresses: Radu Blaga, Agence Française de Sécurité Sanitaire des Aliments, Institut National de Recherche Agronomique, Ecole Nationale Vétérinaire d'Alfort, Université Paris XII Val de Marne, Joint Research Unit 956, Biologie Moléculaire et Immunologie Parasitaire et Fongique, 23 Avenue du Général de Gaulle, BP 67-94703, Maisons-Alfort CEDEX, France, Telephone: 33-1-49-77-13-00, Fax: 33-1-49-77-13-16. E-mail: blecgec@yahoo.com, and Parasitology Unit, Faculty of Veterinary Medicine, University of Agricultural Sciences and Veterinary Medicine, Calea Manastur nr 3-5, 400372 Cluj-Napoca, Romania, Telephone: 40-264-596-384, Fax: 40-264-593-792. Benoit Durand, Epidemiology Unit, Agence Française de Sécurité Santiaire des Aliments, 23 Avenue du Général de Gaulle, BP 67-94703, Maisons-Alfort CEDEX, France, Telephone: 33-1-49-77-13-34, Fax: 33-1-43-68-97-62, E-mail: b.durand@afssa.fr. Silvia Antoniu, Parasitology Unit, Faculty of Veterinary Medicine, University of Agronomical Sciences and Veterinary Medicine, 105 Splaiul Independentei, 050097 Bucharest, Romania, Telephone: 40-21-318-0469, Fax: 40-21-318-0498, E-mail: antoniu_silvia@yahoo.com. Calin Gherman and Vasile Cozma, Parasitology Unit, Faculty of Veterinary Medicine, University of Agricultural Sciences and Veterinary Medicine, Calea Manastur nr 3-5, 400372 Cluj-Napoca, Romania, Telephone: 40-264-596-384, Fax: 40-264-59-37-92, E-mails: calingherman@yahoo.com and cozmavasile@yahoo.com. Carmen M. Cretu, Parasitology Unit, Faculty of Medicine, "Carol Davila" University of Medicine and Pharmacy, 19-21 Str. Gerota, 020027 Bucharest, Romania, Telephone: 40-21-668-5657, Fax: 40-21-211-0276, E-mail: clmcretu6@cmb.ro. Pascal Boireau, Agence Française de Sécurité Sanitaire des Aliments, Institut National de Recherche Agronomique, Ecole Nationale Vétérinaire d'Alfort, Université Paris XII Val de Marne, Joint Research Unit 956, Biologie Moléculaire et Immunologie Parasitaire et Fongique, 23 Avenue du Général de Gaulle, BP 67-94703, Maisons-Alfort CEDEX, France, Telephone: 33-1-49-77-13-27, Fax: 33-1-49-77-13-16, E-mail: pboireau@vet-alfort.fr.

Reprint requests: Joint Research Unit, Biologie Moléculaire et Immunologie Parasitaire et Fongique, Institut National de Recherche Agronomique, Agencie Français de Sécurité Santiaire des Aliments, Ecole Nationale Veterinaire d'Alfort, Université Paris XII Val de Marne, 23 Avenue du Général de Gaulle, BP 67-94703, Maisons-Alfort CEDEX, France.

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