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Seroprevalence of human *Toxocara* infections in the Roma and non-Roma populations of Eastern Slovakia: a cross-sectional study

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SUMMARY

Socioeconomic conditions and health of the Roma population, the most numerous minority in Europe, are worse than that of the non-Roma population. Information about the occurrence of human toxocarosis and other parasitic diseases in the Roma population is scarce or completely missing. The aim of this study was to map the seroprevalence of toxocarosis in the population living in segregated Roma settlements and to compare the data with the occurrence of antibodies in the non-Roma population of Eastern Slovakia. The seropositivity to *Toxocara* in 429 examined Roma inhabitants of segregated settlements reached 22·1%, while only 4/394 samples of the non-Roma population were found to be positive (odds ratio 27·7, $P < 0·0001$). Headache, muscle pain, influenza-like symptoms and diarrhoea occurred significantly more often in seropositive persons than in seronegative individuals. In the Roma population positivity was not influenced by gender, level of education and poverty, but age, lack of sanitary facilities and heating with wood significantly increased the risk of infection. It can be assumed that besides the high prevalence of toxocarosis, other parasitic diseases and communicable diseases will also be more prevalent in the Roma population living in segregated settlements.

Key words: Risk assessment, Roma people, seropositivity, toxocarosis, *T. canis*.

INTRODUCTION

Human toxocarosis is a parasitic disease caused by larval stages of *Toxocara canis* and *Toxocara cati,* frequent parasites of domestic and wild carnivores. The life-cycle of these parasites is direct, adult worms live in the intestinal tract of definitive host and shed eggs via the faeces into the environment. Humans may become infected after the accidental ingestion of embryonated *Toxocara* eggs or, more rarely, by ingesting encapsulated larvae contained in the raw or undercooked tissues of paratenic hosts, such as cows, sheep or chicken. In the small intestine larvae hatch from the eggs and migrate through the body, but do not develop to adult worms. The clinical spectrum of *Toxocara* infestation in humans varies from asymptomatic, the most common form, to severe organ injury. Two clinical syndromes are classically described: visceral larva migrans (VLM; a systemic disease caused by migration of larvae through organs) or, if there is eye damage, ocular larva migrans [1].

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Neurotoxocarosis has been also described in previous studies [2, 3].

The Roma belong to one of the oldest and largest minorities in Europe. In general, their socioeconomic conditions and health, especially those living in segregated settlements, are worse than that of the non-Roma population. Their health status is characterized by shorter life expectancy, higher infant mortality, numerous chronic illnesses, unbalanced nutrition and unhealthy lifestyle [4]. Segregated settlements, often with no access to electricity, tap water and sewage system [5], are concentrated in small areas with large numbers of people and domestic animals in one place. Such conditions can significantly contribute to the spread of infectious and parasitic diseases, but the literature dealing health conditions and occurrence of diseases in the Roma ethnic minority is sparse [6, 7]. Moreover, information about the occurrence of parasitic diseases in Roma people is scarce or completely missing. Therefore, the aim of this cross-sectional population-based study was to map the seroprevalence of human toxocarosis in the population living in separated and segregated Roma settlements and to compare it with the occurrence of specific antibodies in the non-Roma population living in the catchment area of Eastern Slovakia. Occurrence of clinical symptoms and infection risk factors were also analysed.

MATERIAL AND METHODS

Collection of data

Data from the cross-sectional population-based HepaMeta study conducted in Slovakia in 2011 were used. This project aimed to map the prevalence of viral hepatitis B/C and metabolic syndrome in the population living in separated and segregated Roma settlements and to compare it with the occurrence of the same health indicators in the majority non-Roma population. The HepaMeta study was set up following the principles of community-based participatory research. Roma, as the target group, were involved in the process of questionnaire development (designing and piloting) and data collection through active involvement of Roma community workers in all phases of the study [8].

The target population comprised residents of settlements in the Košice region (Eastern Slovakia) and the control group was the non-Roma population in the same region and of the same age composition. With cooperation between the HepaMeta team, general practitioners and Roma community workers a total of 429 Roma respondents from the segregated settlements and 394 respondents from the non-Roma population living in the same sub-region of Eastern Slovakia were included in the study. Inclusion criteria for the respondents were as follows: no preventive medical check-up in the past 2 years, no acute illness, age between 18 and 55 years, and availability during the week of data collection.

Trained medical personnel collected blood samples and selected medical data, and assisted respondents in completing the questionnaire developed by a group of experts (public health experts, academics, Roma health mediators and community workers). The questionnaire gathered information on socio-demographic background, living conditions, health-related behaviour, health, and healthcare use. The questionnaire also contained questions about education which was divided into three categories (elementary, secondary vocational school, higher education) and employment status. The economic situation and poverty were assessed by the presence of any problems regarding regular living expenses (e.g. rent, electricity and water costs, healthcare, general shopping, loans). Style of living was assessed according to the presence of household sanitary facilities, and type of household heating.

The analyses of soil from segregated settlements would have been very useful for better interpretation and understanding of results, but unfortunately no soil samples were taken during the collection of samples and data within the HepaMeta study.

The study was approved by the Ethics Committee of the Faculty of Medicine at Šafárik University, Košice (No. 104/2011). Participation in the study was on a fully voluntary basis and anonymous. Detailed information about the study and its procedures was given to all respondents, and informed consent was obtained prior to the medical examination.

Serological tests

Collection of venous blood was performed under standard conditions, after overnight fasting, from a peripheral vein in the antecubital fossa. After centrifugation of the blood, serum samples were collected and stored at –20 °C until tested. Enzyme-linked immunosorbent assay (ELISA) was used for the detection of anti-*Toxocara* antibodies. T. *canis* larval excretory-secretory (E/S) antigen was prepared according to method of de Savigny [9]. Microtitre plates were coated overnight at 4 °C with antigen containing

1 μg/ml protein diluted in carbonate buffer (pH 9·6). The plates were washed three times and serum samples (diluted 1:200) were placed on plates in a volume of 100 μl per well. After 1 h incubation at 37 °C the plates were repeatedly washed three times. Horseradish peroxidase-labelled anti-human IgG (anti-human IgG, Sigma-Aldrich, USA) diluted 1: 40 000 in a volume of 100 μl was used as conjugate. After incubation for 1 h, plates were washed three times and 100 μl substrate (*o*-phenylenediamine with 0·05% H_2O_2) was added. The reaction was stopped after 20 min of incubation in the dark at room temperature by 50 μl of 2 m H_2SO_4 and optical density (OD) was measured spectrophotometrically at 490 nm (Thermo Labsystems Opsys MR, USA).

Sera of patients with confirmed *Toxocara* infection (obtained with the cooperation of infection clinics) and negative sera were used as controls. Positivity or negativity of control sera was verified by *Toxocara* IgG EIA test kit (Test Line, Czech Republic). Cut-off value was calculated according to OD values of positive and negative control panel sera. Sera with OD values >0·6 were considered as positive. Sera with OD values between 0·6 and 0·9 were interpreted as having low antibody titres, sera with OD values between 0·9 and 1·2 as medium antibody titres, and sera with OD values >1·2 were considered highly positive.

Statistical analyses

Prevalence is described as relative frequency with 95% confidence interval (95% CI). Differences between categorical variables were analysed by χ^2 test, in case of only two categories (2 × 2 contingency table), odds ratios (OR) with 95% CI were also calculated. Differences between continuous variables were analysed by Mann–Whitney test. The risk factors were first tested univariately by logistic regression with adjustment for confounders. Statistically significant predictors in univariate regression were, in meaningful cases, included in the multivariate regression model. A two-sided P value of 0·05 was considered statistically significant.

RESULTS

Seroprevalences in Roma and non-Roma populations

The final sample comprised 429 Roma and 394 non-Roma participants. The seropositivity to *Toxocara* in the Roma inhabitants of segregated settlements reached 22·1% (95% CI 18·5–26·3), while only four samples (1·0%, 95% CI 0·3–2·7) out of the majority population were found to be positive ($P < 0·0001$). Unadjusted relative risk (RR) of seropositivity to *Toxocara* in the Roma population was more than 21 times higher than in the non-Roma population (RR 21·07, OR 27·7, 95% CI 10·1–76·9). After adjustment (standardization) for age and sex the odds ratio was still significantly against the Roma population (OR 25·0, 95% CI 9·2–71·4).

Table 1. *Baseline parameters of the cohort study*

	Roma population *N* (%)	Non-Roma population *N* (%)	*P*
Male sex	159 (35·2)	185 (45·9)	0·001
Unemployed	374 (89·3)	101 (26·6)	<0·0001
Education			<0·0001
Elementary	342 (81·2)	9 (2·3)	
Secondary vocational school	70 (16·6)	83 (21·5)	
Higher	9 (2·1)	294 (76·2)	
Lack of basic household facilities*	269 (62·7)	76 (19·3)	<0·0001
Payment problems†	213 (49·6)	81 (20·6)	<0·0001
Brick house	399 (94·5)	366 (99·5)	<0·0001
Anti-*Toxocara* antibody prevalence	95 (22·1)	4 (1·0)	<0·0001

* Lacking at least one of the following items: sewage system, water supply, flushing toilet, bathroom or shower, electricity supply.

† Inability to pay at least one of the following items: rent, loan payment, healthcare, electricity and water costs, other expenses.

Table 1 summarizes the baseline parameters in the study population and confirms significant differences in the lifestyle of the Roma and non-Roma populations in Slovakia. Roma participants were more frequently unemployed and unable to afford every-day living expenses, and attained a lower level of education. The average age of both analysed groups was similar ($P = 0·043$), reaching $34·7 \pm 9·14$ years in the Roma minority and $33·5 \pm 7·41$ years in the non-Roma population.

Risk factors of Toxocara infection

The seropositivity to *Toxocara* varied with age, gender, education, employment and hygiene habits of

Table 2. *Occurrence of anti-*Toxocara *antibodies in relation to gender, age, education and employment*

	Roma population			Non-Roma population		
	N	(%)	95% CI	*N*	(%)	95% CI
Gender						
Men	148	(20·9)	15·1–28·2	182	(0·0)	0·0–1·8
Women	281	(22·8)	18·3–28·0	212	(1·9)	0·6–4·9
Age, years						
18–29	139	(15·8)	10·6–22·9	131	(0·8)	0·01–4·6
30–39	146	(23·3)	17·1–30·8	182	(1·1)	0·04–4·2
40–49	125	(24·8)	18·0–33·1	63	(0·2)	0·01–9·3
50–55	14	(35·7)	16·2–61·4	9	(0·0)	0·0–26·9
Education						
Elementary school	342	(21·9)	17·9–26·6	9	(0·0)	0·0–26·9
Secondary vocational school	70	(24·3)	15·7–35·6	83	(1·2)	0·01–7·2
Higher	9	(0·0)	0·0–26·9	294	(1·0)	0·00–2·1
Employement						
Employed	45	(13·3)	5·9–26·6	278	(0·7)	0·0–2·8
Unemployed	374	(23·3)	19·3–27·8	101	(2·0)	0·0–7·3
Payment problems						
Yes	213	(23·5)	18·3–29·6	81	(1·2)	0·0–7·3
No	216	(20·8)	15·9– 26·8	313	(0·96)	0·2–2·9
House						
Non-brick	23	(34·9)	18·7–55·2	2	(0·0)	0·0–6·3
Brick	399	(21·3)	17·5–25·7	366	(1·1)	0·3–2·9
Lack of household facilities						
Yes	74	(27·5)	22·5–33·1	2	(2·6)	4·6–10·1
No	21	(13·1)	8·6–19·2	2	(0·6)	0·2–2·3

CI, Confidence interval.

Table 3. *Predictors of positivity to* Toxocara *for the Roma and non-Roma populations*

	Roma population			Non-Roma population		
	OR	95% CI	*P*	OR	95% CI	*P*
Male sex	0·898	0·554–1·458	0·664	n.a.	n.a.	n.a.
Age (years)	1·029	1·003–1·056	0·029	1·017	0·892–1·159	0·802
Unemployed	1·970	0·807–4·809	0·136	2·788	0·387–20·0	0·309
Education (each category)	0·967	0·684–1·366	0·847	0·889	0·276–2·861	0·844
Lack of household facilities*	2·512	1·477–4·271	0·001	4·270	0·592–30·812	0·150
Payment problems†	1·052	0·667–1·660	0·827	2·375	0·242–23·295	0·458

Odds ratio; CI, confidence interval; n.a., not available/not calculated.
* Lacking at least one of the following items: sewage system, water supply, flushing toilet, bathroom or shower, electricity supply.
† Inability to pay at least one of the following items: rent, loan, healthcare, electricity and water costs, other expenses.

analysed persons (Table 2). Risk factors for seropositivity to *Toxocara* were analysed by univariate logistic regression separately for Roma and non-Roma groups (Table 3). Gender, level of education and unemployment did not significantly influence the prevalence of antibodies. Moreover, poverty and living in non-brick houses were not found to be significant risk factors for *Toxocara* seropositivity in the Roma population.

Roma people had a higher risk of being *Toxocara* seropositive with increasing age (OR 1·029 for each year, 95% CI 1·003–1·056) and the major risk factor for positivity to *Toxocara* in Roma people was the

Table 4. *Influence of lack of sanitary facilities in Roma households on seropositivity to Toxocara*

Household facility	Seronegative ($N = 334$) n (%)	Seropositive ($N = 95$) n (%)	aOR	95% CI	P
No sewage system	162 (48·5)	65 (68·4)	2·265	1·388–3·695	0·001
No tap water	120 (35·9)	63 (66·3)	3·400	2·089–5·534	<0·0001
No flushing toilet	142 (42·5)	68 (71·6)	3·210	1·945–5·299	<0·0001
No bathroom or shower	147 (44·0)	65 (68·4)	2·663	1·632–4·344	<0·0001
No electricity	52 (15·6)	22 (23·2)	1·601	0·893–2·871	0·114

aOR, Age-adjusted odds ratio; CI, confidence interval.

lack of household hygiene facilities. The lack of at least one of the following: sewage system, water supply, flushing toilet, bathroom/shower or electricity supply was found to be a significant predictor of positivity to *Toxocara* (OR 2·512, 95% CI 1·477–4·271). None of analysed predictors was found to be significant in the non-Roma population due to the low number of positive individuals (Table 3). Significant predictors of *Toxocara* seropositivity in Roma people (age and household facilities) were included in the multivariate regression model. Both predictors remained statistically significant with OR 2·422 (95% CI 1·418–4·139) for household facilities and 1·029 (95% CI 1·002–1·056) for age, which means they are independent from one another.

As a significant relationship between occurrence of anti-*Toxocara* antibodies and household facilities was detected, we further analysed this aspect in detail. Infection risk factors related to lifestyle and hygiene were evaluated only in Roma respondents, because all participants from the non-Roma population reported availability of adequate sanitary facilities. Table 4 shows the results of logistic regression analyses of individual risk factors associated with living conditions adjusted for age. The highest odds ratio for seropositivity to *Toxocara* was found in Roma people living without tap water, followed by individuals without flushing toilet, bathroom and sewage system. The unavailability of electricity was not found to be a significant predictor of seropositivity ($P = 0·114$). When combined in a multivariate regression model, only the lack of tap water remained independently associated with seropositivity (Table 5).

Table 5. *Multivariate regression model of* Toxocara *seropositivity predictors related to lack of sanitary facilities*

Household facility	OR	95% CI	P
Age	1·026	0·999–1·055	0·062
No sewage system	0·750	0·341–1·652	0·475
No tap water	2·491	1·198–5·181	0·015
No flushing toilet	2·441	0·823–7·236	0·108
No bathroom or shower	0·822	0·302–2·240	0·702
No electricity	0·980	0·524–1·833	0·950

OR, Odds ratio; CI, confidence interval.

Analyses also revealed the influence of heating system on the occurrence of antibodies to *Toxocara* in the Roma minority. Out of 95 seropositive individuals, significantly more (93·7%) participants used wood for heating compared to the seronegative group (84·4%, $P = 0·01$). Age-adjusted odds ratio showed that using wood for heating increased the chance for *Toxocara* seropositivity almost fourfold. On the other hand, the odds ratio of seropositivity in individuals who usually used radiators for heating was more than 80% lower compared to those who used other materials. We performed no multivariate regression due to the high degree of intercorrelation between two significant predictors (wood and radiators; $R = 0·473$, $P < 0·0001$) (Table 6).

Clinical symptoms

In *Toxocara*-seropositive individuals (both Roma and non-Roma participants grouped together) the occurrence of clinical symptoms was analysed. Out of symptoms that could be related to *Toxocara* infection, headache, muscle pain, influenza-like symptoms and diarrhoea occurred significantly more frequently in persons with anti-*Toxocara* antibodies than in negative individuals. These symptoms, except diarrhoea, remained significantly associated with the presence of antibodies to *Toxocara* even after adjustment for age and sex, but the frequency of symptoms did not

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Table 6. *Influence of use of different heating materials in Roma households on positivity to* Toxocara

Material	Seronegative (*N* = 334) *n* (%)	Seropositive (*N* = 95) *n* (%)	aOR	95% CI	*P*
Wood	282 (84·4)	89 (93·7)	3·995	1·399–11·404	0·01
Coal	26 (7·8)	9 (9·5)	1·322	0·593–2·946	0·495
Rubbish	12 (3·6)	3 (3·2)	0·846	0·232–3·084	0·800
Petrol, oil	2 (0·6)	1 (1·1)	1·887	0·168–21·183	0·607
Radiators	33 (9·9)	2 (2·1)	0·197	0·046–0·840	0·028

aOR, Age-adjusted odds ratio; CI, confidence interval.

Table 7. *Occurrence of clinical signs and symptoms related to human toxocarosis in persons positive and negative to* Toxocara*. Age- and sex-adjusted univariate regression.*

Clinical signs and symptoms	Unadjusted difference			Adjusted for age and sex	
	Positive (%) (*N* = 100)	Negative (%) (*N* = 727)	*P*	OR	95% CI
Headache	79·0	62·7	<0·001	2·28	1·31–3·95
Muscle pain	36·4	23·5	0·006	1·61	1·01–2·56
Influenza-like symptoms	36·4	16·9	<0·001	2·67	1·68–4·25
Diarrhoea	11·1	5·5	0·031	2·01	0·96–4·20
Abdominal pain	31·3	24·0	0·116	1·41	0·88–2·27
Cough	36·4	27·2	0·058	1·45	0·92–2·27
Allergy	9·1	10·1	0·75	0·73	0·34–1·58
Fatigue	47·5	45·9	0·76	1·03	0·67–1·58
Insomnia	21·2	22·0	0·87	0·85	0·50–1·45
Anxiety	17·2	13·0	0·25	1·20	0·67–2·14
Stress	28·3	31·2	0·55	0·78	0·48–1·26

OR, Odds ratio; CI, confidence interval.

correlate with the antibody titres. The occurrence of some neurological or psychological disorders that could indicate the presence of neurotoxocarosis did not differ significantly between the seropositive and seronegative groups (Table 7).

DISCUSSION

Toxocarosis is one of the most widespread parasitozoonoses that humans share with dogs, cats and a range of wild definitive hosts, particularly foxes. It is prevalent primarily in the tropics and subtropics and in less industrialized nations, but it is also an important cause of morbidity in developed countries, especially in children and socioeconomically disadvantaged populations [10–12]. The Roma people are considered to be a socioeconomically disadvantaged minority; their health status, particularly those living in settlements, is heavily compromised by poor living conditions, low educational level, unemployment, poverty, segregation and discrimination [13, 14]. In this study, the prevalence of antibodies to *Toxocara* in respondents from the non-Roma population was only 1·0%, while in the Roma minority it was as high as 22·1%. This result highlights the differences between the two population groups. In Slovakia, *Toxocara* seropositivity detected in studies focused exclusively, or mostly so, on non-Roma populations ranges between 1·3% observed in randomly chosen healthy persons [15] and 5·5% detected in women with habitual abortions [16] and 8·4% in pregnant women from the Bratislava region [17]. These data are similar to results observed in other European countries. In Austria, 6·3% of individuals volunteering for military service tested positive for *Toxocara* [18], in Italy 6·6% positivity in 201 healthy persons was reported by Nicoletti *et al.* [19] and 2·4% prevalence was recorded in Denmark [20]. However, in populations living in poor social and hygiene conditions seropositivity is usually higher. Seropositivity in rural settlers in Brazilian Amazonia reached 28·6% [21]; Ajayi *et al.* [22] found 30·4% seroprevalence in adults from Nigeria and 31·6% of positive individuals were detected in three provinces of Patagonia [23].

The prevalence of *Toxocar*a spp. in humans is influenced by environmental, geographical, cultural and socioeconomic factors at the population level; and by age, gender, nutrition, behaviour, susceptibility to infection and genetics at the individual level [12, 24]. In this study positivity was not influenced by gender of either tested population groups. Similarly, unemployment and inability to pay normal living expenses (poverty) were not found to be predictors of human toxocarosis.

Education level is considered to be related to behaviour, health conditions and access to knowledge that can have direct and indirect impacts on activities that can increase the risk of infection [25]. It has been confirmed that education level influences the risk of some infectious diseases, e.g. cystic echinococcosis [26] or human papillomavirus infection [27]. Although some correlation between the level of education and the seropositivity of Roma respondents was expected, the level of completed education did not influence the prevalence of antibodies. It can be assumed that higher and better education of the Roma people did not change their hygiene consciousness or habits. By contrast, in the USA Won *et al.* [28] observed an association between education of the head of household and *Toxocara* positivity. They found that the higher level of completed education decreased the seroprevalence of antibodies in family members.

In this study, age appears to be a significant risk factor of *Toxocara* infestation in the Roma participants. Each year of age increases the chance of *Toxocara* seropositivity by 1·029 times ($P = 0{\cdot}029$). Usually, young age is considered to be the prominent risk factor of infection [21, 29], but children were not included in our study. The positive correlation of seroprevalence with age observed in adult Roma participants is probably related to high infectious pressure of an environment contaminated with *Toxocara* spp. eggs. Cumulative effect of repeated infections that elicits the increase of seroprevalence with age was observed also in studies provided in populations with poor sanitary levels [23, 30].

Analysis of infection of risk factors in Roma participants revealed a very strong association between household sanitary facilities and occurrence of antibodies. People who had no access to a sewage system, tap water, flushing toilet and bathroom were positive significantly more often than persons with better equipped homes. The risk of infection was highest in people without tap water, followed by people without a flushing toilet, bathroom and sewage system in their homes. Similarly to our results, a study from La Réunion confirmed the absence of water supply to be a risk factor of *Toxocara* infection while type of housing did not influence the positivity of inhabitants [30].

Another interesting result was the influence of the type of heating on seropositivity. People that used wood for heating were positive significantly more often than those who used coal, petrol or oil, with almost a fourfold increased risk of being seropositive. We assume that collection and handling of wood, which is often contaminated by soil, together with inadequate hygiene habits and limited access to water significantly increases the possibility of acquiring infection. This assumption also supports the finding of significantly lower prevalence of antibodies in people using electric radiators for heating. The odds ratio of seropositivity in individuals that use radiators was more than 80% lower than in those who used other materials. Several authors have studied risk factors of toxocarosis in humans. Deutz *et al.* [31] discovered a correlation between some occupations and *Toxocara* antibody prevalence. The risk of infection in farmers, veterinarians, slaughterhouse workers and hunters was higher than that in a control group. Dog ownership and occupational animal contact were also significantly associated with a higher risk of seropositivity to *Toxocara* [18, 28]. Higher prevalence of antibodies was recorded in people from rural areas (11·0%) than in those from urban settings (6·6%) [17].

Human *Toxocara* infections are usually clinically asymptomatic. The clinical picture of the most common generalized form, VLM syndrome, includes fever, abdominal pain, vomiting, diarrhoea, respiratory signs, cough, anorexia, weight loss, fatigue and neurological manifestations [12, 32]. In this study, headache, muscle pain and influenza-like symptoms occurred significantly more often in *Toxocara*-positive individuals. Incidence of some neurological or psychological disturbances did not differ significantly between the group of seropositive and seronegative participants.

The life of the Roma minority in segregated settlements consists of a high concentration of people and animals. Poverty, a serious problem of people living in segregated settlements, affects almost every aspect of life of the inhabitants. Inadequate hygiene habits are also frequently described as occurring in the Roma minority [33]. Settlements often lack access to drinking water, sewage, waste pits, sanitary facilities and garbage disposal [5]. The health status of humans as well as their healthcare is unsatisfactory. Available studies suggest the existence of barriers to access of healthcare and overuse of emergency care and underuse of preventative services in the Roma ethnic minority [6, 34]. Poverty was reported as the main barrier in accessing healthcare by almost 50% of the Roma population, compared to only 5% of the majority population [35]. The health status of animals in settlements is also often poor; dogs and cats are usually not treated and dewormed. In a study by Pipíková & Papajová [36] more than 90% dog faecal samples contained eggs of at least one endoparasite species and *T. canis* eggs were found in 41·28% of samples. Prevalence of *T. canis* in dogs from selected settlements in the Košice and Prešov regions of Eastern Slovakia reached 45·2% [37]. The soil in settlements is also heavily contaminated by propagative stages of pathogens. Rudohradská *et al.* [37] found parasite eggs in 79·2% of 106 soil samples collected in five segregated settlements in Eastern Slovakia and the contamination by *Toxocara* spp. eggs ranged between 41·2% and 78·1%, with average prevalence of 57·3%. In a study by Štrkolcová *et al.* [38] *Toxocara* eggs were present in 30% of soil samples collected in a Roma settlement in the Košice region (Eastern Slovakia). By comparison, *Toxocara* eggs were not detected in any of 15 soil samples from urban area of Eastern Slovakia inhabited by non-Roma populations [36]. These factors contribute to higher prevalence of human toxocarosis within the community and increase the possibility of repeated infections. We assume that besides the high prevalence of toxocarosis other parasitic and communicable diseases will also be more prevalent in populations living in segregated settlements.

CONCLUSION

The Roma populations of segregated settlements live in close contact with an environment contaminated by propagative parasite stages. In the present study, a significantly higher seroprevalence of *Toxocara* infection in the Roma minority than in non-Roma population was confirmed. Positivity was not influenced by gender, level of education or poverty of the Roma people, but age, lack of sanitary facilities and using wood for heating significantly increased the risk of infection. Factors such as lack of hygiene, high number of domestic animals and inadequate treatment of animals and humans contribute to the high prevalence of infectious diseases in the Roma population. This is connected not only with a negative impact on their health status and higher costs of treatment but also with an increased risk of spreading communicable diseases, particularly in view of the increased rate of travel of this ethnic minority observed throughout the European Union.

APPENDIX. HEPAMETA TEAM

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DECLARATION OF INTEREST

None.

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