scientific reports

Check for updates

OPEN

Visceral larva migrans among hospitalized patients in Poland: analysis of national hospital discharge data from 2014 to 2023

Krzysztof Kanecki[1], Katarzyna Lewtak[1,2]✉, Paulina Szot[1,3]✉, Paweł Goryński[4], Irena Kosińska[1], Aleksandra Kanecka[5] & Aneta Nitsch-Osuch[1]

Visceral larva migrans (VLM) is a type of toxocariasis and is among the most widespread zoonotic parasitic infections of public health importance. This study aimed to describe the structure and epidemiological trends in hospitalization of patients with VLM in Poland (2014–2023). This population-based, retrospective study utilized hospitalization records of VLM patients in Poland obtained from the Nationwide General Hospital Morbidity Study. A total of 3559 hospital discharge records were assessed. The study group consisted of 1888 males (53% of all patients) and 1671 females (47%). Patients under 20 years of age accounted for 64.8% of all hospitalizations. The mean VLM hospitalization rate was estimated at 0.93 per 100,000. Significant differences were found between mean annual hospitalization rates in 2014–2019 and 2020–2023 (1.1 vs. 0.67 per 100,000, P < 0.001). A significantly greater share of VLM-related hospitalizations was observed in rural populations compared with urban counterparts (59.6% vs. 39.8%; P < 0.001). Hospitalizations of VLM patients primarily involved individuals under 20 years of age, males, and those living in rural areas. The reported data may be useful for comparative analyses in global contexts and suggest a need to promote higher public health standards for the monitoring and prevention of toxocariasis.

Keywords Visceral larva migrans, Toxocariasis, Epidemiology, Hospitalizations, Nationwide register

Abbreviations

VLM	Visceral larva migrans
WHO	World Health Organization
NGHMS	Nationwide General Hospital Morbidity Study
NIPH NIH-NRI	National Institute of Public Health, National Institute of Hygiene – National Research Institute
ICD-10	International Statistical Classifications of Diseases and Related Health Problems, 10th Revision

Visceral larva migrans (VLM) is a syndrome caused by the migration of helminths through the liver or other organs. Clinical manifestations of VLM range from skin disorders (pruritus, urticaria), lung involvement (pleural effusion, asthma-like symptoms), focal hepatic lesions, ocular involvement, and diffuse abdominal involvement (hepatosplenomegaly, abdominal effusion). It is caused by the larvae of *Toxocara canis* and, to a lesser extent, *Toxocara cati* and other parasite species (such as *Ascaris suum*, *Gnathostoma spp*, *Baylisascaris spp*, and capillariasis)[1]. Embryonated *Toxocara* eggs are important environmental contaminants. Humans, particularly children, are primarily infected by ingesting contaminated soil or food. Dogs acquire *Toxocara canis* early in life through transplacental and lactogenic routes, while kittens acquire *T. cati* lactogenically. Pets can also ingest eggs from their environment, with a magnified risk in places like shelters. Among humans, most

[1]Department of Social Medicine and Public Health, Medical University of Warsaw, Pawińskiego 3A, 02-106 Warsaw, Poland. [2]Department of Population Health Monitoring and Analysis, National Institute of Public Health NIH – National Research Institute, Warsaw, Poland. [3]Department of Social Medicine and Public Health, Students' Scientific Circle of Hygiene and Prevention, Medical University of Warsaw, Warsaw, Poland. [4]School of Public Health, Centre of Postgraduate Medical Education, Warsaw, Poland. [5]Faculty of Medical Sciences and Health Sciences, Kazimierz Pulaski University of Technology and Humanities in Radom, Radom, Poland. ✉email: katarzyna.lewtak@wum.edu.pl; paulinaszotszkolny@gmail.com

infections are asymptomatic. It was reported that toxocariasis may encompass a few clinical entities: VLM, ocular larva migrans, covert toxocariasis, common toxocariasis, and neurotoxocariasis[2]. The disease may be associated with numerous complications, primarily allergic or neurological disorders, and may include cognitive or developmental delays in children, as well as visceral and ocular larva migrans. The World Health Organization (WHO) reported soil-transmitted helminthiases, including toxocariasis, to be among the most common human parasitic diseases[3]. Toxocariasis remains a widespread zoonotic parasitic infection, affecting millions of people and their pets worldwide[4].

The overall prevalence of *Toxocara* infection in dogs was reported at 11.1%, ranging from 6.4 to 19.2% across different WHO regions. It is estimated that over 100 million dogs are infected with *Toxocara* worldwide[5]. In another study, the global pooled prevalence of *Toxocara* infection in cats was 17.0%[6]. The overall pooled global prevalence of *T. canis* infection among red foxes was reported at 32.1%, highlighting their potentially significant role in transmitting the infection to both companion animals and humans[7]. A systematic review of studies from 26 European countries reported an average prevalence of 14.6% for *T. canis* infection in dogs and 24.5% for *T. cati* infection in cats. Additionally, the prevalence of patent *Toxocara* infections in both dogs and cats has not shown a notable decline over the past 25 years[8]. The pooled global prevalence of *Toxocara* eggs in public places was reported to be 21%. Estimated prevalence rates across different WHO regions ranged from 13 to 35%, with 18% reported in Europe[9]. In Poland, soil contamination with the eggs of geohelminths was reported to range from 0.9 to 40.5%[10].

High prevalence of patent *Toxocara* infection in canids and felids may increase environmental contamination with embryonated eggs. Large meta-analysis of data from published records indicates that public places are often heavily contaminated with eggs of *Toxocara*[9]. Seroprevalence studies suggest that exposure to the parasite is extremely common[4]. At the population level, environmental contamination, seroprevalence among humans, and, what should be particularly emphasized, hospitalization rates can serve as sentinels of underlying public health conditions related to toxocariasis.

The prevalence of toxocariasis in selected animal groups and the contamination of public places with *Toxocara* eggs can be considered indicators of the degree of exposure to infestation. In some cases, toxocariasis may be asymptomatic or present with few symptoms. The prevalence of toxocariasis may serve as an indicator of public health conditions in the general population.

In a study assessing the global and regional prevalence of anti-*Toxocara* serum antibodies in human populations, the estimated global *Toxocara* seroprevalence rate was 19.0%, with the highest seroprevalence in the African region (37.7%) and the lowest in the Eastern Mediterranean region (8.2%). The pooled seroprevalence in the European region was 10.5%[11]. In another study, overall *Toxocara* seroprevalence in the general European population was 6.2%, with no significant differences between the pooled prevalence rates of European subregions. However, subgroup analysis according to decades (1970–2010s) revealed a significant increase in seroprevalence, with the highest value of 12.4 in the 2010s[12].

The individuals most vulnerable to *Toxocara* infections and to toxocariasis (the symptomatic disease) seem to be those under 18 years of age, particularly young children. In a systematic review and meta-analysis, the global seroprevalence of *Toxocara* infection among children was estimated at 25.0%, with the highest and lowest pooled seroprevalence in Thailand and Colombia (58.2% and 7.04%, respectively)[13]. In another study, the prevalence of *Toxocara* infection ranged from 3.0 to 79.0%, with a pooled global prevalence estimate of 30.0% in the pediatric population[14]. Moreover, the prevalence was higher in Asian populations than in European, American, and African populations.

One important public health concern related to parasitic diseases is their occurrence during pregnancy. Pregnant women with toxocariasis may be at risk of adverse outcomes for both themselves and their unborn children. In a systematic review and meta-analysis based on 11 studies, the pooled prevalence of *Toxocara* infection in pregnant women was 20.8%[15].

Another concern is the economic burden of the disease. The potential economic impact of toxocariasis in 28 countries across Africa, Asia, Europe, North America, and South America, for which seroprevalence data were available from a systematic review[16], has been estimated at 2.5 billion USD per year, based on medical treatment and lost income[17].

The number of studies related to toxocariasis in Poland is limited, and most of them do not address the current situation[18–24]. Given the significant impact of VLM disease (particularly among young children and pregnant women), their potential economic burden, and the paucity of available data, it is important to examine and describe hospitalization trends for these patients in Poland. Studying the occurrence of toxocariasis in the period before and after the outbreak of the COVID-19 pandemic may provide additional information on the impact of sanitary restrictions and public health measures taken on hospitalizations of patients with toxocariasis.

This study aimed to describe hospitalization trends, including their structure and epidemiology, among VLM patients in Poland between 2014 and 2023, with an additional analysis of selected factors.

Methods

Study design and data source

This was a retrospective, population-based study on *Toxocara*-related hospitalizations in Poland from 2014 to 2023, based on data from the national hospital discharge database of the Nationwide General Hospital Morbidity Study (NGHMS), conducted by the National Institute of Public Health NIH – National Research Institute (NIPH NIH-NRI). In Poland, all hospitals, except psychiatric facilities, are legally required to send discharge data to the institute. The data are anonymous and include information on hospitalizations with ICD-10 code diagnoses, dates of admission and discharge, sex, date of birth, and place of residence. All hospitalization records from 2014 to 2023 with a discharge diagnosis of visceral larva migrans (VLM, toxocariasis; ICD-10 code B83.0), recorded as either primary or secondary, were included. Since the NGHMS database does not contain results of diagnostic

tests or other clinical data, study group selection was based solely on the assigned ICD-10 code. To identify the number of repeated hospitalizations, the authors compared the date of birth, sex, and coded place of residence.

Statistical analysis

Most statistical analyses were performed using Statistica (version 13; TIBCO Software Inc)[25], while WINPEPI[26] was used for chi-square tests. For continuous variables, means and 95% confidence intervals were calculated, and medians with interquartile ranges for non-normally distributed data. Nominal variables were summarized using counts and percentages. Hospitalization rates related to VLM were calculated as the estimated number of hospitalizations per 100,000 population, based on national census data from the Statistics Poland[27]. A two-sided p-value less than 0.05 was considered statistically significant.

Results

A total of 3559 hospital discharge records of patients with VLM hospitalized between 2014 and 2023 were assessed (Fig. 1).

The distribution of first-time, second-time, and subsequent hospitalizations during the study period is presented in Table 1. Across all years analyzed, first-time hospitalizations consistently accounted for the majority of cases, ranging from 83.9 to 92.7% annually, with a cumulative proportion of 88.3% over the entire study period. Second-time hospitalizations remained below 13% each year, ranging from 5.4 to 12.7%, with an overall share of 8.9%. Hospitalizations occurring three or more times represented a minor fraction, ranging from 1.0 to 5.0% annually. These findings indicate a consistently dominant contribution of first-time hospitalizations throughout the study period.

The study group included 1888 males (53.0%) and 1671 females (47.0%). Hospitalizations of VLM patients primarily involved individuals under 20 years of age, with more than half of patients (64.8%) below 20 years of age. Age distribution at diagnosis during hospitalization was presented in Fig. 2.

Among children and adolescents under 20 years of age, the highest number of hospitalizations was observed in those aged 10–14 years, whereas among adults aged 20 years and older, the peak occurred in the 55–59-year age group. The overall mean age for the study group was 24.5 years (95% CI: 23.8–25.2 years), with a median age of 14 years (IQR: 8–43 years) and a minimum and maximum age of 123 days and 92 years, respectively. Based on hospital registry and demographic data, the mean annual VLM-coded hospitalization (with VLM as primary or secondary diagnosis) rate was estimated at 0.93 per 100,000 (95% CI: 0.75–1.11). VLM was the primary diagnosis in 1882 hospitalizations, accounting for 52.9% of all hospitalization records. More particularly, annual VLM hospitalization rates per 100,000 in age ranges was presented in Table 2. In most cases, hospitalizations were observed in patients with VLM aged 1–19. Additionally, hospitalization rates in the study group, subgroups and male-to-female ratio were reported in Table 3.

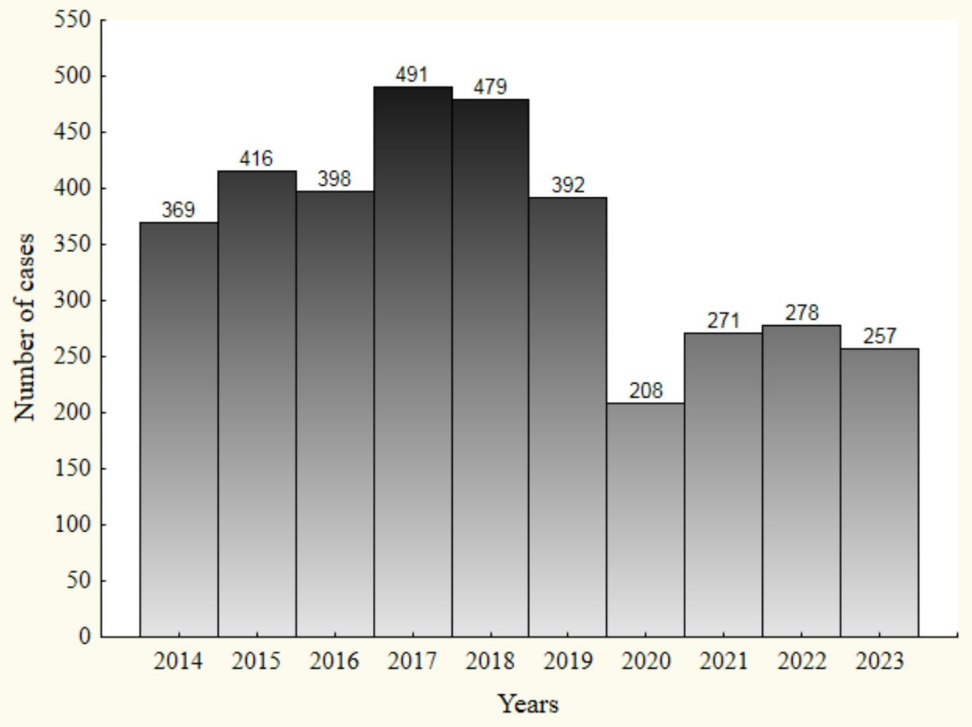

Fig. 1. Number of hospitalizations by year.

Hospitalizations							
Year	All	First		Second		Third and more	
	n	n	%	n	%	n	%
2014	369	342	92.7%	20	5.4%	7	1.9%
2015	416	349	83.9%	53	12.7%	14	3.4%
2016	398	349	87.7%	35	8.8%	14	3.5%
2017	491	432	88.0%	43	8.8%	16	3.3%
2018	479	435	90.8%	39	8.1%	5	1.0%
2019	392	340	86.7%	42	10.7%	10	2.6%
2020	208	183	88.0%	20	9.6%	5	2.4%
2021	271	234	86.3%	25	9.2%	12	4.4%
2022	278	242	87.1%	22	7.9%	14	5.0%
2023	257	235	91.4%	18	7.0%	4	1.6%
Total	3559	3141	88.3%	317	8.9%	101	2.8%

Table 1. The distribution of first-time, second-time, and subsequent hospitalizations (2014–2023).

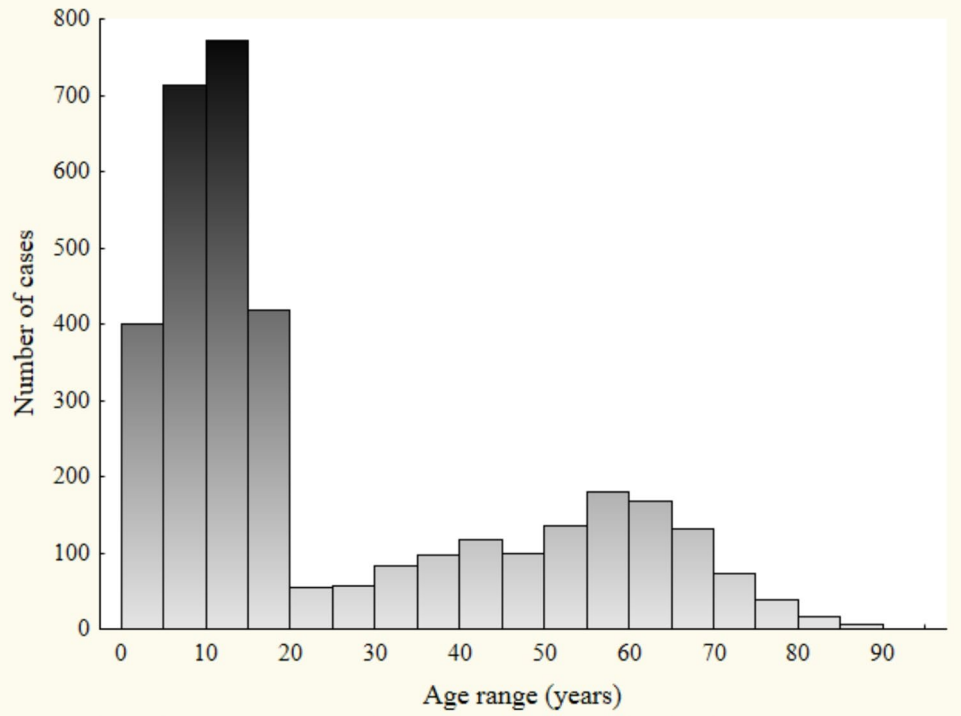

Fig. 2. Age distribution among the study group.

The mean hospitalization rate from 2020 to 2023 was significantly lower compared with 2014 to 2019 (0.67 vs. 1.1 per 100,000; $P < 0.001$). The percentage of male patients in the study group was significantly higher than that in the general population in 2023 (53.0% vs. 48.3%, $P < 0.001$)[27].

According to Statistics Poland, there is a predominance of people living in urban regions in Poland[27]. However, in our study, the percentage of hospitalizations for VLM was significantly higher for rural residents than for urban residents (59.6% vs. 39.8%, $P < 0.001$). The geographic distribution of VLM is presented in Fig. 3.

For 21 hospitalization records, no data on place of residence were reported. Pregnancy was noted in one patient. During the study period, only one hospitalization resulted in the patient's deaths, and the reported cause of death was not related to VLM.

Discussion

In this study, based on hospital registry and demographic data, the mean annual rate of VLM-coded hospitalization (with VLM as primary or secondary diagnosis) was estimated at 0.93 per 100,000 population. According to historical data gathered by the NIPH NIH-NRI, a total of 647 toxocariasis cases were recorded in

Age range	Years									
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
< 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.74
1–4	3.50	3.23	3.23	2.59	2.90	2.40	1.03	2.02	2.48	2.56
5–9	3.73	3.67	3.76	4.15	5.60	3.54	1.76	3.52	3.10	2.78
10–14	4.89	4.66	4.21	6.31	4.94	3.94	2.30	2.51	2.92	3.62
15–19	2.16	2.84	2.51	3.22	2.71	2.10	1.50	1.89	1.44	1.71
20–24	0.47	0.36	0.25	0.18	0.32	0.39	0.05	0.10	0.22	0.11
25–29	0.17	0.35	0.07	0.51	0.27	0.39	0.12	0.00	0.13	0.09
30–34	0.25	0.46	0.46	0.25	0.16	0.24	0.21	0.32	0.26	0.08
35–39	0.13	0.32	0.58	0.38	0.66	0.28	0.19	0.25	0.19	0.10
40–44	0.31	0.60	0.40	0.73	0.65	0.40	0.26	0.39	0.16	0.16
45–49	0.43	0.47	0.43	0.46	0.49	0.59	0.26	0.22	0.39	0.24
50–54	0.43	0.78	0.63	0.82	0.96	0.79	0.53	0.39	0.34	0.08
55–59	0.48	0.87	1.18	0.93	0.94	0.94	0.38	0.44	0.36	0.41
60–64	0.49	0.48	0.51	1.09	0.83	0.98	0.59	0.27	0.64	0.33
65–69	0.74	0.77	0.68	0.78	0.92	0.57	0.28	0.48	0.32	0.20
70–74	0.32	0.25	0.32	1.02	0.59	0.78	0.38	0.41	0.30	0.19
75–79	0.17	0.18	0.09	0.73	0.56	0.57	0.10	0.19	0.53	0.32
80–84	0.00	0.12	0.23	0.23	0.00	0.57	0.00	0.24	0.62	0.00
85+	0.00	0.00	0.00	0.40	0.00	0.25	0.12	0.00	0.00	0.12
Total	0.96	1.08	1.04	1.28	1.25	1.02	0.54	0.71	0.73	0.68

Table 2. Annual VLM hospitalization incidences per 100,000 in age groups.

Year	Hospitalization rates per 100.000					Male-to-female ratio
	Overall	Males	Females	Urban areas*	Rural areas*	
2014	0.96	1.10	0.83	0.63	1.46	1.24
2015	1.08	1.32	0.86	0.71	1.65	1.45
2016	1.04	1.16	0.92	0.69	1.55	1.17
2017	1.28	1.45	1.12	0.79	1.94	1.21
2018	1.25	1.30	1.20	0.87	1.81	1.02
2019	1.02	1.03	1.01	0.70	1.51	0.96
2020	0.54	0.58	0.51	0.39	0.77	1.06
2021	0.71	0.74	0.68	0.46	1.08	1.02
2022	0.73	0.79	0.68	0.51	1.07	1.09
2023	0.68	0.72	0.65	0.42	1.04	1.04
Mean	0.93	1.02	0.85	0.62	1.39	1.13
SD	0.25	0.30	0.22	0.17	0.38	0.14
95% CI	0.75–1.11	0.81–1.23	0.69-1.00	0.50–0.73	1.12–1.66	1.02–1.23

Table 3. Hospitalization rates in the study group, subgroups and male-to-female ratio by year. *In 21 cases there was no data allowing for the assessment of the place of residence.

2008, with 59.2% requiring hospitalization. The overall incidence of toxocariasis was reported to be 1.7 cases per 100,000[28]. In our study the relatively lower mean annual hospitalization rate of VLM-related hospitalization per 100,000 population may suggest that a significant number of cases might be asymptomatic or that their clinical course did not require hospitalization or annual number of VLM cases decreased in 2014–2023. In most cases, hospitalizations were observed most frequently in patients with VLM aged 1-19, and children and adolescents constituted a significant proportion of hospitalizations, which may indicate the need for special preventive measures in this group. Children and adolescents may be considered a group of patients with a higher risk of hospitalization compared to adults. Additionally, in a Portuguese study assessing 846 serum samples from individuals suspected of toxocariasis, collected from 2010 to 2020, seropositivity was detected in 18.8%. Overall, 59.7% of positive results were observed in individuals under 20 years of age, including 35.2% in the 0-9 age group and 24.5% in the 10-19 age group[29]. In China, the seroprevalence of *Toxocara spp*. ranged from 12.14% to 44.83%, with an overall seroprevalence of 19.3% in children in 2015[30]. In our study, hospitalization rates were lower in adults than in those under 20 years old, likely reflecting higher hygienic awareness and a generally milder clinical course in adults. Additionally, older individuals may exhibit greater resistance to VLM. This aligns with

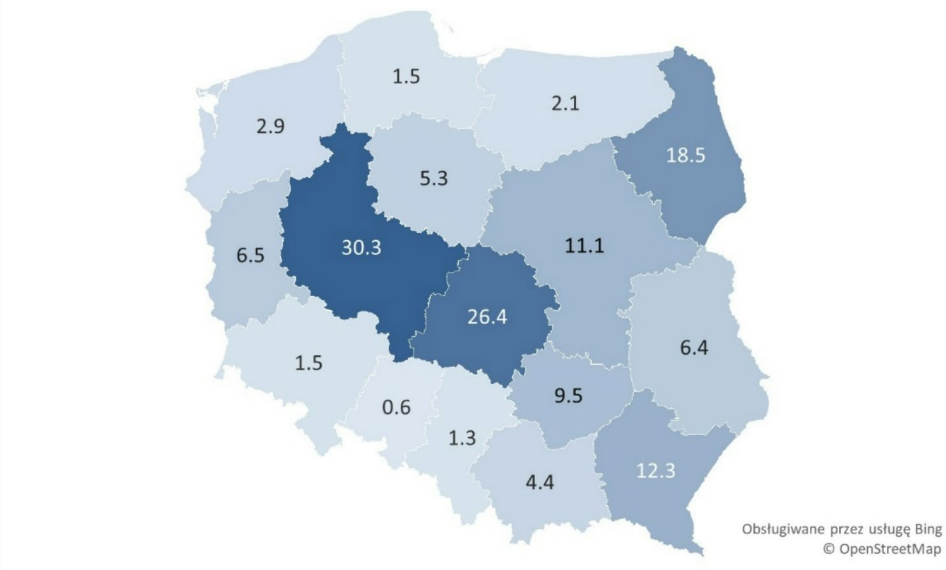

Fig. 3. Hospitalization rates per 100,000 population due to VLM in Poland by region.

a meta-analysis finding showing a significantly higher pooled seroprevalence in individuals older than 50 years compared to younger cohorts[12]. In our population, most hospitalized patients were male, and this was observed in almost every year of the study, except 2019, as reported in Table 3. This may reflect higher engagement in behaviors or occupations with soil exposure and animal contact, leading to a higher likelihood of infection and subsequent hospitalization. Boys, for instance, may be suggested to be more active in outdoor settings, which increases the possibility of contamination. The results are in line with the other study reporting that male sex was associated with a higher risk of *Toxocara spp*. compared to the female sex. However, in the study, rural residence was not linked to a higher risk of the infection compared to urban residence[13]. In contrast, our study showed significantly higher hospitalization rates in patients living in rural areas compared to those in urban areas, and it was observed in each year of the study as reported in Table 3. This may be explained by a higher risk of contact with infected animals in rural regions. In addition, urban residents may have better access to veterinary care and appropriate prophylactic measures. A study from France assessing the prevalence of endoparasites in client-owned cats reported that rural location was another risk factor for *T. cati* infections[31]. One of the main routes of infection in humans may be the ingestion of embryonated eggs found in the soil. In Turkey, *Toxocara* seropositivity was reported to be more common in men, in childhood, in those living in rural areas, having a low income level, owning dogs, and biting their nails or practicing geophagia. In addition, toxocariasis was reported to be a risk factor for veterinarians, farmers, and pet-shop workers[32]. In a previous study from Poland evaluating human exposure to *Toxocara* eggs based on serological tests along with epidemiological and clinical data from 1025 inhabitants of the north-eastern regions, most participants were male (71.0%) and country inhabitants (58.9%)[23]. Another Polish study evaluating contamination of soil samples from the households of children with toxocariasis in rural and urban areas of the Łódzkie voivodeship revealed high contamination with *Toxocara* eggs, with higher levels in rural (30.4%) than in urban areas (23.3%)[21]. On the other hand, no differences in soil contamination with geohelminth eggs were reported between rural and urban areas in Poland[10]. It may be suggested that urban recreational areas may have higher contamination due to smaller surface areas with higher animal density, leading to concentrated fecal deposition. However, further research is required to evaluate this suggestion. Finally, it should be noted that a systematic review and meta-analysis identified several potential risk factors associated with *Toxocara* seropositivity, including male sex, rural residence, and young age[11]. We observed higher hospitalization rates in several regions as presented in Fig. 3, which may indicate local clusters of infected animals. In a study assessing the prevalence of *T. canis* in dogs and red foxes in north-western Poland, infection rates in dogs ranged from 2.67% to 55.0%. The highest prevalence was observed in Gorzów Wielkopolski and its neighboring villages. The lowest prevalence was reported in the urban region of Słupsk. In the forest regions examined, the prevalence of *T. canis* in red foxes was reported at 43.0%[33]. While a detailed comparison of our results to previous national research would be valuable, the existing Polish literature on toxocariasis presents significant heterogeneity. Prior studies concentrated on prevalence in animals[18,19,33], serological epidemiology within small populations[20,22,23] or employed different research designs[21,24].

In our study, the number of hospitalizations significantly decreased after the outbreak of the coronavirus disease-2019 (COVID-19) pandemic. It is possible that measures taken to limit the spread of the pandemic and increase public awareness may have reduced the number of toxocariasis cases. Another reason might be related to changes in the organization of hospital care in the previous years, for instance, reducing hospital admissions for non-urgent conditions, increasing diagnostic capabilities, or changes in specialized outpatient care, or other public health behaviors during the COVID-19 pandemic. On the other hand, the decrease in hospitalizations of patients with the disease diagnosed as toxocariasis may be related to the COVID-19 pandemic or other factors.

A study analyzing the overall seroprevalence of larval toxocariasis in the Czech Republic suggested a decrease during the period 2012–2016 compared to findings from 1998 to 2004. Additionally, the reported rates were similar to, or even lower than, those observed in some other Central European countries[34].

The study was conducted during the period of Russian military aggression in Ukraine, when millions of Ukrainian refugees, including a significant number of children, arrived in Poland. As of April 7, 2025, nearly 2 million refugees from Ukraine had applied for asylum or similar form of national protection, and almost 1 million were recorded as residing in Poland[35]. In fact, Russian military operations against Ukraine started in 2014, and an increased influx of Ukrainian citizens into Poland has been reported since[36]. It is worth noting that a study analyzing hospitalization data of Ukrainian patients in Poland from 2014 to 2022 found that the most frequently reported principal reasons for hospitalizations among children and adolescents were infectious and parasitic diseases[37].

In a study from Ukraine, it was reported that from 300,000 to 400,000 cases of helminthiasis were officially registered every year, 80.0% of which concerned children[38]. In the recent documents there were no official data reported on the prevalence of toxocariasis in Ukraine[39,40]. For a better assessment of the situation, it is worth noting that the overall incidence of toxocariasis in Russia appears to be low, ranging from 1.6 to 2.7 per 100,000 population[41]. Migration from Ukraine may have influenced the incidence of the toxocariasis in Poland. The influence seems to be very low, as a decrease in hospitalizations due to toxocariasis was observed toward the end of the study period.

Preventing initial environmental contamination with *T. canis* and *T. cati* eggs should be one of the main public health measures. Additionally, the WHO has set six global targets for soil-transmitted helminthiasis to be achieved by 2030[42]. Close collaboration between veterinary and public health professionals is considered crucial for providing the public with appropriately presented information and for delivering consistent recommendations to pet owners[43]. Prevention strategies include educational programs, promotion of hygienic and behavioral changes, strengthening the role of veterinarians, and the implementation of anthelmintic regimens to control active infections[44]. Toxocariasis is not a disease that is mandatory to report to the State Sanitary Inspection in Poland, as this requirement was abolished in 2009. Considering the prevalence of this disease in other countries, the migration of foreigners due to war or other reasons, the significant impact of toxocariasis on the health of the population, especially children and adolescents, and the need to undertake targeted public health measures based on current epidemiological data, reintroducing monitoring of this disease in Poland seems particularly justified.

This study has several limitations, mainly due to its retrospective design. A primary limitation of this study is its reliance on NGHMS discharge codes (ICD-10 B83.0) to identify VLM hospitalizations, reflecting primary or secondary inpatient diagnoses. The database does not include patient-level diagnostic data such as serological tests, eosinophilia, or imaging results. Although case coding is based on diagnostic investigations performed during hospitalization, misclassification remains possible. It is assumed that clinicians adhered to current diagnostic standards; however, the accuracy of individual diagnoses could not be independently verified. Misclassification bias may inflate or underestimate true VLM cases. An additional limitation was that a substantial proportion of VLM patients were likely treated in the outpatient system. These limitations are mitigated by the extended study period, which enabled the assessment of trends in VLM-related hospitalizations.

Conclusions

The actual number of cases and the prevalence of toxocariasis in Poland are likely underestimated due to the lack of recent population-based epidemiological studies and limited clinical awareness of the disease. While the number of VLM-related hospitalizations in Poland was relatively small and decreased in recent years, it remains a significant health concern. Most hospitalized patients with VLM were individuals under 20 years of age, males, and rural residents. Reported data may be useful for comparative analyses in the global and European context. The study highlights the need to strengthen public health standards for the monitoring and prevention of toxocariasis.

Data availability

The datasets used in this study are held by the National Institute of Public Health NIH - National Research Institute (NIPH NIH-NRI) and are available to researchers upon reasonable request, subject to legal restrictions. Requests should be directed to pzh@pzh.gov.pl.

Received: 4 July 2025; Accepted: 1 September 2025
Published online: 06 October 2025

References

1. Francalanci, E. et al. Visceral larva Migrans in a young Italian patient: A diagnostic dilemma. *Acta Parasitol.* **23** (4), 937–941 (2023).
2. Auer, H. & Walochnik, J. Toxocariasis and the clinical spectrum. *Adv. Parasitol.* **109**, 111–130 (2020).
3. World Health Organization. Regional Office for Europe. Framework for control and prevention of soil-transmitted helminthiases in the WHO European Region 2016–2020. (2016). (accessed 21 May 2025); https://iris.who.int/handle/10665/344001.
4. Macpherson, C. N. L. The epidemiology and public health importance of toxocariasis: a zoonosis of global importance. *Int. J. Parasitol.* **43** (12–13), 999–1008 (2013).
5. Rostami, A. et al. Global prevalence of Toxocara infection in dogs. *Adv. Parasitol.* **109**, 561–583 (2020).
6. Rostami, A. et al. Global prevalence of Toxocara infection in cats. *Adv. Parasitol.* **109**, 615–639 (2020).
7. Holland, C. V., Afra, Z. G., Valizadeh, S., Ebrahimi, M. & Rostami, A. The global prevalence of *Toxocara canis* among red foxes (*Vulpes vulpes*): A systematic review and meta-analysis. *Int J. Parasitol. Parasites Wildl* **25**, 100984 (2024).

8. Overgaauw, P. & Nijsse, R. Prevalence of patent Toxocara spp. Infections in dogs and cats in Europe from 1994 to 2019. *Adv. Parasitol.* **109**, 779–800 (2020).
9. Fakhri, Y. et al. Toxocara eggs in public places worldwide - A systematic review and meta-analysis. *Environ. Pollut.* **242** (Pt B), 1467–1475 (2018).
10. Kłapeć, T. & Stroczyńska-Sikorska, M. Evaluation of epidemiological situation concerning toxocariasis from the aspect of risk for human health. *Med Og Nauk Zdr.* **15** (1), 45–53 (2009). (accessed 13 April 2025); https://www.monz.pl/pdf-73116-9938?filename=OCENA%20SYTUACJI.pdf.
11. Rostami, A. et al. Seroprevalence estimates for toxocariasis in people worldwide: A systematic review and meta-analysis. *PLoS Negl. Trop. Dis.* **13** (12), 0007809 (2019).
12. Strube, C., Raulf, M. K., Springer, A., Waindok, P. & Auer, H. Seroprevalence of human toxocarosis in europe: A review and meta-analysis. *Adv. Parasitol.* **109**, 375–418 (2020).
13. Owjinezhad, D. et al. Global Seroprevalence of Toxocara spp. In children: A systematic review and Meta-analysis. *Acta Parasitol.* **69** (1), 164–174 (2020).
14. Abedi, B. et al. The global prevalence of Toxocara spp. In pediatrics: a systematic review and meta-analysis. *Clin. Exp. Pediatr.* **64** (11), 575–581 (2021).
15. Shayanfar, S., Bahadory, S., Taghipour, A., Foroutan, M. & Abdoli, A. Seroprevalence of Toxocara spp. in Pregnant Women: A Systematic Review and Meta-Analysis. *Infect Dis Obstet Gynecol.* **2024**, 1943353 (2024).
16. Ma, G. et al. Global and regional Seroprevalence estimates for human toxocariasis: A call for action. *Adv. Parasitol.* **109**, 275–290 (2020).
17. Antonopoulos, A., Giannelli, A., Morgan, E. R. & Charlier, J. Quantifying the neglected: initial Estimation of the global burden and economic impact of human toxocariasis. *Curr. Res. Parasitol. Vector Borne Dis.* **5**, 100180 (2024).
18. Felsmann, M. et al. Invasive forms of canine endoparasites as a potential threat to public health - A review and own studies. *Ann. Agric. Environ. Med.* **24** (2), 245–249 (2017).
19. Szwabe, K. & Błaszkowska, J. Stray dogs and cats as potential sources of soil contamination with zoonotic parasites. *Ann. Agric. Environ. Med.* **24** (1), 39–43 (2017). (accessed on 3 May 2025); https://www.aaem.pl/pdf-72604-9833?filename=Stray%20dogs%20and%20cats%20as.pdf.
20. Kotłowski, A., Kowalewska, B. & Rudzińska, M. Toxocara eggs in children kindergartens in tri-city area and evaluation of interdependence quantification of invasion with frequence of antibodies incidence among population under study. *Med Srod.* 14(2), 45–50 (2011). (accessed 3 May 2025); https://www.environmed.pl/pdf-115354-44599?filename=Toxocara%20eggs%20in%20children.pdf.
21. Borecka, A., Gawor, J., Niedworok, M. & Sordyl, B. Occurrence of Toxocara spp. Eggs in household environment of children with diagnosed toxocariasis in Łódź voivodeship. *Wiadomości Parazytologiczne.* **56**, 141–144 (2010).
22. Borecka, A. & Kłapeć, T. Epidemiology of human toxocariasis in Poland - A review of cases 1978–2009. *Ann. Agric. Environ. Med.* **22** (1), 28–31 (2015).
23. Hermanowska-Szpakowicz, T., Kondrusik, M., Swierzbińska, R., Zajkowska, J. & Pancewicz, S. Incidence of antibody detection against Toxocara canis and clinical symptoms in inhabitants of North-Eastern Poland. *Pol. Merkur Lekarski.* **10** (57), 168–170 (2001).
24. Żukiewicz-Sobczak, W. et al. Prevalence of antibodies against selected zoonotic agents in forestry workers from Eastern and Southern Poland. *Ann. Agric. Environ. Med.* **21** (4), 767–770 (2014).
25. TIBCO Software Inc. Statistica (Data Analysis Software System), Version 13. (2017). Available at: http://statistica.io
26. Abramson, J. H. WINPEPI Updated: Computer programs for epidemiologists, and their teaching potential. *Epidemiol. Persp* **8**, 1 (2011).
27. Statistics Poland. (accessed 21 May 2025); https://stat.gov.pl.
28. National Institute of Public Health – National Institute of Hygiene – Department of Epidemiology. Chief Sanitary Inspectorate – Department of Communicable Diseases Control. Infectious diseases and poisonings in Poland in 2008. (2008). (accesssed 18 May 2025); https://wwwold.pzh.gov.pl/oldpage/epimeld/2008/Ch_2008.pdf.
29. Alho, A., Ferreira, M., Clemente, P. M., Grácio, I. & Belo, M. A. A. Human toxocariasis in Portugal-An overview of a neglected zoonosis over the last decade (2010–2020). *Infect. Dis. Rep.* **13** (4), 938–948 (2021).
30. Kong, L. & Peng, H. J. Current epidemic situation of human toxocariasis in China. *Adv. Parasitol.* **109**, 433–448 (2020).
31. Henry, P. et al. Epidemiological survey on gastrointestinal and pulmonary parasites in cats around Toulouse (France). *Helminthologia* **59** (4), 385–397 (2022).
32. Taylan-Ozkan, A. Sources and Seroprevalence of toxocariasis in Turkey. *Adv. Parasitol.* **109**, 465–482 (2020).
33. Cisek, A., Ramisz, A., Balicka-Ramisz, A., Pilarczyk, B. & Laurans, L. The prevalence of Toxocara canis (Werner, 1782) in dogs and red foxes in north-west Poland. *Wiad Parazytol.* **50** (3), 641–646 (2004).
34. Skulinova, K., Novak, J., Kasny, M. & Kolarova, L. Seroprevalence of larval toxocarosis in the Czech Republic. *Acta Parasitol.* **65** (1), 68–76 (2020).
35. UNHCR. Ukraine situation. UNHCR Operational Data Portal. (2025). (accessed 25 August 2025); https://data.unhcr.org/en/situations/ukraine.
36. Office for Foreigners: Obywatele Ukrainy w Polsce – raport. (2021). (accessed 23 May 2025); https://www.gov.pl/web/udsc/obywatele-ukrainy-w-polsce--aktualne-dane-migracyjne2.
37. Lewtak, K. et al. Hospitalizations of Ukrainian migrants and refugees in Poland in the time of the Russia-Ukraine conflict. *Int. J. Environ. Res. Public. Health.* **19** (20), 13350 (2022).
38. Yershova, I., Mochalova, B., Lokhmatova, H. O., Manashova, I. A. & Petrenko, M. H. O., V. Non-Specific Manifestations of Helminthiasis in Children. *Child's Health.* 8.68, 45–50 (2015). (accessed 11 May 2025); https://childshealth.zaslavsky.com.ua/index.php/journal/article/view/736.
39. Kryvych, I. P., Chumak, Yu. Yu. & Gusieva, H. M. Modern state of the health of the population in Ukraine. *Environ. Health.* **3** (10), 4–12 (2021). (accessed 4 September 2025); http://www.dovkil-zdorov.kiev.ua/env/100-0004.pdf.
40. Annual report on the state of health of the population of Ukraine and the epidemic situation for 2023. (2023). (accesssed 6 June 2025); https://moz.gov.ua/storage/uploads/386da5b2-66ed-4e85-932c-d9828ba76a7a/Щорічний-звіт-за-2023-рік.pdf.
41. Akhmadishina, L. Seroprevalence and incidence of human toxocarosis in Russia. *Adv. Parasitol.* **109**, 419–432 (2020).
42. World Health Organization. Soil-transmitted helminth infections. (2025). (accessed 11 May 2025); https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections.
43. Gawor, J., Borecka, A., Marczyńska, M., Dobosz, S. & Żarnowska-Prymek, H. Risk of human toxocarosis in Poland due to Toxocara infection of dogs and cats. *Acta Parasitol.* **60** (1), 99–104 (2014).
44. Henke, K. et al. Who let the dogs out? Unmasking the neglected: A Semi-Systematic review on the enduring impact of toxocariasis, a prevalent zoonotic infection. *Int. J. Environ. Res. Public. Health.* **20** (21), 6972 (2023).

Author contributions

Conceptualization: KK, KL, AK, PG, IK, PS, and AN-O; methodology: KK, KL; software: KK and PG; validation: KL and PG; formal analysis: KK and PG; investigation: KK and KL; resources: PG; data curation: KK and PG; writing - original draft preparation: KK, AK, and IK; writing - review and editing: KK, KL, AK, PG, IK, PS, and AN-O; visualization: KL, AK, PS; supervision: AN-O. All authors read and approved the final manuscript.

Funding
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declarations

Competing interests
The authors declare no competing interests.

Ethical approval and consent to participate
This study was approved by the Institutional Review Board of the Medical University of Warsaw, Poland (Opinion of the Bioethics Committee at Medical University of Warsaw No. AKBE/151/2025). All data were obtained in an anonymized format from NGHMS kept by NIPH NIH-NRI. Given the nature of the data, the requirement for informed consent was waived. In this study all methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication
Not applicable.

Additional information
Correspondence and requests for materials should be addressed to K.L. or P.S.