



Human Toxocariasis in individuals with blood disorders and cancer patients: the first seroepidemiological study in Iran

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Abstract Toxocara is one of the most prevalent nematodes in Iran, which infect humans as an intermediate host. Infection complications result from the larva migration. Human toxocariasis prevalence was various in Iran according to the area of study and population. This study was designed to evaluate the seropositivity of Toxocara IgG in patients with blood disorders and cancer patients in south-west Iran. Moreover, the study of the associated risk factors for this infection. A total of 1122 serum samples, from February 8, 2019 to August 21, 2019, including 600 healthy individuals and 522 individuals with cancer and blood disorders patients were collected. Serum samples were collected for detection of Toxocara IgG by using ELISA (Enzyme-Linked Immunosorbent Assay) kit. Sociodemographic data of all participants were collected and examined to determine their association with the infection. Out of 101 individuals with white blood cell disorders (5.94%), red blood cell disorders (7.48%) and cancer patients (11.06%) were seropositive for Toxocara IgG antibodies. The

infection rate among all study population revealed that (10.76%) were positive for Toxocara IgG. This study showed the fundamental role of contact with pets and infection in groups with blood cell disorders (P -value $\leq 0.05\%$); while in cancer patients the association wasn't significant. Other factors such as age, location of residence, and sex showed that the association with this infection wasn't significant.

Keywords Seroprevalence · Human toxocariasis · Blood disorders · Cancer patients · Iran

Introduction

Toxocariasis is a zoonotic disease caused by the larva of Toxocara spp, which primarily infects populations in the tropical and subtropical areas around the world. Two species of Toxocara infect humans: Toxocara canis and Toxocara cati. Definite hosts of it include cats, dogs, foxes, and

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wolves, while humans are among the possible intermediate hosts. *Toxocara* spp infection is usually asymptomatic; however, it has severe complications such as blindness or meningoencephalitis. Clinical disease is due to the migration of the parasite through extra-intestinal tissues (Abdi et al. 2012; Chen et al. 2018; Raissi et al. 2020a, b). Symptoms of toxocariasis are categorized as visceral larva migrants (VLM), ocular larva migrants (OLM), neurologic, and covert toxocariasis (Fialho and Corrêa 2016; Raissi et al. 2020a, b). Toxocariasis is also known as peripheral blood eosinophilia and eosinophilic infiltration of different organs (Chang et al. 2006; Kwon et al. 2006). Also, anemia, leucocytosis, neutropenia, and raised ESR were reported in the majority of infected patients (Fialho and Corrêa 2016). Globally, cancer is the most common cause of death, which responsible for approximately 7.6 million deaths (13% of all deaths) (Cannon et al. 2012). Recently, infection with some infectious agents, such as certain viruses, bacteria, and parasites has been proven as one of the most common and preventable causes of cancer globally; so that nearly a fifth of cancer types are incurred by pathogens (Bouvard et al. 2009; Ahmed 2012). Cancers that resulted from infections mainly show a higher mortality rate than other cancers (Cannon et al. 2012). Many studies have shown the adverse association between some parasitic infections and cancer worldwide (Darani and Yousefi 2012). To our knowledge, there is a low number of studies on the association between toxocariasis and both cancer and blood disorders in Iran. Therefore, the current study aims to evaluate the seroprevalence of *Toxocara* spp IgG among cancer patients and blood disorders in individuals from, southwest Iran.

Materials and methods

A cross-sectional study was conducted in Shahid Baghaei Hospital in Ahvaz province, Iran. People who participated in the study were clinically healthy individuals, Cancer Patients, Red blood cell disorders individuals, and White blood cell disorders, individuals. A total of 1122 participants from February 8, 2019 to August 21, 2019, comprised of 600 clinically healthy individuals (control group), 127 Cancer Patients, 294 Red blood cell disorders individuals, and 101 White blood cell disorders individuals (case study groups) were recruited. Although the number of healthy individuals in this study as a control group was slightly higher compared to the case study, almost a lot of similarities in terms of age and gender were seen in the two groups. In this study, the control group consisted of hospitalized individuals who were diagnosed with no cancer and blood disorders but were uncertain about toxocariasis. A structured questionnaire was used for collecting biodata and for assessing risk factors such as the

area of residence; the history of contact with dogs and cats and pica (a psychological disorder characterized by an appetite for largely non-nutritive substances, such as soil, ice, stone, etc.) we reset. Furthermore, everyone had not been a previous history and knows of toxocariasis. Approximately 3–5 ml of venous blood samples were drawn from each individual. Blood samples were left overnight at room temperature to allow clotting and centrifuged at 1500 RPM for 10 min. The serum was collected in Eppendorf tubes and stored at 4 °C for not more than 24–72 h and transported in an icebox to Laboratory of Immunology at Tehran University of Medical Sciences where they were kept at – 20 °C until testing. Serum samples were detected for anti-*Toxocara* IgG antibodies using an Enzyme-Linked Immunosorbent Assay “*Toxocara canis* IgG” kit (IBL International GmbH, Hamburg, Germany). Absorbance reading equal to or greater than 0.38 OD units were considered to be positive. All tests were performed following the instructions of the manufacture. Data were analysed by the SPSS 20.0 software package. Both dependent and independent variables were dichotomous variables. Prevalence ratio (PR) values were considered statistically significant within the 95% CI and, Probability (*P*) value ≤ 0.05 was considered statistically significant in all the analyses.

Results

Prevalence of toxocariasis in population with white blood cells disorders

Among 1122 participants 101 individuals have different white blood cell disorders and 122 healthy individuals, toxocariasis showed positivity in 6/101 (5.94%), 8/122(6.55%) respectively with a significant association, while the association with each disorder separately isn't significant. Unhealthy individuals who contacted with pets showed that 4/6 (66.6%) and 6/8 (75%) of healthy individuals were positive. The residency location of participants in rural and urban areas showed no association with infection in both healthy and unhealthy individuals. Age groups showed no difference in the rate of infection with age, and also sex showed no significant association while the infection rate in females (5/6, 83.34%) is higher than males (1/6, 16.66%) (Table 1).

Prevalence of toxocariasis in population with Red blood cell disorders

Table 2 showed the association between *Toxocara* infection with different red blood cell disorders, 22/294 (7.48%) of unhealthy individuals and 14/338 (4.14%) of healthy

individuals positive for *Toxocara* IgG with ($P \leq 0.05$) and also contact with pets showed significant association with *Toxocara* IgG, 14/22 (63.6%) of unhealthy and 9/14 (64.3%) of healthy individuals were positive in case of contact with pets, while location, age groups, and sex weren't significantly associated with infection.

Prevalence of Toxocariasis in cancer patients

Different cancer types were included in this study; Table 3 showed that the association between *Toxocara* positivity and cancer was statistically significant ($P \leq 0.05$). The prevalence rate of infection among cancer and healthy individuals 14/127(11.6%) and 4/140(2.85%) were reported respectively. Other variables such as contact with pets, location, age group, and sex weren't significantly associated. *Toxocara* infection among all study populations including White blood cell disorders, Red blood cell disorders, Cancer Patients, and healthy individuals are summarized in Table 4.

Discussion

In the present study, to our knowledge for the first time in Iran, we evaluated the seroprevalence of *Toxocara* IgG antibodies among patients with blood cell disorders and cancer patients from the Southwest. The obtained study findings showed that from 101 individuals with white blood cell disorders, toxocariasis showed positivity in 6 (5.94%); while, 8 (7.92%) of the 101 healthy individuals were positive for *Toxocara* IgG. This study also showed that out of 294 individuals with red blood cell disorders were positive for *Toxocara* antibody 22 (7.48%); while 14 (4.14%) of the 338 healthy individuals were positive and the association between infection and blood disorders were statistically significant ($P \leq 0.05$). Among studied variables as risk factors for *Toxocara* infection in blood disorders patients, contact with pets showed as an estimated risk factor with a positive correlation ($P \leq 0.05$) in both individuals with white and red blood cell disorders are agreeing with Raissi et al. (2018) who reported the association between the *Toxocara* infection rate increase with contact with pets. Other variables like a residency in urban and rural areas weren't significantly associated with the present study. These findings are agreeing with Alavi et al. (2011) who reported that did not show an association was detected between the infection rate and children of residency. In contrast to a study obtained in Shiraz, southern Iran, on children, showed that the prevalence rate was 20.2% lived in rural areas, while 30.1% were urban areas resident's children (Sadjjadi et al. 2000). According to

these study findings the age and sex weren't shown are recognized with the *Toxocara* infection rate, that's agreeing with Raissi et al. (2018). The National Cancer Institute reported that eight million cases of cancers are diagnosed annually worldwide (INCA, 2016). Cancer patients in developing countries are recognized as a more susceptible group to opportunistic agents due to anticancer treatment and deficiency in immunity system barriers (Vento and Cainelli 2003). The parasitic infection in cancer patients is usually more severe and may become life-threatening (Marcos and Gotuzzo 2013). Our study findings demonstrated that the infection rate of toxocariasis is higher in cancer patients than in a healthy group. The cancer patient group showed seropositivity in 14 (11.06%), while the healthy group showed only 4 (2.85%). Based on our study results, we found that there was a significant association between cancer and *Toxocara* IgG positivity. None of the studied variables such as (pets contact, location of residence, age, and sex) were showed association with the infection rate in cancer patients. That's agreeing with several studies that reported that there was no significant variation in the *Toxocara* infection rate between males and females (Sadjjadi et al. 2000; Fan et al. 2004; Esfandiari et al. 2019; Khozime et al. 2019). Also, the differences in the rate of infection according to age groups weren't statistically significant, while the infection rate in the age group (62 or more) is 8 (57.18%), which is higher than other compared age groups. In agreement with various investigations showed similar results (Sadjjadi et al. 2000; Fan et al. 2004; Hosseini-Safa et al. 2015). The obtained findings of this study revealed that there is no significant association between *Toxocara* IgG positivity and residency in urban and rural areas. In line with the study results obtained by Hosseini et al. (2015) who found that living in urban and rural areas in Iran don't have a significant association with the seroprevalence of *Toxocara* infection. On the other hand, Sadjjadi et al. (2000) demonstrated the role of residency in infection rate variation. In the present study, we found that there wasn't a statistically significant association between infection and contact with pets in cancer patients. Several epidemiological studies were obtained in Iran and other countries to understand the situation of toxocariasis, Lucio-Forster et al. (2016), Raissi et al. (2020a; b) have reported that the seroprevalence of soil contamination and dog's infection rate was about 2% and 26.8% respectively. Moreover, in a study conducted by Raissi et al. (2018) on diabetic patients and pregnant women in Ilam Province (Southwest, Iran), 14.81% and 21.16% showed positivity for toxocariasis respectively. In 2014, 2011, and 2019, the prevalence of toxocariasis in multiple sclerosis patients and epileptic patients and patients with uveitis 14.7%, 14.1%, and 14.8% had been reported respectively by Zibaei and Ghorbani (2014),

Table 1 Prevalence of Toxocariasis among individuals with white blood cell disorders compared to Healthy individuals

Variables	Samples N (%)	Positivity N (%)	Prevalence ratio	<i>P</i> value
Prevalence of Toxocariasis				
<i>With blood cell disorders</i>				
Multiple myeloma	09(8.91%)	01(0.99%)	1	
Acute myeloid (or myelogenous%) leukemia (AML)	18(17.82%)	01(0.99%)	0.86	
Chronic myeloid (or myelogenous) leukemia (CML)	09(8.91%)	00	0	
Acute lymphocytic (or lymphoblastic) leukemia (ALL)	31(30.7%)	02(01.98%)	0.65	
Chronic lymphocytic leukemia (CLL)	14(13.86%)	01(0.99%)	0.64	
Hodgkin's lymphoma	11(10.89%)	01(0.99%)	0.9	
Non Hodgkin's lymphoma	06(5.94%)	00	0	
burkitt's lymphoma	03(2.97%)	00	0	
Total	101(100%)	06(05.94%)		
Healthy individuals				<i>P</i> > 0.05
Total	122(100%)	08(06.55%)	0.89	
<i>Pica</i>				
<i>With blood cell disorders</i>				
Yes	08(7.92%)	01(0.99%)	1	<i>P</i> > 0.05
No	93(92.08%)	05(04.95%)	0.95	
<i>Healthy individuals</i>				
Yes	43(35.25%)	06(05.94%)	1	<i>P</i> ≤ 0.05
No	79(64.75%)	02(01.98%)	0.32	
<i>Contact with dog and cat</i>				
<i>With blood cell disorders</i>				
Yes	21(20.8%)	04(03.96%)	1	<i>P</i> ≤ 0.05
No	80(79.2%)	02(01.98%)	0.13	
<i>Healthy individuals</i>				
Yes	68(55.74%)	07(06.93%)	1	<i>P</i> > 0.05
No	44(44.26%)	01(0.99%)	0.69	
<i>Location</i>				
<i>With blood cell disorders</i>				
Urban area	77(76.24%)	05(04.95%)	1	<i>P</i> > 0.05
Rural area	24(23.76%)	01(0.99%)	0.84	
<i>Healthy individuals</i>				
Urban area	77(63.11%)	04(03.96%)	1	<i>P</i> > 0.05
Rural area	45(36.89%)	04(03.96%)	1.24	
<i>Age</i>				
03–22	12(11.88%)	01(16.66%)	1	
23–42	22(21.78%)	02(33.34%)	1.02	
43–62	48(47.53%)	02(33.34%)	0.31	
63 or more	19(18.81%)	01(16.66%)	0.65	
Total	101(100%)	06(100%)		
<i>Sex</i>				
<i>With blood cell disorders</i>				
Male	41(40.59%)	01(16.66%)	1	<i>P</i> > 0.05
Female	60(59.41%)	05(83.34%)	0.38	

Zibaei et al. (2011), Zibaei et al. (2019). In a study conducted in the same area on people with hydatidosis, the prevalence of toxocariasis was more than 40% (Karami et al. 2019). In the following, the prevalence of toxocariasis

in Mexican pediatric patients was reported by about 25% (Caballero-García et al. 2020). In addition to previous research, Kaplan et al. reported the prevalence of Toxocariasis in Schizophrenic Patients 45.9%. Results in seven

Table 2 Prevalence of Toxocariasis among individuals with Red blood cell disorders compared to Healthy individuals

Variables	Samples N (%)	Positivity N (%)	Prevalence ratio	P value
Prevalence of Toxocariasis				
<i>Red blood cell disorders</i>				
Major Thalassemia	38(12.93%)	03(01.02%)	1	
Minor Thalassemia	71(24.15%)	04(01.36%)	0.95	
Sickle cell anemia	07(02.38%)	01(0.34%)	1.02	
Iron-deficiency anemia	169(57.48%)	12(04.08%)	0.9	
Aplastic anemia	05(1.70%)	01(0.34%)	1.14	
Megaloblastic anemia	04(01.36%)	01(0.34%)	1.37	
Total	294(100%)	22(07.48%)		
Healthy individuals				<i>P</i> > 0.05
Total	338(100%)	14(04.14%)	0.88	
<i>Pica</i>				
Red blood cell disorders				<i>P</i> ≤ 0.05
Yes	29(09.86%)	08(02.72%)	1	
No	265(90.14%)	14(04.76%)	0.77	
Healthy individuals				<i>P</i> > 0.05
Yes	19(05.62%)	02(0.68%)	1	
No	319(94.38%)	12(04.08%)	0.98	
<i>Contact with dog and cat</i>				
Red blood cell disorders				<i>P</i> ≤ 0.05
Yes	92(31.3%)	14(04.76%)	1	
No	202(68.7%)	08(02.72%)	0.79	
Healthy individuals				<i>P</i> > 0.05
Yes	155(45.86%)	09(03.06%)	1	
No	183(54.14%)	05(01.7%)	0.91	
<i>Location</i>				
Red blood cell disorders				<i>P</i> > 0.05
Urban area	218(74.15%)	17(05.78%)	1	
Rural area	76(25.85%)	05(01.70%)	0.96	
Healthy individuals				<i>P</i> > 0.05
Urban area	122(36.09%)	06(02.04%)	1	
Rural area	216(63.91%)	08(02.72%)	0.65	
<i>Age</i>				
05–24	109(37.08%)	09(40.9%)	1	
25–44	101(34.36%)	04(18.19%)	0.48	
45–64	55(18.70%)	06(27.28%)	1.11	
65 or more	29(9.86%)	03(13.64%)	1.03	
Total	294(100%)	22(100%)		
<i>Sex</i>				
Male	116(39.46%)	09(41%)	1	<i>P</i> > 0.05
Female	178(60.54%)	13(59%)	0.97	

previous studies showed that prevalence in the individuals was higher than the present study (Kaplan et al. 2008). Also, some studies showed less prevalence of toxocariasis (in patients with asthma, multiple sclerosis and rheumatoid arthritis, cancer HIV-1, pregnant women, and in individuals with epilepsy) than in the present study (Noormahomed

et al. 2014; Santos et al. 2015; Mousavi et al. 2016; Pereira et al. 2016; Modi et al. 2018; Esfandiari et al. 2019; Khozime et al. 2019). Of course, case studies had been also reported in people (with sigmoid colon cancer and ovarian cancer) infected with toxocariasis (Won et al. 2015; Kim et al. 2018).

Table 3 Prevalence of Toxocariasis among Patients with different types of cancer compared to Healthy individuals

Variables	Samples N (%)	Positivity N (%)	Prevalence ratio	<i>P</i> value
Prevalence of Toxocariasis				
<i>Types of cancer</i>				
Brain cancer	04(3.15%)	01(0.79%)	1	
Skin cancer	07(5.51%)	00	0	
Breast cancer	42(33.08%)	03(02.37%)	0.31	
Colorectal cancer	12(9.45%)	01(0.79%)	0.61	
Pancreatic cancer	04(3.15%)	01(0.79%)	1	
Testicular cancer	03(2.36%)	00	0	
Liver cancer	19(14.96%)	03(02.37%)	0.75	
Lung cancer	06(4.72%)	01(0.79%)	0.91	
Soft tissue sarcoma	02(1.57%)	00	0	
Esophageal cancer	08(6.3%)	01(0.79%)	0.88	
Ovarian cancer	09(7.09%)	01(0.79%)	0.75	
Gastric cancer	11(8.66%)	02(01.58%)	0.79	
Total	127(100%)	14(11.06%)		
Healthy individuals				<i>P</i> ≤ 0.05
Total	140(100%)	04(02.85%)	0.73	
<i>Pica</i>				
Cancer patients				<i>P</i> > 0.05
Yes	09(7.09%)	01(0.79%)	1	
No	118(92.91%)	13(10.27%)	0.31	
Healthy individuals				<i>P</i> > 0.05
Yes	25(17.85%)	01(0.79%)	1	
No	115(82.15%)	03(02.37%)	0.17	
<i>Contact with dog and cat</i>				
Cancer patients				<i>P</i> > 0.05
Yes	36(28.35%)	07(05.53%)	1	
No	91(71.65%)	07(05.53%)	0.74	
Healthy individuals				<i>P</i> > 0.05
Yes	27(19.29%)	02(01.58%)	1	
No	113(80.71%)	02(01.58%)	0.15	
<i>Location</i>				
Cancer patients				<i>P</i> > 0.05
Urban area	96(75.59%)	10(07.90%)	1	
Rural area	31(24.41%)	04(03.16%)	1.09	
Healthy individuals				<i>P</i> > 0.05
Urban area	96(68.57%)	03(02.37%)	1	
Rural area	44(31.43%)	01(0.79%)	0.96	
<i>Age</i>				
02–21	05(3.94%)	01(7.14%)	1	
22–41	19(14.96%)	00	0	
42–61	54(42.52%)	05(35.72%)	0.65	
62 or more	49(38.58%)	08(57.14%)	0.89	
Total	127(100%)	14(100%)		
Sex				<i>P</i> > 0.05
Male	49(38.58%)	05(35.72%)	1	
Female	78(61.42%)	09(64.28%)	1.06	

Table 4 Comparison of Toxocariasis frequency between all patients and healthy individuals

Toxocariasis	Samples N (%)	IgG Positivity N (%)	P value
Cancer Patients	127 (11.32%)	14 (12.8%)	
Red blood cell disorders individuals	294 (26.20%)	22 (20%)	
White blood cell disorders individuals	101 (09.00%)	06 (5.4%)	
Healthy individuals	600 (53.48%)	68 (61.8%)	
Total	1122 (100%)	110 (100%)	$P > 0.05$

Conclusion

Toxocariasis in southwest Iran can be considered to be one of the main public health problems. The prevalence of it is varied according to study populations, hygiene, sociodemographic variables, and sample size. The present study may contribute to increasing the awareness about *Toxocara* infection in blood disorders and cancer patients as a risk group for this infection. This study concluded that the prevalence of *Toxocara* IgG antibodies in white, red blood cell disorders, and cancer patients 5.94%, 7.48%, and 11.06% were reported, respectively. The infection rate of the overall studied groups was 09.80%. This study provides greater insight into *Toxocara* infection in cancer and hematological disorders patients.

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Compliance with ethical standards

Conflicts of interest The authors and co-authors declare that they have no conflict of interest that affects this study.

Ethical statement This study was approved ethically by the Ethics Committees at Shahid Baghaei Hospital in Ahvaz province, Iran. Before collecting blood samples, all individuals approved the informed consent form, and then blood samples were taken based on the guidelines of the Ethics Committees at Shahid Baghaei Hospital in Ahvaz province, Iran.

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