

Diagnosics of a Zoonotic Parasitic Disease: Total Serum Immunoglobulin E in Patients with Toxocariasis and Clinically Healthy Persons in Bulgaria

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Abstract: Toxocariasis is a zoonotic parasitic disease in humans caused by migration in the human body of infective larvae of canine and (or) feline nematodes of the genus *Toxocara* Stiles, 1905 (Ascaridida: Toxocaridae). The aim of the present study is to establish the levels of total serum IgE in patients with toxocariasis in Bulgaria, to compare them with the levels in clinically healthy individuals and to evaluate their significance for diagnosis of toxocariasis. The levels of total IgE were examined in sera samples from 130 patients with serological and clinical signs of toxocariasis. Of them, 120 were with visceral form of the disease and 10 with ocular larva migrans. The values of IgE in this group ranged from 4 IU/ml to 957.95 IU/ml. The geometric mean of total serum IgE was 153.7 ± 39.8 . Serum samples from a control group of 50 clinically healthy blood donors were also tested and their serum IgE levels ranged from 2 IU/ml to 230 IU/ml (geometric mean of 49.40 ± 15.1 IU/ml). Our study is the first of its kind from Bulgaria and our results display a geometric mean of IgE in patients with toxocariasis (153.7 IU/ml) of about 3 times higher than the one in clinically healthy individuals (49.4 IU/ml).

Key words: toxocariasis; IgE; geometric mean; allergy

Introduction

Toxocariasis is a zoonotic parasitic disease in humans caused by migration in the human body of infective larvae of canine and (or) feline nematodes *Toxocara canis* (Werner, 1782) and (or) *Toxocara cati* (Schrank, 1788) (BEAVER et al. 1952). Several clinical forms have been described, the main ones being visceral and ocular larva migrans. The causative agents of toxocariasis belong to the genus *Toxocara* Stiles, 1905 (Ascaridida: Toxocaridae). The family Toxocaridae includes 21 species but the most important pathogens causing human disease are *T. canis* and *T. cati*. Definitive hosts of these nematodes are representatives of the families Canidae and Felidae,

which spread non-embryonated parasite's eggs in the environment with the fecal mass. Hatching eggs need to stay in the environment for about 21 days to become embryonated and invasive. Ingestion of embryonated eggs of *Toxocara* initiates infection in both definitive and intermediate hosts. There are some differences in the life cycle of the nematodes in definitive and intermediate hosts. In definitive hosts, second-stage larvae hatch from ingested eggs in the host's intestines and then migrate through the liver to the heart and lungs, reaching the gut again, where the parasite becomes mature (tracheal migration). Another part of larvae reach the lungs and dissemi-

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nates to different organs and tissues (somatic migration) through the blood vessels, without any further development (hypobiosis). Complete life cycle occurs usually in female hosts and their offspring and larvae reactivation occurs only in pregnant or lactating cats and dogs. The larvae in pregnant dogs could be activated by hormone impulses and transmitted to the foetus transplacentally, explaining the reason for newborn dogs being often infected (DUBEY 1978). Transplacental transmission in cats does not occur and the primary infection of kittens is through transmammary transmission, which is less significant in dogs (BURKE & ROBERSON 1985). In paratenic hosts including humans, larvae encyst in intestine after ingestion of embryonated eggs, then penetrate the mucosa and migrate by lymph and blood flow to organs (lungs, liver, eyes and brain); however, they cannot develop to the adult forms and encyst in tissues, being encapsulated and surrounded by eosinophilic granulomas. There, the larvae can remain viable for one or more years in inactive stage. However, at any time they may be reactivated and start to migrate (PAWLOWSKI 2001). Pathology in the human toxocariasis is a result of tissue damage caused by inflammatory responses to the larvae and their metabolites (enzymes, waste products and cuticle components) (KAYES 1997). Immune response of the human host is associated with development of eosinophilia, increased levels of total IgE and production of specific antibodies (HOGARTH-SCOTT et al. 1969, DATTOLI et al. 2011).

Toxocariasis is a zoonotic disease and in the literature there is no data for direct transmission from human-to-human.

Human toxocariasis has a worldwide distribution. The prevalence of anti-*Toxocara* antibodies in the human population depends on several factors: place of residence (urban or rural), age, socio-economic status and professional exposure (KANEVA et al. 2015). Different studies reported relatively low prevalence of toxocariasis in developed countries: 1.6% in Japan, 2.4% in Denmark, 6.3% in Austria, 7% in Sweden, 14% in the USA, and high in developing countries: 81% in Nepal, 63.2% in Indonesia, 58% in Malaysia, 36% in Brazil (WON et al. 2008). Studies conducted in Bulgaria showed seroprevalence of 12.25% (RAINOVA & KURDOVA 2007) or 19.1% (HARIZANOV et al. 2019).

The diagnosis of human toxocariasis is difficult, and it is based mainly on detection of specific anti-*Toxocara* IgG antibodies. The applied serodiagnostic tests have few disadvantages, i.e. possible cross reactions with other nematodes. The stage of the disease and the treatment success cannot be de-

termined due to the long circulation of specific antibodies (GILL et al. 1988). The difficulties in the diagnosis of *T. canis* active infection are a serious problem and, by this reason, additional tests have been developed: measurement of circulated antigens (ROBERTSON et al. 1988), determination of total serum IgE level (DATTOLI et al. 2011) and eosinophil cationic protein (ECP) (MAGNAVAL et al. 2001).

Immunoglobulin E (IgE) is one of the five classes of immunoglobulins; normally, it is a very small fraction of all serum immunoglobulins in the blood at a concentration of less than 1 UI/ml (BENNICH et al. 1968). The significance of IgE as a component of the normal immune response is primarily associated with atopic conditions (SCHWARTZ 1994). According to JOHANSSON et al. (1968), its concentration increases in case of parasitic invasion.

One of the first scientific reports for elevated IgE levels in patients with toxocariasis encompasses a group of persons with histologically confirmed visceral larva migrans (VLM). Their levels of IgE were 10–15 times higher than normal, which according to the authors is due to a series of allergic mechanisms arising from the interaction between the parasite and the host (HOGARTH-SCOTT et al. 1969). Further reports of elevated levels of serum IgE in patients with toxocariasis confirmed that *Toxocara* larvae induce high-eosinophilia and IgE production (CAPRON & CAPRON 1994, ALONSO et al. 2000). According to some authors, a statistically significant association was found between infection with *Toxocara* larvae, eosinophilia above 10% and high production of IgE (CAPRON & CAPRON 1994, DATTOLI et al. 2011). There is an opinion that levels of total serum IgE > 500 IU/ml indicate recent *Toxocara* spp. infection (MAGNAVAL et al. 2001). The basic methods for diagnosis of toxocariasis are serological: enzyme-linked immunosorbent assay (ELISA) and Western blot (WB) based on the use of total excretory-secretory (TES) antigen, which define specific IgG antibodies to TES-Ag (DE SAVIGNY et al. 1979, MAGNAVAL et al. 1991). Retention of these antibodies for long periods of time does not allow evaluating the effectiveness of treatment and it is necessary to monitor additional markers such as the total serum IgE (BASS et al. 1987). However, data on the significance of this immunoglobulin in toxocariasis and its usefulness as a marker in the assessment of the treatment effectiveness are controversial.

The aim of the present study was to establish the levels of total serum IgE in patients with toxocariasis in Bulgaria, to compare them with the levels in clinically healthy individuals and to evaluate their significance for diagnosis of toxocariasis.

Materials and Methods

The levels of total IgE were examined in sera samples from 130 patients with serological (positive ELISA for IgG anti-TES-Ag antibodies and presence of specific bands on confirmatory WB test) and clinical signs of toxocariasis. After receiving the positive results from serological tests patients were treated depending on the severity of clinical symptoms with Albendazole at 10 mg/kg for 10 or 14 days. Suspected for visceral form of the disease were 120 from all tested patients and 10 were with ocular form.

In view of the possibility of cross-positive reactions, all persons were investigated for intestinal parasites and proved negative. In 25 patients (11 men and 14 women), the levels of total serum IgE were monitored at different intervals of time after the primary screening: on month 6 ($n = 21$), between 6 and 12 months ($n = 8$), and after more than a year ($n = 2$).

Serum samples from a control group of 50 clinically healthy blood donors (20 men and 30 women) were also tested for total IgE. The persons in the control group have also been tested in ELISA for the presence of anti-*Toxocara* IgG antibodies and negative result have been obtained for all of them.

To determine the presence of specific anti-*Toxocara* antibodies, a commercial kit Ridascreen Toxocara IgG - ELISA (RBiopharm, Germany) was used according to the manufacturer's instructions. At sample index (SI) of the serum samples above 1.1, the results were reported as positive for a presence of specific anti-*Toxocara* IgG antibodies. At SI < 0.9 , results were reported as negative while samples with SI ranging from 0.9 to 1.1 were recognised as borderline.

As a confirmatory test, commercial kit TOXOCARA Western blot (WB) IgG Kit (LD BIO, France) was used. All sera positive for the presence of specific anti-*Toxocara* antibodies in ELISA were further tested in WB to confirm the result. The presence on the strip of two or more low molecular weight bands in 24-35 kDa range is indicative for the presence of anti-*Toxocara* IgG antibodies in the serum sample.

For determination of total serum IgE, a commercial kit Total IgE ELISA (EUROIMMUN, Germany) was used according to the manufacturer's protocol. Serum levels of total IgE were determined by plotting a calibration curve using calibration sera from 1 to 4 (Cal.1 is with 500 IU/ml human IgE; Cal. 2 – 100 IU/ml human IgE; Cal.3 – 10 IU/ml human IgE and Cal.4 – 0 IU/ml human IgE).

Detection limit of the assay was 0.1 IU/ml. The reference values for different age groups are as follows: infants up to 12 months of age from 1.2 to 12.7 IU/ml, 1–5 years 60 IU/ml, 6–9 years 155 IU/ml, 10–15 years 199 IU/ml and over 16 years 100 IU/ml.

In view of the possibility of cross-positive reactions, all persons were investigated for intestinal parasites. For detection of intestinal protozoa, the following methods were used: examination of direct wet smear; staining with Lugol's iodine; commercial rapid immunochromatographic tests (*Giardia* and *Cryptosporidium* spp.). Tests for intestinal helminth infections were carried out by microscopic examination of eggs after processing the sample with formalin-ether and other concentration techniques, microscopic examination of scotch tape for detection of eggs in perianal area.

The survey data were processed with statistical software GraphPad Prism 6.0 (GraphPad Software, Inc.).

Results

Total serum IgE in clinically healthy individuals

Fifty serum samples from clinically healthy blood donors aged 20–65 years were examined. In this group, the values of total serum IgE ranged from 2 IU/ml to 230 IU/ml. The geometric mean of total serum IgE was 49.40 ± 15.1 IU/ml. In 82% of the subjects ($n = 41$), the mean total IgE did not exceed 100 IU/ml. Of these persons, 17 (34%) were male, 24 (48%) were female, and the geometric mean of total serum IgE was 37.52 ± 10.60 IU/ml. In nine (18%) clinically healthy individuals, i.e. three males (6%) and six females (12%), the levels of total IgE were more than 100 IU/ml. Geometric mean of total IgE in these samples was 173.1 ± 39.3 IU/ml. Table 1 presents the values of total serum IgE found among healthy persons distributed by age and gender. The largest number of individuals with values of IgE in excess of 100 IU/ml was found among the age groups of 25–29 ($n = 2$) and 30–34 ($n = 3$). The geometric mean of total serum IgE in clinically healthy males was 44.14 ± 26.73 IU/ml, while in females was 53.26 ± 21.11 IU/ml.

Total serum IgE in persons with toxocariasis

For the determination of the total serum IgE level, 130 persons serologically positive for toxocariasis were tested. These were 71 (54.6%) males and 59 (45.4%) females. By age distribution, 43 (33.1%) were children and adolescents under age of 19, and 87 (66.9%) were adults. The values of total serum IgE in persons with toxocariasis ranged from 4 IU/

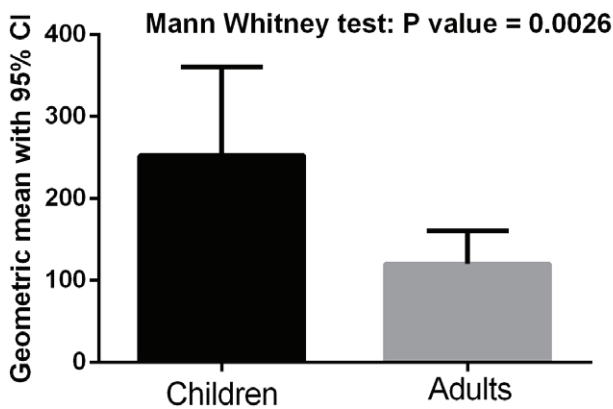


Fig. 1. Geometric mean of IgE (IU/ml) in children and adults with toxocariasis.

ml to 957.95 IU/ml. Values up to 100 IU/ml were detected in 50 (38.5%) persons, between 100 and 500 IU/ml in 48 (36.9%) persons, and levels above 500 IU/ml in 32 (24.6%). The geometric mean of total serum IgE was 153.7 ± 39.8 .

Because infants up to 12 months of age were not included in the study, we divided the surveyed persons into four age groups according to the IgE reference ranges given by the manufacturer of the diagnostic kit: 1-5 years, 6-9 years, 10-15 years and over 16 years of age. Data for the total serum IgE levels in the different age groups are presented in Table 2. Higher values of the IgE geometric mean were found in children from 1 to 5 years of age (322.7 IU/ml), and in the age group from 6 to 9 years of age (187.8 IU/ml). With exception of the age group of 10-15 years old, in the other groups, a significant difference of the total serum IgE levels with the reference values specified by the manufacturer was found. Distributed by gender, persons with levels of 100 to 500 IU/ml were 24 men and 24 women, and over 500 IU/ml, 16 men and 16 women. Geometric mean values of total IgE in males and females were 168.1 IU/ml and 143.5 IU/ml, respectively, and we did not find statistically significant difference (Mann Whitney test: P value = 0.5117).

The most common clinical manifestation demanding laboratory tests for toxocariasis and measurement of the serum levels of total IgE was the skin-allergy, affecting 36.2% (n = 47) of the patients. In 44.7% (n = 21) of them, the levels of total serum IgE were lower than 100 IU/ml, in 36.2% (n = 17) were from 100 to 500 IU/ml, and in 19.1% (n = 9) were above 500 IU/ml. The second largest group were people with peripheral blood eosinophilia (n = 43, 33.1%). Of them, 11 patients (25.6%) were with levels of total serum IgE up to 100 units, 15 (34.9%) with levels from 100 to 500 IU/ml, and 17 (39.5%)

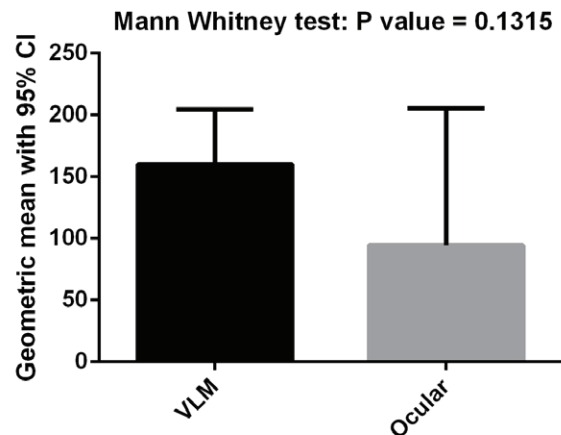


Fig. 2. Geometric mean of IgE (IU/ml) in patients with visceral and ocular toxocariasis.

with levels above 500 IU/ml. In the remaining 20 (15.4%) patients with visceral manifestations of toxocariasis (protracted low grade fever, pulmonary symptoms, anemic syndrome, alopecia, gastrointestinal disorder), six (30%) were with IgE values exceeding 500 IU/ml. In patients with ocular toxocariasis (n = 10), the values of total serum IgE did not exceed 500 IU/ml. In six of them IgE levels were from 100 to 500 IU/ml, and in four up to 100 IU/ml.

In 32 (24.6%) of all infected subjects (n = 130), total serum IgE values were found to exceed 500 IU/ml. In this group IgE values varied between 505.0 IU/ml (minimum) and 958.0 (maximum). Median value of total serum IgE was $683.7 \text{ IU/ml} \pm 121.5 \text{ SD}$ and geometric mean was 692.0 IU/ml. Conversely, in subjects with total serum IgE <500 IU/ml these were: 4.000 (minimum), 490.0 (maximum), median value $95.82 \pm 136.6 \text{ SD}$ and geometric mean 94.07 IU/ml. The difference in the median values was significant (Mann – Whitney test: P < 0.0001).

Tracking the dynamics of total serum IgE in patients with toxocariasis after the primary screening

In 25 patients with toxocariasis, we followed the dynamics in the levels of total serum IgE at different points of time: on the sixth month the immunoglobulin level was tested in 21 patients, between six and twelve months in eight and over a year in two patients after their initial examination. In seven patients with values of 500 IU/ml or more, followed up at six months after the first study, there was a retention or increase in the level of total IgE antibodies, and this indicated that the disease was still active. In other 13 individuals tested on the sixth month, the IgE level decreased or remained the same. The tendency of decreased IgE levels was observed in seven individuals (four men and three women) tested between sixth and twelfth months

Table 1. Values of total serum IgE in healthy blood donors by age groups.

Age groups	Number of persons	Values of total serum IgE (IU/ml)		Average geometric mean of total serum IgE (IU/ml)
		Male sex	Female sex	Male & Female
20 - 24 years	6	53	80	47.78
		14	92	
			22	
			99	
25 - 29 years	5		208	83.18
			89	
			35	
			32	
30 - 34 years	8	44	11	66.95
		45	230	
		150	117	
		82	56	
35 - 39 years	5	16	39	48.08
		72		
		65		
		88		
40 - 44 years	3	29	21	27.73
		35		
45 - 49 years	10	123	34	30.47
		36	89	
		68	12	
		2	63	
			50	
			10	
50 - 54 years	2	14	30	20.49
55 - 59 years	7	75	42	59.06
			75	
			27	
			53	
			34	
			218	
60 - 65 years	4	71	28	89.54
		145	223	
Geometric mean		44.14	53.26	77.90
95% CI of geo. mean		± 26.73	± 21.11	± 18.92
Mann-Whitney test	P value = 0.8253		Significantly different (P < 0.05)	

after the first screening. Among those 7 individuals, the IgE values were almost twice lower than the initial result. In one of the tested individuals, the initial test showed a value of 438 IU/ml for total IgE and on the sixth month the value increased to 959.79 UI/ml. The third test carried out between the 6th and the 12th month after the primary screening showed decreasing values from 959.79 to 470 IU/ml. For more than 12 months, only two persons were tested – one was the female with decreased level of total IgE from 6 to 12 month and in this study this level increased again to 660.58 IU/ml. The second one was also a female and the last test showed permanent decrease of total IgE level (Table 3).

Discussion

The results obtained by various authors who have tried to define the normal levels of total serum IgE in healthy non-allergic adults display great variations (ROWE & WOOD 1970, SPITZ et al. 1972, NYE et al. 1975, BARBEE et al. 1981). Due to this, it was difficult to establish reliable range of the 95% CI for IgE (BARBEE et al. 1981). Large differences in the values are probably related to the use of diverse techniques for determining the levels of IgE in various population-based studies, and also due to different standards (SPITZ et al. 1972). There are also difficulties in appropriately expressing the average

Table 2. Total serum IgE levels in different age groups among patients with toxocariasis (Wilcoxon Signed Rank Test was performed to find differences between median levels of IgE in different age groups and upper limit of the reference range (IU/ml) of ELISA test)

	Age groups			
	1-5 years	6-9 years	10-15 years	>16 years
Patients (n)	24	9	7	90
Upper limit of the reference range of total serum IgE given by the manufacturer	60 IU/ml	155 IU/ml	199 IU/ml	100 IU/ml
Ranges of total serum IgE in persons with toxocariasis by age groups	30.00 - 958.0 IU/ml	4.000 - 650.1 IU/ml	47.00 - 880.3 IU/ml	4.000 - 958.0 IU/ml
Median	394.4	403.0	233.0	118.4
Mean	436.2	343.3	289.9	254.2
Std. Deviation	262.1	215.2	292.9	267.3
Geometric mean	322.7	187.8	186.6	124.9
95% CI of geo. mean	216.1 - 481.8	50.89 - 693.3	71.01 - 490.2	93.94 - 166.2
	Wilcoxon Signed Rank Test			
Sum of signed ranks (W)	286.0	35.00	4.000	1743
P value (two tailed)	< 0.0001*	0.0391*	0.8125	0.0004*

* Significant (alpha=0.05)

Table 3. Dynamic of total serum IgE levels in patients with toxocariasis.

Patient #	Sex	Age	Values of total serum IgE IU/ml			
			initial value	on sixth month	between six to twelve months	more than twelve months
1	female	55	795.84	727.16		
2	female	2	780.05	316	190	13
3	male	78	140		60	
4	male	4	614.53	380		
5	male	48	571.37		340	
6	male	26	154	382		
7	male	2	305	160		
8	female	4	718.74		596.63	
9	female	2	596.64	717.68		
10	female	60	646.11	972.68		
11	female	52	770.84	769.79		
12	female	52	302.8	122.8		
13	female	26	371.1	454.94		
14	female	38	957.95	984.26		
15	male	63	248.8	319.53		
16	female	49	625.58	954.26		
17	female	60	438.2	959.79	470	660.58
18	male	38	313.3		126.6	
19	male	6	526.37	131.2		
20	male	12	258.8	233.5	85.2	
21	female	9	252.7	307.07		
22	male	7	650.05	594		
23	male	2	408.7	30.23		
24	female	68	290.8	115.6	32	
25	female	38	116	171		
Geometric mean			410.7	341.0	157.3	92.67

values of this immunoglobulin in clinically healthy individuals and for separate groups of patients (BARBEE et al. 1981). The irregular distribution of IgE in all populations was investigated and resulted in the need to shift from arithmetic to logarithmic values reflecting averages and ranks in the groups (SPITZ et al. 1972, GROVE et al. 1975, BARBEE et al. 1981). In our study, the normal distribution is observed using the geometric mean of IgE 49.40 ± 15.1 IU/ml in clinically healthy blood donors. BARBEE et al. (1981) reported geometric mean values of 32.1 IU/ml in 2743 individuals (aged from 6 to 90 years) with or without symptoms of atopy (BARBEE et al. 1981). They found 12.1% values higher than 200 IU/ml and 40% below 20 IU/ml. In our study, 6% (n=3) of the values are above 200 IU/ml and values below 20 IU/ml are missing. In another study, geometric mean was 320 IU/ml in 97 black non-allergic individuals and 123 IU/ml in white non-allergic individuals (GRUNDBACHER & MASSIE 1985). GROVE et al. (1975) reported a geometric mean value of 98 IU/ml in 100 clinically healthy persons. Except for the technological and methodological differences variations in values depend on the degree to which study population was selected randomly or selectively as none-atopic (AGHA et al. 1997). The age and sex specifics also influence IgE levels in healthy subjects (ROWE & WOOD 1970, BARBEE et al. 1981). According to some authors, male individuals have higher levels of IgE at any age (BAZARAL et al. 1974, GRUNDBACHER & MASSIE, 1985). Survey of the reference levels of total serum IgE in young adults from ten West-European countries provides reference levels for IgE of 148 IU/ml in females and 169 IU/ml in males (CAROSSO et al. 2007). According to other authors, higher geometric mean values of total serum IgE are found among persons of female gender (SHOORMASTI et al. 2010). The results of our study are similar. Geometric mean values of IgE in healthy females were higher than those of men (Table 1). Regardless of gender highest geometric mean values, we found in the age groups of 25–29 years (82.94 IU/ml) and 60–65 years (89.54 IU/ml). Our data are similar to those of other surveys who did not find significant differences in IgE levels between genders and in different age groups (SPITZ et al. 1972, GRUNDBACHER & MASSIE 1985, GLICKMAN et al. 1987).

Several studies presented data for increasing levels of total serum IgE in patients with toxocariasis; some authors consider that the values exceeding 500 IU/ml are indicative for recent infection (GLICKMAN et al. 1987, ALONSO et al. 2000, MAGNAVAL et al. 2001). Our study of serum IgE levels in patients

with serologically verified toxocariasis show that their geometric mean of IgE (153.7 IU/ml) is about 3 times higher than that in clinically healthy subjects (49.4 IU/ml). Due to a lack of sufficient studies in Bulgaria enabling establishment of a total serum IgE reference values for the local population, we used the reference values proposed by the manufacturer of the diagnostic kit (THOMAS, 1992). In patients with toxocariasis, we found broad variations in the total serum IgE levels (ranging from 4 to 957.95 IU/ml). In 14 persons (10.8%), IgE levels were below the reference values established for the certain age group. In the remaining 116 patients (89.2%), IgE values exceeded the reference threshold. In this regard, our data are similar to those from other studies, according to which 79% of the patients with toxocariasis presented with an increased level of total serum IgE (MAGNAVAL et al. 1994). In the age group of 1–5 years (n = 24), only three (12.5%) children had total serum IgE levels lower than the upper limit of the reference range (60 IU/ml) and the median in this group exceeded 5 times the reference value. In the age group 6–9 years (n = 9), two children (22%) had IgE values below the reference range. The value of mean total serum IgE of this group was significantly different from the reference for this age group (Table 2). We received similar results for the group over 16 years of age. Of the 90 subjects in this age group, in six (17.7%) the total serum IgE levels did not exceed the upper limit of the reference range (100 IU/ml). The mean IgE levels also significantly exceeded the reference value. However, in the age group 10–15 years, we found no significant differences between the levels of total serum IgE with the reference values. This may be due to the relatively small number of individuals in this age group (n = 7), certain features in the immune response in adolescents and the relatively high upper limit of the reference range (199 IU/ml). Our study did not detect significant differences in median IgE values in male and female patients (Mann–Whitney test: $P = 0.5117$) but between children and adults there was significant difference (Fig. 1).

According to MAGNAVAL et al. (2001), total serum IgE values above 500 IU/ml are sign for recent infection. Although limited in size, our study confirms this because we found significant differences in median serum IgE levels in subjects with toxocariasis with IgE > 500 IU/ml and those with IgE levels < 500 IU/ml.

Comparison of the median values of total IgE between visceral and ocular toxocariasis displayed that in patients with visceral involvement (Geometric mean = 160.1 IU/ml) the levels were higher than in

patients with ocular toxocariasis (Geometric mean = 94.47 IU/ml) but without significant difference among the values (Fig. 2). As in ocular toxocariasis, the production of specific IgG anti-*Toxocara* antibodies is lower than that in visceral involvement; according to some authors, the assessment of IgE may be supplementary for the serological diagnosis of ocular disease (GLICKMAN & SCHANTZ 1981, GENCHI et al. 1986).

In our study, all persons diagnosed with toxocariasis were treated with albendazole at a dosage of 10 mg/kg b.w. daily for 10–14 days. The levels of IgE did not display tendency for sharp decrease after treatment in the observed patients. In fact, we observed a gradual decline of IgE within about a year and in this sense, our data correlate with those of other authors (MAGNAVAL et al. 2001).

Conclusion

Our study presents the first summarized data for Bulgaria on the values of total serum IgE in clinically healthy individuals and in persons infected with *Toxocara* spp. Well established fact is that in allergies and parasitic diseases, often accompanied by allergic symptoms, the immune response in humans is associated with production of IgE antibodies. We made an effort to define their importance as an additional marker in the diagnosis of some parasitic diseases, such as toxocariasis. Our data display that values of total serum IgE above the reference for certain age group may be an indication for searching toxocariasis. We also tried to define the reference levels of IgE in healthy persons to serve as a threshold value above which it is appropriate to seek pathology that induces IgE antibody response. Although in small-scale, our study is the first one to present data for Bulgaria in this field and our data could be of help for future research in this direction.

Compliance with ethical standards

Conflicts of interest: Authors declare that they have no conflict of interest.

Statement of human rights: For this type of study, formal consent is not required.

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