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ORIGINAL ARTICLE

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Toxocariasis: potential association with bronchial asthma, and pneumonia among pediatric children

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Abstract Toxocariasis is an underestimated geohelminthic infection which shows respiratory changes concurrent with larval migration. The purpose of the present study was to detect *Toxocara* seropositivity in asthmatic and pneumonic children, and in turn to evaluate its association with the children clinical manifestations, laboratory test results, and sociodemographic risk factors. A total of 50 asthmatic, 50 pneumonic children and 50 healthy controls were subjected to stool analysis by direct wet mount and concentration techniques to exclude possible cross reactivity. Blood samples were collected for complete blood count and assessment of eosinophil count. Sera were examined for anti-*Toxocara* IgG antibodies, and measurement of total IgE level. Anti *Toxocara* IgG was detected in 27.3% (41/150) of the studied children. It was significantly higher in asthmatic group compared to controls (26%. p value = 0.033) and significantly highest in pneumonia group compared to both bronchial asthma group (46%. p value = 0.030) and control group (10%. p value = 0.001). There was a significant association between anti *Toxocara* IgG seroprevalence and each of eosinophilia, total IgE and both combined. Anti *Toxocara* IgG showed significant higher percentage in asthmatic children who recorded history of soil contact and pets contact as compared to control and pneumonic groups. *Toxocara* IgG seropositivity was highly associated with fever, cough, wheezes and dyspnea with statistical significance. *Toxocara* seropositivity has to be considered as a vital associated factor for asthmatic and pneumonic children, and eventually better to be considered in differential diagnosis by pediatricians. Further studies are still needed to explore the correlation between toxocariasis and different patient categories.

Keywords Toxocariasis · Seroprevalence · Bronchial asthma · Pneumonia · Children

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Introduction

Human toxocariasis is a worldwide neglected zoonotic disease caused by helminthic infection of *Toxocara canis* (*T. canis*) and *Toxocara cati* (*T. cati*), the ascarid worms in dogs and cats, respectively (Temsah et al. 2021). The seroprevalence of human toxocariasis varies from 0.6% in Canada to 86% in Nigeria in either developing or developed countries (Ma et al. 2018). In Egypt, *Toxocara* infection occurs specially in low-income populations with poor hygienic practices where stray and household dogs and cats have an important role in the spread of toxocariasis among Egyptians (Farghly et al. 2016).

Toxocara infection occurs through ingestion of embryonated eggs in raw vegetables, or contaminated soil, or by accidental consumption of *Toxocara* larvae in raw or insufficiently cooked meat or liver of paratenic hosts (Fialho and Corrêa 2016). Children are the most susceptible group to *Toxocara* infection owing to their common behaviors,

such as geophagia, contact with soil while playing, direct contact with animals having eggs in their fur, poor personal hygiene, and absence of parents' supervision (Despommier 2003; El-Tantawy et al. 2013).

In humans, the parasite can't develop beyond the larval stage and the migrating larvae cause allergic reactions and intense local inflammatory response in different organs such as liver, lungs, eye and brain causing visceral, covert, ocular, and cerebral toxocariasis (Despommier 2003). In the first two conditions, children may be asymptomatic or develop asthma symptoms (Smith et al. 2009). Infected children may also suffer from fever, cough, hepatomegaly, abdominal pain, or dermatological lesions (Nash 2005). However, the severity of infection depends on the intensity of infection, the site of migrating larvae, age of the child, and the host's immune system qualification (Pawlowski 2001).

Bronchial asthma (BA) is a global health problem that seems to be the most widespread chronic disease in children. In last decades, it increased progressively due to new lifestyle and different environmental risk factors (Nunes et al. 2017). The relationship between asthma and toxocariasis has always been an issue of research.

Toxocariasis could be risk factor for the inception of allergic diseases including asthma, or may accelerate pulmonary symptoms in asthmatic patients as well (Cooper 2008; Aghaei et al. 2018). Moreover, asthma is described in various studies as a toxocariasis-associated factor (Cooper 2009; Cadore et al. 2016).

Pulmonary involvement in toxocariasis is common and manifests by wheezing, coughing, and dyspnea (Despommier 2003), while some lung diseases can also occur as asthma, acute bronchiolitis or pneumonitis (Lassmann et al. 2007). Yet, there are rare reports recording severe clinical manifestations in children like acute severe asthma and diffuse interstitial pneumonia (Demirci et al. 2012). The presumptive mechanism of pulmonary infiltration is assumed to the larval allergic reaction in the lung (Yoshikawa et al. 2011).

Since human toxocariasis is largely unknown and uncommon to health professionals, it is still a poorly diagnosed disease in Egypt. Direct techniques can't diagnose the disease and thus ELISA is usually used for this purpose especially during epidemiologic studies. ELISA gives highly sensitive and specific results with minor degrees of cross-reactivity in case of using second-stage *T. canis* larvae excretory and secretory (E/S) antigens (Magnaval et al. 2001).

The purpose of the present study was to investigate *Toxocara* seropositivity in diagnosed asthmatic and pneumonic children in comparison to healthy children in Beni-Suef University Hospital, and to evaluate its association with the children clinical manifestations, laboratory test results and sociodemographic risk factors.

Subjects and methods

Study design and population

A case control hospital-based study was conducted from May 2020 to January 2022 on a total of 150 children aged between 2 and 15 years. The studied cases (n. = 100) were categorized into 50 asthmatic children diagnosed clinically and according to GINA recommendations (GINA 2019), and 50 pneumonic children diagnosed clinically and radiologically by finding of nodules or, ground glass opacities, or areas of consolidations or all of them. The studied cases were attending Allergy and Immunology Outpatient Clinic and Pediatric Department of Beni-Suef University Hospital, while the controls (n. = 50) were sex/age-matched healthy children with no respiratory manifestations.

Exclusion criteria for cases included children aged < 2 years old, children with malignancy, autoimmune diseases, or taking systemic steroid therapy, children positive for helminthic infections by stool analysis to exclude the cross reactivity with toxocariasis. In asthmatic cases, genetic and allergic asthma were ruled out from the study as well.

A structured questionnaire was obtained from each child parent/legal guardian to assess the possible association with *Toxocara* seropositivity including socio-epidemiological, environmental, and clinical data. Also, all children were subjected to full clinical examination.

Samples collection

Stool samples

Three consecutive fecal samples were collected from each child 1 day apart, and examined for parasitic infections at Medical Parasitology Department, Faculty of Medicine, Beni-Suef University. Samples were subjected to direct microscopic examination and formalin-ethyl acetate concentration technique. Positive samples (ova/larvae) of helminthic infections (fascioliasis, ascariasis, strongyloidiasis, trichuriasis, ancylostomiasis) were excluded to get out of possible cross reactions.

Blood samples

Two venous blood samples were collected individually from studied children. The first blood sample (3 ml) was collected on EDTA anticoagulant for complete blood count (CBC) and assessment of eosinophil count where values > 400/mm^3 was expressed as eosinophilia (Figueiredo et al. 2005). The second sample of blood was centrifuged, and serum samples were separated and stored at -20 °C until used for detection of anti-*Toxocara* IgG antibodies and measurement of total IgE level.

Serological tests

Detection of anti-Toxocara IgG antibodies

Serum samples of all children were analyzed for IgG anti-*Toxocara* antibodies against (E/S) *Toxocara* larval antigens using the commercial Human *Toxocara Canis* Antibody ELISA kit (Bioassay England, Cat # ED4450) according to the manufacturer's instructions. The optical density (OD) was read at a wavelength of 450 nm with a microplate ELISA reader and calculation of cut-off value was done as mean of negative controls OD value plus 0.15.

Measurement of total IgE level

The measurement of total IgE was performed quantitively using the commercial Human IgE ELISA kit (ThermoFisher Scientific) following manufacturer instructions. OD was determined at 450 nm. Construction of the standard curve was done as well as calculation of samples concentration in relation to the mean absorbance from the standard curve.

Statistical analysis

Statistical analysis was done using statistical package for social sciences (SPSS) computer software (version 25), IBM software, USA. All the studied variables were categorical, that were described as the total number and percentage for each category and were compared to the chi-square $\chi 2$ test. p value equal to or < 0.05 was considered of significant value.

Results

A total of 150 children participated in this study were distributed as follows: 100 cases (50 children with BA and 50 children with pneumonia), and 50 controls without respiratory manifestations. Table 1 provides the sociodemographic characteristics of the cases and controls children showing a single statistical difference among all participants in pets contact variable (p value = 0.037). Participants' age ranged from 2 to 11 years old; the mean age of the case patients was 4.05 ± 1.98 years and that of the control group was 4.28 ± 2.01 years old.

As demonstrated in Table 2, anti *Toxocara* IgG was detected in 27.3% (41/150) of the studied children. It was significantly higher in BA cases (26%) as compared to controls (10%)/(p value = 0.033). Also, anti *Toxocara* IgG was significantly highest in pneumonia cases group (46%) as compared to both BA cases (p value = 0.030) and control group (p value = 0.001). Eosinophil count was higher in BA cases as compared to controls, though it was not statistically significant (p value > 0.05). Eosinophil count was significantly higher in the pneumonia cases group as compared to both normal control (p value = 0.011) and BA cases (p value = 0.032). Total IgE in the BA cases group was significantly higher than in control group (p value = 0.008), while there was non-statistically significant difference

Table 1 Sociodemographic characteristics of the studied case patients and controls; (N = 150)

	Studied population			Total N = 150	p value
	BA N = 50	Pneumonia N = 50	Controls N = 50		
Sex					
Male	26 (52.0%)	34 (68.0%)	23 (46%)	95 (63.3%)	0.123
Female	24 (48.0%)	16 (32.0%)	27 (54%)	55 (36.7%)	
Residence					
Rural	39 (78.0%)	32 (64.0%)	35 (70%)	106 (70.7%)	0.123
Urban	11 (22.0%)	18 (36.0%)	15 (30%)	44 (29.3%)	
Socioeconomic level					
Low	17 (34.0%)	19 (38.0%)	18 (36%)	54 (36.0%)	0.412
Middle	22 (44.0%)	25 (50.0%)	23 (46%)	70 (46.7%)	
High	11 (22.0%)	6 (12.0%)	9 (18%)	26 (17.3%)	
Soil contact					
Positive	30 (60.0%)	27 (54.0%)	28 (56%)	85 (56.7%)	0.545
Negative	20 (40.0%)	23 (46.0%)	22 (44%)	65 (43.3%)	
Pets contact					
Positive	23 (46.0%)	13 (26.0%)	18 (36%)	54 (36.0%)	0.037*
Negative	27 (54.0%)	37 (74.0%)	32 (64%)	96 (64.0%)	

Table 2 Comparison of anti *Toxocara* IgG, Eosinophilia and total IgE between studied groups

	Studied population			Total N = 150	p value
	BA N = 50	Pneumonia N = 50	Controls N = 50		
Anti-Toxocara IgG					
Positive	13 (26.0%)	23 (46.0%)	5 (10.0%)	41 (27.3%)	0.033*[a]
Negative	37 (74.0%)	27 (54.0%)	45 (90.0%)	109 (72.7%)	0.001*[b] 0.030*[c]
Eosinophilia					
Yes	14 (28.0%)	24 (48.0%)	12 (24.0%)	50 (33.3%)	0.410[a]
No	36 (72.0%)	26 (52.0%)	38 (76.0%)	100 (66.7%)	0.011*[b] 0.032*[c]
Total IgE					
Positive	17 (34.0%)	11 (22.0%)	6 (12.0%)	34 (22.7%)	0.008*[a]
Negative	33 (66.0%)	39 (78.0%)	44 (88.0%)	116 (77.3%)	0.143[b] 0.133[c]

[a] p value for comparison between controls versus BA patients

[b] p value for comparison between controls versus pneumonia patients

[c] p value for comparison between BA versus pneumonia patients

between pneumonia group versus controls (p value > 0.05). Non-statistically significant difference was observed in IgE level between BA and pneumonia cases (p value > 0.05).

There was a statistically significant association between anti *Toxocara* IgG seroprevalence and each of eosinophilia, IgE seropositivity, and combined eosinophilia with IgE seropositivity. Nineteen out of forty-one (46.3%) children with positive anti *Toxocara* IgG had eosinophilia (p value = 0.031), and fifteen (36.6%) of positive anti *Toxocara* IgG showed positive total IgE (p value = 0.013). Also, nine (22%) children with positive anti *Toxocara* IgG had combined eosinophilia with IgE seropositivity with statistical significance (p value = 0.008) as shown in Table 3.

There was non-statistically significant association between *Toxocara* IgG seropositivity, with some studied variables such as sex, residence and socioeconomic level (p values > 0.05). We couldn't detect any statistically significant difference in each group separately compared to control and compared to the other group. However, seropositivity of *Toxocara* IgG in children with positive soil contact showed higher percentages in BA cases as compared to both controls (p value = 0.040), and pneumonic cases (p value = 0.043) with statistical significance. Also, *Toxocara* IgG seropositivity was significantly higher in children with positive pets contact in the BA cases group as compared to control group (p value = 0.045) as shown in Table 4.

Table 5 demonstrates some important statistical differences regarding associated clinical manifestations. All studied children with positive *Toxocara* IgG in BA cases didn't have fever (p value < 0.001), and complained of chronic cough (p value = 0.016). Anti *Toxocara* IgG was more prevalent among pneumonia cases who have dyspnea as compared to BA cases (p value = 0.032). Also, anti *Toxocara* IgG was higher in most of asthmatic cases who have wheezes (92.3%) with statistical significance (p value = 0.042).

Table 3 Association between anti *Toxocara* IgG seroprevalence and each of eosinophilia, total IgE, and combined eosinophilia with IgE

	Anti-*Toxocara* IgG		Total N = 150	p value
	Positive N = 41	Negative N = 109		
Eosinophilia				
Positive	19 (46.3%)	31 (28.4%)	50 (33.3%)	0.031*
Negative	22 (53.7%)	78 (71.6%)	100 (66.7%)	
Total IgE				
Positive	15 (36.6%)	19 (17.4%)	34 (22.7%)	0.013*
Negative	26 (63.4%)	90 (82.6%)	116 (77.3%)	
Combined eosinophilia with IgE				
Positive	9 (22.0%)	7 (6.4%)	16 (10.7%)	0.008*
Negative	32 (78.0%)	102 (93.6%)	134 (89.3%)	

*p value < 0.05 was considered statistically significant

Table 4 Association of anti-*Toxocara* IgG seropositivity in BA and pneumonia cases compared to controls; (N = 41), with frequency of studied variables

	Positive anti-*Toxocara* IgG				p value
	BA N = 13	Pneumonia N = 23	Controls N = 5	Total N = 41	
Sex					
Male	7 (53.8%)	14 (60.9%)	2 (40%)	23 (56.1%)	0.705[a]
Female	6 (46.2%)	9 (39.1%)	3 (60%)	18 (43.9%)	0.686[b]
					0.633[c]
Residence					
Rural	12 (92.3%)	17 (73.9%)	4 (80%)	33 (80.5%)	0.123[a]
Urban	1 (7.7%)	6 (26.1%)	1 (20%)	8 (19.5%)	0.332[b]
					0.342[c]
Socioeconomic level					
Low	6 (46.1%)	11 (47.8%)	1 (20%)	18 (43.9%)	0.412[a]
Middle	3 (23.1%)	9 (39.1%)	2 (40%)	14 (34.1%)	0.087[b]
High	4 (30.8%)	3 (13.1%)	2 (40%)	9 (22%)	0.787[c]
Soil contact					
Positive	11 (84.6%)	15 (65.2%)	3 (60%)	29 (70.7%)	0.040*[a]
Negative	2 (15.4%)	8 (34.8%)	2 (40%)	12 (29.3%)	0.085[b]
					0.043*[c]
Pets contact					
Positive	8 (61.5%)	12 (52.2%)	2 (40%)	22 (53.6%)	0.045*[a]
Negative	5 (38.5%)	11 (47.8%)	3 (60%)	19 (46.4%)	0.063[b]
					0.223[c]

*p value < 0.05 was considered statistically significant

[a]p value for comparison between controls versus BA patients

[b]p value for comparison between controls versus pneumonia patients

[c]p value for comparison between BA versus pneumonia patients

Discussion

Generally, human toxocariasis are difficult to diagnose due to asymptomatic infection in most of cases and inaccessibility of the parasite (Hotez and Wilkins 2009). The main diagnosis is based on direct detection of *Toxocara* sp. larvae in tissues. However, identification of larvae seems to be difficult due to their extended allocation and tiny size. Moreover, tissue biopsy is considered an invasive procedure (Ma et al. 2018). PCR-based approaches are not commonly used for toxocariasis routine diagnosis, but they are used for gene analysis and identification of species (Gasser 2013). Serological diagnoses by ELISA techniques and CT scan for chest lesions can diagnose toxocariasis without risk of invasiveness (Despommier 2003).

Serodiagnosis of toxocariasis may cross reacts with other helminthic infections, in particular, geohelminthic ones. To rule out geohelminthic parasites in our study, we examined three consecutive fecal samples from each child using direct microscopic examination and formalin-ethyl

Table 5 Association of anti-*Toxocara* IgG seropositivity in BA and pneumonia cases; (N = 36), with clinical manifestations

Clinical manifestations	Positive *Toxocara* Ig G		Total N = 36	*p* value
	BA N = 13	Pneumonia N = 23		
Fever				
Positive	0 (0.0%)	13 (56.5%)	13 (36.1%)	< 0.001*
Negative	13 (100.0%)	10 (43.5%)	23 (63.9%)	
Chronic cough				
Positive	13 (100.0%)	15 (65.2%)	28 (77.8%)	0.016*
Negative	0 (0.0%)	8 (34.8%)	8 (22.2%)	
Wheezes				
Positive	12 (92.3%)	2 (8.7%)	14 (38.9%)	0.042*
Negative	1 (7.7%)	21 (91.3%)	22 (61.1%)	
Dyspnea				
Positive	3 (23.1%)	14 (60.9%)	17 (47.2%)	0.032*
Negative	10 (76.9%)	9 (39.1%)	19 (52.8%)	
GIT manifestations				
Positive	2 (15.4%)	6 (26.1%)	8 (22.2%)	0.382
Negative	11 (84.6%)	17 (73.9%)	28 (77.8%)	

acetate concentration technique, and any positive results were excluded. Hence, the ELISA test using (E/S) antigen derived from *T. canis* second-stage larvae was the most suitable screening diagnostic approach for human toxocariasis in our study with acceptable 91% sensitivity and 86% specificity (Jacquier et al. 1991).

As regards results analysis of the present study, the overall anti *Toxocara* IgG seropositivity in all studied children was 27.3%. Anti *Toxocara* IgG was found in 13 (26%) of asthmatic children as referred to 5 (10%) of healthy control children. These results were accepted with that reported in Egypt by Badawey et al. (2018), and Shahat et al. (2019) who detected 17%, 22.2% of toxocariasis in asthmatic children compared to 10%, 6.9% in controls from Zagazig and Damietta cities, respectively. Meanwhile, El-Tantawy et al. (2013) observed higher seropositivity of toxocariasis in 42% of asthmatic children compared to 8% in controls from Dakahlia, Egypt. Temsah et al. (2021) reported lower anti *Toxocara* IgG level in 15% of asthmatic children in Damietta, Egypt. Variable seroprevalence results were illustrated worldwide such as Iran (45%, 9.8%), Cuba (40.1%), and Brazil (63.6%) (Momen et al. 2018; Salemi et al. 2021; Kanobana et al. 2013; Mendonca et al. 2013) respectively. Other researches didn't detect anti *Toxocara* IgG in sera of control group (Sadri et al. 2019). Previous variable *Toxocara* seropositivity may be due to the different ecological conditions of environments in these studied areas, and methods used for diagnosis in each study.

Our obtained results showed significant association between anti *Toxocara* IgG seropositivity and BA. This was consistent with previous observations (Fernando et al. 2009; El-Tantawy et al. 2013; Shahat et al. 2019). Contrarily, some authors hadn't found any correlation between them (Sadri et al. 2019; Shamsian et al. 2019; Salemi et al. 2021).

In the preceding literature, eosinophil count was higher in BA cases (28%) as compared to controls (24%), though it was not statistically significant. This obtained result went in hand with previous results that revealed no significant association between eosinophilia level in asthmatic children (Badawey et al. 2018; Shahat et al. 2019) and in contrast with others who reported a statistical difference between BA children and control group as regards eosinophilia (El-Tantawy et al. 2013).

Regarding pneumonia cases, seropositivity of anti *Toxocara* IgG (46%) and eosinophil count (48%) were significantly highest as compared to both control group and BA cases. Among positive anti *Toxocara* IgG pneumonic children, eosinophilia was detected in (47.8%) so that eosinophilic pneumonia cases showed statistically significant association in our study. Roig et al. (1992) recorded 64% eosinophilia and diffuse lung infiltration in patient with toxocariasis. They declared that the diagnosis of pulmonary infiltration with high eosinophilia best performed by routine ELISA of toxocariasis as it detected unsuspected and undetermined numbers of cases of toxocariasis with lung involvement. Bouchard et al. (1994) diagnosed case report of acute severe eosinophilic pneumonia positive for anti *Toxocara* IgG. Another case report of toxocariasis with eosinophilic pneumonia was detected using serological test (Demirci et al. 2012).

Estimation of total IgE level provides evidence of atopy, which is almost a general finding in asthmatic children and described as a capability to produce excessive amount of IgE when exposed to allergens (Burrowset al. 1989). Increased reactivity of the airway to variable stimuli such as irritants, cold air, allergens, viruses, and exercise frequently tends to occur in asthmatic patients (Borish et al. 2005).

Total IgE in the BA cases was significantly higher than in control group (34% vs. 12%), and this is completely in accordance with El-Tantawy et al. (2013). These data agreed with other researches suggesting that elevation of total IgE and eosinophilia in asthmatic patients are highly related to toxocariasis (Figueiredo et al. 2005; Bahnea et al. 2008). Concerning our observations, total IgE was higher (22%) in pneumonia group versus controls (12%) and this result was confirmed by other studies reporting that young children having pulmonary lesions with hyperimmunoglobulinemia E and high eosinophilia could be suggestive of toxocariasis (Mazur-Melewska et al. 2015).

Based on our findings, there was a statistically significant association between anti *Toxocara* IgG seroprevalence in BA (26%), and each of eosinophilia (28%) and total IgE (34%). This was agreed with the results of Mendonca et al. (2012)

who reported that toxocariasis was an important provocative of eosinophilia and IgE. Anti *Toxocara* IgG seropositivity (46.3%) was detected among (33.3%) of positive eosinophilia individuals. This result agreed with Gueglic et al. (1994) who suggested that patients with eosinophilia were at 149 times higher risk of having toxocariasis compared to other patients with negative eosinophilia. Martin et al. (2008) and Espinoza et al. (2008) had previously demonstrated higher rates of eosinophilia in nearly 87% of toxocariasis positive cases. El-Shazly et al. (2013), Shahat et al. (2019) and Song et al (2020) detected lower *Toxocara* IgG seropositivity in 29%, 36.4%, and 22.2% eosinophilic cases in Egypt and Korea, respectively.

In the present work, behavioral, and sociodemographic data, were debatable. The obtained result revealed non statistically significant association between anti *Toxocara* IgG seropositivity with studied variables regarding sex, and socioeconomic level in the total studied groups together. This agrees with Badawey et al. (2018), Shahat et al. (2019) Guadalupe et al. (2021) and Temsah et al. (2021). Other researches related between toxocariasis and sex (Silva et al. 2016), socioeconomic status (Souza et al. 2011; Alvarado 2013).Meanwhile, *Toxocara* IgG seropositivity was significantly higher in asthmatic children with positive pets contact (61.5%) as compared to control group, which is similar to other studies (Badawey et al. 2018; Shahat et al. 2019; Temsah et al. 2021).

Our results revealed non statistical significance between *Toxocara* IgG seropositivity and residence, although percentages were higher in rural areas (80.5%) than urban areas (19.5%) which is parallel to findings with variable statistical values observed by Nyan et al. (2001), Badawey et al. (2018), and Shahat et al. (2019). Also, higher anti-*Toxocara* IgG (70.7%) was detected in children that had positive soil contact and showed statistical significance which matches with others (El-Tantawy et al. 2013; Badawey et al. 2018; Shahat et al. 2019).

Regarding the outcome of respiratory manifestations in BA children, all studied cases with positive *Toxocara* IgG in their sera (100%) didn't have fever and complained of chronic cough and this showed high significant statistical difference. Dyspnea was more prevalent among positive anti *Toxocara* IgG pneumonic cases (60.9%) as compared to BA cases (23.1%) with significant statistical difference. Wheezes were observed in most of asthmatic cases (92.3%) with statistical significance. The obtained results revealed significant association between *Toxocara* seropositivity and respiratory symptoms in BA patients in the same way illustrated previously by Shahat et al. (2019).

Fever in pneumonic children was (56.5%) which may be owed to hyper-reaction of *T. canis* larvae in systemic or pulmonary involvement (Park et al. 2014). All children in pneumonia group (asymptomatic and symptomatic) underwent classical chest radiography screening. Children who revealed abnormalities in their chest X ray were subjected to anti *Toxocara* IgG test, that was previously approved by others (Park et al. 2014; Mazur-Melewska et al. 2015).

Pulmonary symptoms are the most frequent clinical respiratory manifestations recorded in toxocariasis (Gueglic et al. 1994). Respiratory manifestations occur in toxocariasis are owed to migration of larvae and infected subjects are most probably start to wheeze in response to larval invasion (Nash 2005).

In the preceding literature, *Toxocara* IgG seropositivity had no significant association with GIT manifestations, which was in contrast to Bahnea et al. (2008), and Shahat et al. (2019) results at this point.

In conclusion, the present study illustrated a potential significant association between *Toxocara* seropositivity, BA and pneumonia in pediatric children in our Governorate confirming the role of toxocariasis as a vital associated factor for this category of children. It's necessary to evaluate the impact of this neglected parasitic infection on the public health. Pediatricians should keep in mind to consider toxocariasis as a common differential diagnosis in BA and eosinophilic pneumonia especially in our country Egypt. Further studies are still needed to explore the correlation between toxocariasis and different patient categories. Extended researches from different localities in Egypt as well as larger sample size are recommended.

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Declarations

Conflict of interest The authors declare that they have no competing interests.

Ethical approval The study was approved by Research Ethical Committee of Beni-Suef University, Faculty of Medicine, Egypt. Ethical approval certificate is registered under number FMBSUREC/08052022. Written informed consent was obtained from children's parents/guardians after detailed description of the study's purpose. Pediatricians were informed with children positive results to describe appropriate treatment.

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