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Human Toxocariasis in patients with Leukemia: The First Seroepidemiological Study in Egypt

Rasha Elgamal[1], Hend Mohamed Shamhout[2], Nashwa S. M. Abdeen[3], Reham F. Othman[4], Wesam M. A. Elgendy[5], Shima Gafar Mansor[6]

Department of [1]Clinical Pathology, Faculty of Medicine, Suez University, Suez, Egypt

Departments of [2]Pediatric, [3]Clinical Pathology and

[5]Medical Parasitology, Faculty of Medicine, Tanta University, Tanta, Egypt

Department of [4]Internal Medicine, School of Medicine, Newgiza University, Giza, Egypt

Department of [6]Clinical Pathology, South Egypt Cancer Institute, Assiut University, Assiut, Egypt

***Corresponding author:** Shima Gafar Mansor, **Mobile:** +201064824053, **Mail:** shimaagaf@aun.edu.eg

ABSTRACT

Background: Toxocariasis is a neglected zoonotic parasitic disease with global distribution, yet data from Egypt remain limited, particularly in immunocompromised patients such as those with leukemia. *Toxocara* larval migration may cause severe complications in this population.

Objective: This study aimed to determine *Toxocara* seroprevalence, associated risk factors, and its impact on hematological as well as the biochemical parameters among leukemic patients.

Methods: This case-control study included 200 participants: 100 leukemia patients and 100 healthy controls. Sociodemographic data were collected via questionnaire. *Anti-Toxocara canis* IgG antibodies were detected by ELISA, and biochemical tests (liver, renal, glucose & lipid profile) along with complete blood counts were assessed.

Results: Overall seroprevalence was 10.5%, significantly higher in leukemia patients (15%) than controls (6%). Infection was most frequent in acute lymphocytic leukemia (20.9%), followed by acute myeloid leukemia (16%). Significant risk factors included male gender, pediatric age, soil contact, and pet contact. Infected leukemia patients showed elevated WBCs and liver enzymes (ALT & AST) with reduced albumin, hemoglobin, and platelets compared to seronegative counterparts.

Conclusion: Leukemia patients demonstrated significantly higher *Toxocara* seropositivity, with pediatric age, male sex, and environmental exposures as key risk factors. Infection adversely affected hematological and biochemical profiles, highlighting the need for preventive measures and screening in immunocompromised groups.

Keywords: Seroprevalence, Human toxocariasis, *Toxocara canis*, Leukemia, Biochemical, Hematological, Egypt.

INTRODUCTION

Cancers are a global health problem that continue to cause significant economic and health losses each year. Nearly 10 million deaths and about 20 million new instances of cancer are recorded annually, with projections estimating up to 30 million new cases worldwide by 2040 [(1)]. Leukemia is a frequent hematological malignancy characterized by abnormal proliferation of leucocytes in the bone marrow and blood. Leukemia, as defined by the World Health Organization and supported by contemporary epidemiological evidence, is generally classified into four principal forms: acute myeloid leukemia (AML), acute lymphoblastic leukemia (ALL), chronic myeloid leukemia (CML), in addition to the chronic lymphocytic leukemia (CLL) [(2)].

A negative correlation between parasitic infection and cancer has been increasingly studied in recent years due to the immunomodulatory properties of helminths [(3-4)]. Certain parasites and their excretory-secretory products can modulate host immunity, influencing tumor biology. In hematological malignancies, infections are among the leading causes of morbidity and mortality, especially in acute leukemia, due to recurrent neutropenia induced by chemotherapy. Infections not only increase mortality rates but also prolong hospitalization, hinder chemotherapy administration, and impact quality of life [(5)].

Toxocariasis is a zoonotic parasitic disease with broad distribution in tropical and subtropical regions, resulting from the migration of *Toxocara* larvae within host tissues. Of the 26 identified species, *Toxocara canis* and *Toxocara cati* represent the primary sources of human infection [(6-7)]. Dogs, foxes, and wolves serve as definitive hosts for *T. canis*, while cats harbor *T. cati*. Humans act as accidental hosts when embryonated eggs are ingested through contaminated soil, food, or water [(8)]. Although most infections remain asymptomatic, larvae migration to extraintestinal tissues can result in severe clinical outcomes such as meningoencephalitis, ocular damage, or visceral organ involvement [(6)].

Toxocariasis presents with varied clinical features that are generally classified into four entities: visceral larva migrans (VLM), ocular larva migrans (OLM), neurotoxocariasis (NT) and covert/common toxocariasis (CT) [(6)]. Diagnosis is primarily based on clinical suspicion supported by laboratory detection of anti-*Toxocara* IgG antibodies. Enzyme-linked immunosorbent assays (ELISA) using excretory-secretory antigens of third-stage larvae remain the most widely applied diagnostic method [(9)].

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As far as we know, there is a lack of studies that evaluate the association between leukemia disorders and *toxocariasis*, in Egypt. Consequently, the purpose of the current study was to assess the seroprevalence of *Toxocara* infection among patients diagnosed with various types of leukemia and the related risk factors in addition to its potential impact on hematological and biochemical markers.

MATERIALS AND METHODS

Study design and populations: This case-control research on leukemia patients was carried out in Clinical Pathology Department, Faculty of Medicine, Tanta University. One hundred patients diagnosed with leukemia (study group) were included in the study while visiting Oncology and Paediatric Outpatient Clinics, Tanta University Hospital, Egypt for follow up. Another 100 apparently healthy individuals (control group) were recruited in the study, after being matched by age and gender. Biodata and risk variables, including residential area and history of contact with dogs, were collected using a standardized questionnaire.

Inclusion criteria: Either adults or children who were previously diagnosed with different types of leukemia. Participants who were not diagnosed with cancer or blood disorders were enrolled as healthy controls.

Exclusion criteria: Individuals who refused or were unable to provide informed consent, any individual with a previous diagnosis or history of toxocariasis, individuals who had solid tumors or other cancers, and patients who were taking anti-parasitic drugs for one week before participation.

Samples collection: Five millilitres of venous blood were drawn from each participant. Following collection, each blood specimen was divided into two aliquots. The first was transferred into a tube containing the anticoagulant ethylenediaminetetraacetic acid (EDTA) for hematological analysis, while the second was placed into a plain tube without anticoagulant to allow clot formation. The latter was subsequently centrifuged at 1500 revolutions per minute for 10 minutes to separate the serum. The obtained serum was carefully aspirated, dispensed into sterile Eppendorf tubes, and preserved at –20 °C in the Clinical Pathology Department, Faculty of Medicine, Tanta University, until the time of serological testing.

Quantitative measurement of anti-*Toxocara* IgG: Following the manufacturer's instructions, serum samples were subjected to an Enzyme-Linked Immunosorbent Assay using *Toxocara canis* IgG kit (ELISA) (IBL International GmbH, Hamburg, Germany) to identify anti-*Toxocara* IgG antibodies. A positive absorbance reading was defined as one that had 0.38 optical density (OD) units or above.

Each serum sample included in this study was also subjected to several laboratory tests, as follows; liver function tests in the form of alanine aminotransferase (ALT), Aspartate aminotransferase (AST), and albumin measurements; kidney function tests including urea and creatinine; blood glucose profile by estimating fasting blood sugar (FBS) and postprandial blood sugar (PPBS) in addition to complete lipid profile including cholesterol, triglycerides, High-Density Lipoprotein (HDL), and Low-Density Lipoprotein (LDL). All biochemical tests were performed in compliance with the instructions supplied by the kit's manufacturer using the fully automated auto-analyzer Cobas c 6000 (Roche Diagnostics, Mannheim, Germany). A complete blood count was performed using EDTA blood samples using the Sysmex 5 differential part (Siemens AG, Erlangen, Germany).

Ethical approval: The study was carried out in compliance with the World Medical Association's Code of Ethics (Declaration of Helsinki). The research was approved by The Ethics Committee of The Faculty of Medicine, Tanta University (Approval Code: 36264PR1232/5/25). Participants' information was kept private and only authorized researchers had access to it. Medical care is unaffected by unwillingness to participate in the study, which is entirely voluntary. There were no associated risks in the study, except mild discomfort associated with taking the blood sample. All participants or their guardians provided written informed consent after receiving full information about the study.

Statistical analysis

The data were analyzed by SPSS version 28.0 software package. There was a dichotomy between dependent and independent variables. Person chi-square test, independent t-test and one way ANOVA were used to assess the statistical significance of different variables. $P \leq 0.05$ indicated a statistical significance.

RESULTS

Clinical profile and sociodemographic data: Out of the 200 participants, 82 (41.0%) were males, and 118 (59.0%) were females. with ages ranged from 2 to 65 years. On comparing sociodemographic data of the study and control groups, no statistically significant difference was detected regarding age and gender, however, urban residency was significantly higher in the study group. On comparing both groups regarding the clinical data, AST, FBS, PPBS, and total WBCs were significantly higher, while, albumin, hemoglobin, and platelet count were significantly lower in leukemia patients compared to healthy control as shown in table (1).

Table (1): Sociodemographic and clinical data of study and control groups

Variables	Leukemia Study group (n=100)	Healthy control group (n=100)	Significance *(P*-value)
Sociodemographic parameters			
Age (years)	24.1 ± 19.1	21.7 ± 18.4	0.367
Sex (M/F)	38/62	44/56	0.388
Residence (Rural/Urban)	24/76	37/63	0.047*
Liver functions			
ALT (U/L)	21.9 ± 5.4	20.8 ± 3.9	0.399
AST (U/L)	28.5 ± 7.1	21.3 ± 5.1	P < 0.0001*
Albumin (g/dL)	3.3 ± 0.8	3.9 ± 0.7	P < 0.0001*
Kidney Functions			
Urea (mg/dL)	28.3 ± 6.9	26.3 ± 6.3	0.276
Creatinine (mg/dl)	1.1 ± 0.2	1.0 ± 0.2	0.246
Blood glucose profile			
FBS (mg/dL)	123.5± 30.3	101.7 ± 24.8	0.0003*
PPBS (mg/dL)	151.7± 36.9	134.1 ± 33.3	0.015*
Lipid profile			
Cholesterol (mg/dL)	179.1 ± 42.3	170.8 ± 47.6	0.193
Triglycerides (mg/dL)	162.7 ± 39.7	155.5± 36.9	0.292
HDL (mg/dL)	50.5 ± 12.8	44.8 ± 10.7	0.244
LDL (mg/dL)	95.8 ± 23.4	86.5 ± 21.2	0.168
Complete Blood Count (CBC)			
Haemoglobin (g/dl)	10.8 ± 0.6	11.9 ± 0.8	P < 0.0001*
Total WBCs X 10^3 µL	14.8 ± 0.8	5.5 ± 1.3	P < 0.0001*
PLT X 10^3 µL	156.4 ± 7.8	266.7 ± 8.9	P < 0.0001*

FBS: Fasting blood sugar; PPBS: Postprandial blood sugar; HDL: High density lipoprotein; LDL: Low density lipoprotein; WBCs: White blood cells; PLT: Platelets; * Statistically significant; Data was represented as mean ± Standard deviation. Person chi-square test and independent t-test were used to assess the statistical significance.

Prevalence of toxocariasis: Anti-*Toxocara* IgG antibodies were positive in 15/100 (15.0%) of the leukemia patients and 6/100 (6.0%) of the control group (**Figure 1**). The Chi-square test showed a statistically significant correlation between leukemia and *Toxocara* IgG seropositivity (P = 0.047). As illustrated in table (2), distribution of *Toxocara* infection with various types of leukemia revealed that patients with acute lymphocytic (or lymphoblastic) leukemia (ALL) had the highest prevalence of *Toxocara* infection (20.9%), followed by AML (16.0%), then CLL (10.5%). Regarding sociodemographic characteristics of *Toxocara* seropositive individuals in the study and control groups, table (3) showed that seroprevalence of anti-*Toxocara* IgG antibodies in leukemia patients was significantly correlated with contact with pets (P=0.013) compared to *Toxocara* seropositive control. In contrast, sex differences, rural residency, education level, and contact with soil were found to be non-significant between *Toxocara* seropositive leukemia patients and control (P>0.05).

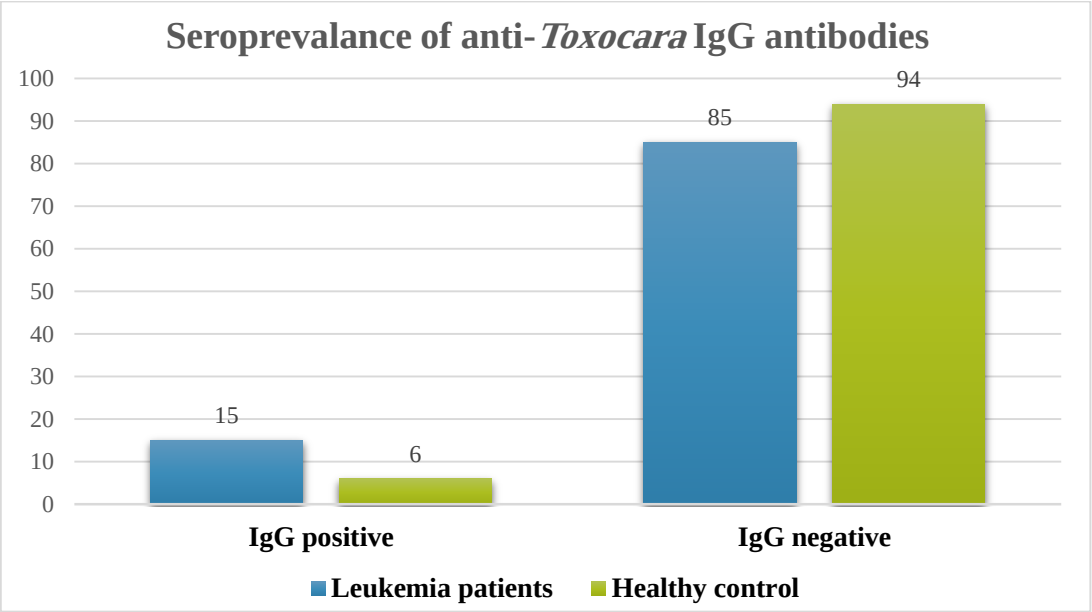

Figure (1): Seroprevalence of anti-*Toxocara* IgG antibodies in study and control groups.

Table (2): Seroprevalence of anti-*Toxocara* IgG antibodies in patients suffering from different types of leukemia

Leukemia types	Total	Negative anti-*Toxocara* IgG antibodies	Positive anti-*Toxocara* IgG antibodies	Significance (P-Value)
Acute myeloid leukemia (AML)	25 (25.0%)	21 (84.0%)	4 (16.0%)	0.00009*
Chronic myeloid leukemia (CML)	13 (13.0%)	13 (100.0%)	0 (0.0%)	
Acute lymphoblastic leukemia (ALL)	43 (43.0%)	34 (79.1%)	9 (20.9%)	
Chronic lymphocytic leukemia (CLL)	19 (19.0%)	17 (89.5%)	2 (10.5%)	
Total	100 (100%)	85 (85.0%)	15 (15.0%)	

* Statistically significant; One-way ANOVA test was used for statistical analysis.

Table (3): Sociodemographic characteristics and potential risk factors in *Toxocara* seropositive individuals in the study and control groups

Parameters	Leukemia patients with anti-*Toxocara* IgG (+ve) (n=15)	Healthy control with anti-*Toxocara* IgG (+ve) (n=6)	Significance (P-Value)
Sociodemographic parameters			
Age (years)	9.3 ± 12.8	11.4 ± 10.0	0.724
Sex (M/F)	10/5	4/2	1.00
Residence (Rural/Urban)	6/9	2/4	0.777
Education level (Illiterate/ Literate)	7/8	3/3	0.890
Contact with soil (Yes/No)	13/2	4/2	0.306
Contact with pets (Yes/No)	14/1	2/4	0.013*

*Significant.

***Toxocara* risk factors in leukemia patients:** Table (4) showed that *Toxocara* IgG seropositivity in patients suffering from leukemia was significantly higher in paediatric age ($P < 0.0001$) compared to adults and in males compared to females (P=0.018). Moreover, a statistically significant association was detected between *Toxocara* IgG seropositivity in leukemia patients and contact with soil (P=0.036), and pets (P=0.0005) as potential risk factors for *Toxocara* infection in the study group. Furthermore, total WBCs and liver enzymes (ALT and AST) showed a significant increase, while conversely albumin, hemoglobin level and platelet count significantly decreased in *Toxocara* seropositive leukemia patients compared to seronegative ones.

Table (4): *Toxocara* seroprevalence in leukemia patients with associated sociodemographic and clinical data

Parameters	Leukemia patients with *Toxocara* IgG (+ve) (n=15)	Leukemia patients with *Toxocara* IgG (-ve) (n=85)	*Significance*
Sociodemographic parameters			
Age (years)	9.3 ± 12.8	39.2 ± 15.9	P < 0.0001*
Sex (M/F)	10/5	28/57	0.018*
Residence (Rural/Urban)	6/9	18/67	0.124
Education level (Illiterate/ Literate)	7/8	23/62	0.134
Contact with soil (Yes/No)	13/2	47/38	0.036*
Contact with pets (Yes/No)	14/1	22/63	0.0005*
Liver functions			
ALT (u/l)	30.7 ± 2.5	13.1 ± 2.2	P < 0.0001*
AST (u/l)	35.5 ± 1.9	21.5 ± 5.5	P < 0.0001*
Albumin	2.9 ± 0.2	3.7 ± 0.6	0.0001*
Kidney Functions			
Urea (mg/dl)	24.3 ± 1.1	22.3 ± 1.1	0.644
Creatinine (mg/dl)	0.9 ± 0.2	0.8 ± 0.2	0.537
Blood glucose profile			
FBS (mg/dl)	129.0 ± 7.1	118.0 ± 7.1	0.313
PPBS (mg/dl)	161.5 ± 6.6	141.9± 4.0	0.142
Lipid profile			
Cholesterol (mg/dl)	181.6 ± 44.8	176.6 ± 39.8	0.661
Triglyceride (mg/dl)	160.2 ± 44.4	165.2 ± 49.3	0.714
HDL (mg/dl)	53.0 ± 8.2	48.0 ± 3.2	0.600
LDL (mg/dl)	98.3 ± 5.2	93.3 ± 5.2	0.727
Complete Blood Count (CBC)			
Haemoglobin (g/dl)	10.1 ± 0.5	11.5 ± 0.7	P < 0.0001*
Total WBCs X 10^3 µL	16.3 ± 1.1	13.3 ± 0.5	P < 0.0001*
PLT X 10^3 µL	140.4 ± 6.5	172.4 ± 9.1	P < 0.0001*

FBS: Fasting blood sugar; PPBS: Postprandial blood sugar; HDL: High density lipoprotein; LDL: Low density lipoprotein; WBCs: White blood cells; PLT: Platelets; *significant; Data was represented as mean ± Standard deviation. Person chi-square test and independent t-test were used to assess the statistical significance.

DISCUSSION

One of the top five neglected parasitic diseases that call for public health intervention, is human toxocariasis. About 1.4 billion individuals were exposed to *Toxocara* infection as stated by **Yang *et al.*** [10]. However, in Egypt, very little is known about toxocariasis seroprevalence particularly in patients suffering from leukemia. Public knowledge of human toxocariasis, particularly among leukemia patients, has to be increased to advocate for a "One Health" response to this significant zoonotic disease. Thus, this epidemiological study was conducted to determine the prevalence of anti-*Toxocara* IgG antibodies among patients with different types of leukemia with identification of the potential risk factors for the infection, in addition to its impact on hematological and biochemical parameters.

Leukemia is more common in younger people, yet it can strike anyone at any age. ALL is most prevalent in early childhood (children under 15 years old) and peaks between the ages of 2 and 5 years [11]. In the present study, leukemia was significantly higher in metropolitan areas (P=0.047). This finding is consistent with **Malagoli *et al.*** [12], who found that children in urban settings have an increased risk of leukemia regardless of their exposure to vehicle pollution.

In the present study, the mean serum AST level in leukemia patients was significantly higher compared to the healthy control (P < 0.0001). Leukemia can be linked to elevated AST levels, especially when the diseased cells invade the liver or while chemotherapy is being administered. This result is in line with those of **Islam *et al.*** [13], who found that serum AST levels increase in response to chemotherapeutic medications during the treatment of acute leukemia. In the current study, the albumin level was significantly lower in leukemia patients compared to healthy controls (P<0.0001). AML is one of several leukemia forms that exhibit low albumin levels. Lower albumin levels are associated with higher mortality and treatment problems, according to studies, which suggest that hypoalbuminemia may be a prognostic factor in leukemia [14]. The FBS and PPBS levels were significantly higher in leukemia patients compared to healthy controls, in the present study (P=0.0003 &

P=0.015 respectively). This result is in agreement with a previous study that hyperglycemia occurs as a complication of chemotherapy or steroid medication taken by the leukemia patients [15].

Regarding hematological parameters, leukemia patients showed significantly lower hemoglobin levels and platelet counts compared to healthy controls (P < 0.0001), in the present study. This result coincides with previous studies, as anemia and leukemia are closely related. Leukemia frequently results in a reduction in the formation of red blood cells, which causes anemia. Leukemia is caused by the growth of aberrant white blood cells in the bone marrow, which crowds out and interferes with the formation of healthy red blood cells. Anemia may ensue from decreased hemoglobin levels, which are caused by the oxygen-carrying protein in red blood cells [16].

Screening for anti-*Toxocara* antibodies in Egypt has produced heterogeneous prevalence estimates, largely influenced by the clinical background of the studied population and regional characteristics. Children, who are particularly vulnerable due to frequent soil contact and limited hygienic awareness, have been the focus of many reports. Notably, *Toxocara* seropositivity was observed in 10.7% of pediatric patients with renal disorders [17]**.** Lower rates, around 6.2%, were described in children presenting with respiratory illness or unexplained fever, whereas a higher prevalence of 18% was identified in febrile adults from Tanta City [18]**.** Strikingly, the highest proportion, nearly 48.5%, was documented in children diagnosed with cryptogenic epilepsy [19]**.**

Despite the significant relationship that has been demonstrated between *Toxocara* infection and many other diseases as asthmatic bronchitis [20] and chronic urticaria [21], so far, no studies assessed the possible correlation between seroprevalence of toxocariasis and leukemia in Egypt. In immunocompromised patients as patients suffering from leukemia, toxocariasis can induce unique challenges, as exacerbation or reactivation during chemotherapy in addition to the possibility of severe, unusual clinical presentation or disseminated forms of toxocariasis [22]. Even though the prevalence of toxocariasis among patients suffering from leukemia is still undetermined worldwide.

In the present study, 21 out of 200 enrolled participants tested positive for anti-*Toxocara* IgG antibody (10.5%). *Toxocara* seroprevalences were 15.0%, and 6.0% in leukemia patients and healthy controls respectively with a statistically significant difference between both groups.

Prevalence of *Toxocara* infection in the control group in the current study lies within the range of other studies conducted in Egypt [21]. However, *Toxocara* seroprevalences in leukemia patients (15.0%) in the present study was higher than that reported by **Raissi *et al.*** [23] who revealed that 5.94% of patients suffering from white blood cell disorders including various types of leukemia, lymphoma and multiple myeloma were seropositive to anti-*Toxocara* IgG antibodies in Iran.

In the current study, the distribution of *Toxocara* infection with different types of leukemia showed that *Toxocara* infection was most prevalent in patients with ALL (20.9%), followed by AML (16.0%), then CLL (10.5%), while no cases of CML showed *Toxocara* IgG positivity. This is in accordance with **Raissi *et al.*** [23]. Contact with pets was one of the variables that were examined as a risk factor for *Toxocara* infection in leukemia patients, and it was found to be an estimated risk factor with a significant positive association with *Toxocara* infection (P=0.013). This result agrees with **Raissi *et al.*** [23]. On the contrary, the current study revealed no significant correlation between residency either urban or rural and the rate of *Toxocara* infection. These results concur with **Raissi *et al.*** [23]. The current study revealed that age and gender differences showed non-significant association in *Toxocara* seropositive leukemia patients compared to seropositive control (P>0.05). This is also consistent with **Raissi *et al.*** [23].

In terms of the risk factors for *Toxocara* infection in leukemia patients, the mean age of infected individuals was 9.3 ± 12.8 years, which was significantly lower than that of non-infected ones in the study group (P < 0.0001). This is in alignment with previous study by **Mubarak *et al.*** [24] who observed the highest T. canis seropositivity at the young age group.

In the present study, among patients suffering from leukemia, males had a significantly higher prevalence of *Toxocara* infection than females (P=0.018). This is consistent with **Na-Ek *et al.*** [25] who detected higher prevalence of *Toxocara* infection in males suggesting male gender as a potential risk factor for toxocariasis.

Regarding potential risk factors for *Toxocara* infection in patients suffering from leukemia, the current study illustrated that contact with soil (P=0.036), and pets (P=0.0005) are significant risk factors in *Toxocara* seropositive leukemia patients compared to seronegative ones. These results are in harmony with previous studies [21, 26, 27]. Moreover, **Raissi *et al.*** [23] similarly confirmed the vital role of contact with pets in *Toxocara* infection of patients with blood cell disorders.

Contamination of public places as parks and playgrounds with dog's stool containing *Toxocara* eggs, causes environmental contamination with subsequent transmission of such zoonotic infection to humans via contaminated soil **Keegan *et al.*** [28]. This is in accordance with our results of a significant correlation between soil exposure and *Toxocara* infection in leukemia patients (P=0.036). Moreover, this also agrees with **Bayoumy *et al.*** [21]. **Raissi *et al.*** [23] similarly declared the crucial role of contaminated soil as a public threat in the transmission of human toxocariasis. Furthermore, **Merigueti *et al.*** [27]

suggested that contaminated soil can be physically transferred via the shoes of the pet owner and even cause infection to his/her dewormed pet animals as dogs, converting them to potential helminth carriers.

Regarding biochemical parameters associated with *Toxocara* infection in leukemia study group, liver enzymes (ALT and AST) were significantly higher in infected individuals than in non-infected ones (P<0.0001). As declared by **Wang *et al.* [(29)]**, following ingestion of *Toxocara* embryonated eggs, larvae emerge in the small intestine, penetrate the intestinal wall to be carried by the blood stream primarily to the liver with subsequent damage of tissues caused by larval migration and hence the name VLM. The inflammatory response triggered by migrating larvae and their antigens can have a substantial effect on the liver demonstrated in granuloma formation, liver abscess, multiple focal hepatic lesions with necrosis and chronic inflammatory cellular infiltration and increased liver enzymes[(30)].

In leukemia study group of the present study, a significant decrease in albumin levels was revealed in *Toxocara* seropositive patients compared to seronegative ones (P=0.0001). The decrease in protein levels could be due to hepatic injury with subsequent disruption of its protein synthesis capability, which could result from both larval migration and the consequently increased oxidative stress [(31)].

Regarding hematological parameters, significantly lower hemoglobin levels and platelet counts, while significantly higher total WBCs were detected in *Toxocara*-infected compared to non-infected individuals in leukemia study group (P < 0.0001). **Gouda *et al.* [(32)]** confirmed similar results of significant decrease in the mean hemoglobin level and significant increase of total white blood cell count in patients with toxocariasis however, it was contradictory with our results with regards to the platelet count. This can be explained by the difference in the target population between the two studies in addition to the possible added effect of leukemia in reducing the total platelet count [(33)].

CONCLUSION

Up to date, this is the first study of toxocariasis seroprevalence in patients suffering from leukemia. The study provided valuable insights not only into the seroprevalence, but also to the potential risk factors associated with toxocariasis infection in those vulnerable immunocompromised patients in addition to assessment of the impact of the infection on various biochemical and hematological parameters. The prevalence of *Toxocara* in leukemia patients was significantly higher than healthy controls. Infection was strongly linked to young age, male gender, pet contact, and soil contact, highlighting the role of behavioral, environmental, and sociodemographic factors in *Toxocara* transmission to leukemia patients. *Toxocara* infection in leukemia patients showed a negative impact on the biochemical and hematological parameters. Finally, further large-scale studies are needed to determine the exact prevalence and risk factors of *Toxocara* infection in larger sample size of patients diagnosed with leukemia and other blood disorders, which could contribute to improved prevention and management strategies.

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REFERENCES

1. **Sung H, Ferlay J, Siegel R *et al.* (2021)**: Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin., 71 (3): 209-249.
2. **Du M, Chen W, Liu K *et al.* (2022)**: The global burden of leukemia and its attributable factors in 204 countries and territories: Findings from the Global Burden of Disease 2019 study and projections to 2030. J Oncol., 22: 1612702. doi: 10.1155/2022/1612702.
3. **Eissa M, Salem A, El Skhawy N *et al.* (2024)**: Parasites revive hope for cancer therapy. Eur J Med Res., 29: 489. doi: 10.1186/s40001-024-02057-2.
4. **Maizels R (2020)**: Regulation of immunity and allergy by helminth parasites. Allergy, 75 (3): 524-534.
5. **Šegulja S, Vranešević K, Đorđević A *et al.* (2024)**: Infections in children with acute lymphoblastic leukemia. Medicina (Kaunas), 60 (9): 1395. doi: 10.3390/medicina60091395.
6. **Henke K, Ntovas S, Xourgia E *et al.* (2023)**: Who let the dogs out? Unmasking the neglected: A semi-systematic review on the enduring impact of toxocariasis. Int J Environ Res Public Health, 20 (21): 6972. doi: 10.3390/ijerph20216972.
7. **Holland C (2023)**: A walk on the wild side: A review of the epidemiology of Toxocara canis and Toxocara cati in wild hosts. Int J Parasitol Parasites Wildl., 22: 216-228.
8. **Yang Y, Zhong D, Wu H *et al.* (2025)**: Prevalence of Toxocara infection and associated risk factors: A cross-sectional study in Zhejiang, China. Infect Dis Poverty, 14: 43. doi: 10.1186/s40249-025-01312-w.
9. **Huang L, Sun L, Liu C *et al.* (2021)**: Diagnosis of ocular toxocariasis by serum and aqueous humor IgG ELISA. Transl Vis Sci Technol., 10 (3): 33. doi: 10.1167/tvst.10.8.33.
10. **Yang Y, Zhong D, Wu H *et al.* (2025):** Prevalence of Toxocara infection and associated risk factors: A cross-sectional study in Zhejiang, China. Infect Dis Poverty, 14 (1): 43. https://doi.org/10.1186/s40249-025-01312-7.
11. **Ekpa Q, Akahara P, Anderson A *et al.* (2023):** A review of acute lymphocytic leukemia (ALL) in the pediatric population: Evaluating current trends and changes in guidelines in the past decade. Cureus, 15 (12): e49930. https://doi.org/10.7759/cureus.49930.
12. **Malagoli C, Malavolti M, Costanzini S *et al.* (2015):** Increased incidence of childhood leukemia in urban areas: A population-based case-control study. Epidemiol Prev., 39 (4 Suppl. 1): 102-107.
13. **Islam T, Rahman A, Hasan M *et al.* (2020):** Liver function tests in patients of acute leukemia before and after induction chemotherapy. J Biosci Med., 8 (2): 110-121.

14. **Tang Q, Li X, Sun C (2024):** Predictive value of serum albumin levels on cancer survival: A prospective cohort study. Front Oncol., 14: 1323192. https://doi.org/10.3389/ fonc.2024.1323192.
15. **McCormick M, Sharp E, Kalpatthi R *et al.* (2020):** Hyperglycemia requiring insulin during ALL induction chemotherapy associated with increased adverse outcomes and healthcare costs. Pediatr Blood Cancer, 67 (9): e28475. doi: 10.1002/pbc.28475.
16. **Jaime-Pérez J, García-Arellano G, Herrera-Garza J *et al.* (2019):** Revisiting the complete blood count and clinical findings at diagnosis of childhood acute lymphoblastic leukemia: 10-year experience at a single center. Hematol Transfus Cell Ther., 41 (1): 57-61.
17. **Nada S, Abbaza B, Mahmoud L *et al.* (1996):** Toxocariasis as a cause of renal disease in children in Sharkia Governorate, Egypt. J Egypt Soc Parasitol., 26 (3):709–717.
18. **Antonios S, Eid M, Khalifa E *et al.* (2008):** Seroprevalence study of Toxocara canis in selected Egyptian patients. J Egypt Soc Parasitol., 38: 313-318.
19. **El-Tantawy N, El-Nahas H, Salem D *et al.* (2013):** Seroprevalence of Toxoplasma gondii and Toxocara spp. in children with cryptogenic epilepsy. Am J Infect Dis Microbiol., 1 (5): 92-95.
20. **Shahat S, Mohammad K, Saad M *et al.* (2019):** Clinico-seroepidemiological evaluation of toxocariasis in asthmatic Egyptian children. Egypt J Hosp Med., 76 (5): 4195-4201.
21. **Bayoumy A, Atallah R, Mohamed K, *et al.* (2019):** Seroepidemiological evaluation of toxocariasis in Egyptian children suffering from recurrent urticaria. Egypt J Hosp Med., 76 (6): 4262-4268.
22. **Lupia T, Crisà E, Sangiorgio V *et al.* (2024):** Presumptive pulmonary toxocariasis in a patient affected by acute myeloid leukemia and Hodgkin lymphoma: Case report and review of the literature in immunocompromised hosts. Infez Med., 32 (1): 103-112.
23. **Raissi V, Sohrabi N, Bayat F *et al.* (2021):** Human toxocariasis in individuals with blood disorders and cancer patients: The first seroepidemiological study in Iran. J Parasit Dis., 45 (3): 643-650.
24. **Mubarak A, Mohammed E, Elaadli H *et al.* (2023):** Prevalence and risk factors associated with Toxocara canis in dogs and humans in Egypt: A comparative approach. Vet Med Sci., 9 (6): 2475-2484.
25. **Na-Ek P, Narkkul U, Phasuk N *et al.* (2022):** Seroprevalence of anti-Toxocara canis antibodies and associated risk factors among dog owners in the rural community of Nakhon Si Thammarat province, southern Thailand. Trop Med Health, 50 (1): 32. https://doi.org/10.1186/s41182-022-00425-4.
26. **Foroutan M, Soltani S, Bahadoram S *et al.* (2022):** Seroprevalence and risk factors of Toxocara canis infection in children aged 2–15 years from southwest Iran. Comp Immunol Microbiol Infect Dis., 85: 101801. https://doi.org/10.1016/j.cimid.2022.101801.
27. **Merigueti Y, Giuffrida R, da Silva R *et al.* (2022):** Dog and cat contact as risk factor for human toxocariasis: Systematic review and meta-analysis. Front Public Health, 10: 854468. https://doi.org/10.3389/fpubh.2022.854468.
28. **Keegan J, Airs P, Brown C *et al.* (2025):** Park entrances, commonly contaminated with infective Toxocara canis eggs, present a risk of zoonotic infection and an opportunity for focused intervention. PLoS Negl Trop Dis., 19 (3): e0012917. https://doi.org/10.1371/journal.pntd.0012917.
29. **Wang N, Sieng S, Liang T *et al.* (2025):** Effect of Toxocara canis infection on liver and lung microbial flora diversity and composition in dogs. Parasite, 32: 17. https://doi.org/10.1051/parasite/2025011.
30. **Huynh T, Tran K, Dinh T *et al.* (2024):** Atypical Toxocara canis-induced hepatic visceral larva migrans: Diagnostic challenges and literature review. Korean J Gastroenterol., 83 (6): 247-252.
31. **Soeters P, Wolfe R, Shenkin A (2019):** Hypoalbuminemia: Pathogenesis and clinical significance. J Parenter Enteral Nutr., 43 (2): 181-193.
32. **Gouda M, Abdelgawad A, Rizk M *et al.* (2024):** Neglected toxocariasis among eosinophilic children: A cross-sectional study in Shibin El Kom, Menoufia Governorate, Egypt. Parasitol United J., 17 (1): 18-23.
33. **Zeidler L, Zimmermann M, Möricke A *et al.* (2012):** Low platelet counts after induction therapy for childhood acute lymphoblastic leukemia are strongly associated with poor early response to treatment as measured by minimal residual disease and are prognostic for treatment outcome. Haematologica, 97 (3): 402-409.