

The Effects of *Toxocara* spp. and *Toxoplasma gondii* on the Level of IgE and Hematological Parameters in Pet Handlers seropositive in Al-Qadisiyah Province, Iraq.

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Abstract

Toxocariasis and toxoplasmosis are important zoonotic parasitic infections that may induce immunological and hematological alterations in exposed individuals. This study aimed to evaluate total immunoglobulin E (IgE) levels and selected hematological parameters among pet handlers seropositive for *Toxocara* spp. and *Toxoplasma gondii* in Al-Qadisiyah Governorate, Iraq. A total of 91 blood samples were collected from pet handlers. Serum samples were examined for anti-*Toxocara* IgG and anti-*T. gondii* IgG using enzyme-linked immunosorbent assay (ELISA). Total IgE levels were quantified by ELISA, while hematological parameters were assessed using an automated complete blood count analyzer. The seroprevalence of *Toxocara* spp. and *T. gondii* infections was 13.1% and 24.1%, respectively. Total IgE levels were significantly higher in individuals positive for *Toxocara* spp. (120.3 ± 9.66 ng/ml) and *T. gondii* (69.95 ± 7.89 ng/ml) compared with seronegative individuals ($P < 0.05$). *Toxocara* infection was associated with significant increases in white blood cells, eosinophils, and lymphocytes, accompanied by significant reductions in hemoglobin and hematocrit levels. In contrast, *T. gondii* infection was characterized by significant increases in white blood cells, neutrophils, and monocytes, together with a significant decrease in eosinophil counts. Both parasitic infections were associated with elevated total IgE levels and distinct hematological changes. These findings suggest that IgE and routine hematological parameters may serve as supportive indicators for assessing zoonotic parasitic infections among individuals with frequent animal exposure.

Keyword: Toxocariasis, Toxoplasmosis, Immunoglobulin E, Parasite, Infective.

الخلاصة :

داء السهميات وداء المقوسات من الأمراض الطفيلية الحيوانية المنشأ الهامة التي قد تسبب تغيرات مناعية ودموية لدى الأفراد المعرضين لها. هدفت هذه الدراسة إلى تقييم مستويات الغلوبولين المناعي (IgE) الكلي وبعض المؤشرات الدموية لدى مُربي الحيوانات الأليفة الذين يحملون أجساماً مضادة لداء السهميات *Toxocara* spp. وداء المقوسات الغوندية *Toxoplasma gondii* في محافظة القادسية، العراق. جُمعت 91 عينة دم من ملاسي الحيوانات الأليفة. فُحصت عينات المصل للكشف عن الأجسام المضادة IgG لداء السهميات وداء المقوسات الغوندية باستخدام اختبار المقايضة المناعية الإنزيمية المرتبطة ELISA. قُيسَت مستويات IgE الكلي باستخدام اختبار ELISA، بينما قُيِّمت المؤشرات الدموية باستخدام جهاز تحليل تعداد الدم الكامل الآلي. بلغت نسبة انتشار داء السهميات 13.1%، وداء المقوسات الغوندية 24.1%. وكانت مستويات IgE الكلي أعلى بشكل ملحوظ لدى الأفراد الذين يحملون أجساماً مضادة لداء السهميات (120.3 ± 9.66 نانوغرام/مل) و (69.95 ± 7.89 نانوغرام/مل) من طفيلي المقوسة القوندية مقارنةً بالأفراد ذوي النتائج السلبية ($P < 0.05$). ارتبطت عدوى التوكسوكارا بزيادة ملحوظة في عدد خلايا الدم البيضاء، والحمضات، والليمفاويات، مصحوبة بانخفاض ملحوظ في مستويات الهيموغلوبين والهيماتوكريت. في المقابل، تميزت عدوى التوكسوبلازما بزيادة ملحوظة في عدد خلايا الدم البيضاء، والعدلات، والوحيدات، بالإضافة إلى انخفاض ملحوظ في عدد الحمضات. ارتبطت كلتا العدوى الطفيلية بارتفاع مستويات الغلوبولين المناعي IgE الكلي وتغيرات دموية مميزة. تشير هذه النتائج إلى أن الغلوبولين المناعي IgE ومعايير الدم الروتينية قد تُستخدم كمؤشرات داعمة لتقييم العدوى الطفيلية الحيوانية المنشأ لدى الأفراد الذين يتعرضون للحيوانات بشكل متكرر.

الكلمات المفتاحية: داء السهميات، داء المقوسات، الغلوبولين المناعي E، طفيلي، مُعدٍ.

Introduction:

Toxocariasis and toxoplasmosis are globally distributed zoonotic parasitic diseases that continue to represent an important concern for public health and veterinary medicine [1]. Both diseases are often underreported because of inadequate surveillance systems and their predominantly mild, non-specific, or asymptomatic clinical course following infection. They remain a top priority for public healthy interventions due to their potential to induce

severe systemic and chronic complications in human, often share exposure pathways by close contact with domestic definitive hosts [2].

Humans act as paratenic hosts in toxocariasis [3], which develops following accidental ingestion of embryonated *Toxocara* eggs [4], these eggs from contaminated soil, water, vegetables, fruits, or through contact with infected dogs and cats [5]. After ingestion, third-stage larvae migrate through different tissues and organs [6], resulting in clinical

syndromes that include visceral larva migrans, ocular toxocariasis, neurotoxocariasis, and covert toxocariasis [7]. Toxocariasis is commonly associated with chronic weakness, hypereosinophilia, abdominal pain and different signs of allergy [8], IgE levels elevated sometimes with the infection [9]. Symptoms may include cough, fever, stomach discomfort, hepatomegaly or skin manifestations [10]. Symptoms in children's may include abdominal pain, coughing, wheezing and headaches [11]. Diagnosis of toxocariasis can be made using the common methods, like complete blood count and precisely eosinophil, histopathological detection, or molecular techniques usually based on the polymerase chain reaction to identify the DNA of larvae in tissue or fluids samples [12]. Serologically, enzyme-linked immunosorbent assay (ELISA) and immune blot are widely used for detecting anti-*Toxocara* antibodies [13].

Toxoplasma gondii, causes toxoplasmosis, consider as one of the most worldwide protozoan parasite that infect human and animals [14]. *T. gondii* is an obligate intracellular protozoan parasite belonging to the phylum Apicomplexa [15]. Members of the cat family serve as definitive hosts [16]. whereas a wide range of warm-blooded animals act as intermediate hosts [17]. Human infection may occur through ingestion of tissue cysts in undercooked meat, consumption of food or water contaminated with sporulated oocysts, or congenital transmission [18]. Serological assays, especially ELISA -based detection of anti-*T. gondii* antibodies, remain among the most commonly applied diagnostic methods [19] in addition to molecular techniques such as PCR [20].

Although numerous studies have investigated the epidemiology of these parasites, information regarding their influence on hematological and

immunological parameters in Al-Qadisiyah Governorate remains limited. Therefore, the present study was conducted to evaluate total IgE levels and selected hematological indices among pet handlers seropositive for *Toxocara* spp. and *T. gondii*.

Materials and Methods:

samples collecting

From pet handlers, 91 blood samples were collected in Al-Qadisiyah Province. About (4ml) of venous blood samples of patients and control divided to two parts, the first part was 2 ml in EDTA tubes used to testing the CBC and specifically to know the percentage of eosinophils, the second part was 2 ml in gel tube used to IgG and IgE.

Ethical approval

Verbal consent was obtained from the handlers and owner prior to the sample collection process. The study was approved by the research committee (No.010), Department of Biology, College of Sciences, University of Al-Qadisiyah.

Serological test

Serological methods have been used to detect human *Toxocara* IgG and *Toxoplasma gondii* IgG by Enzyme linked Immunosorbent Assay (ELISA) The examination was carried out according to the manufacturer's procedures, identifying those who were infected and those who were not by calculating the cutoff value.

Human IgE (Immunoglobulin E)

The level of IgE were detected by ELISA kit ordered from company (Elabscience, P. R. C.) and carried out according to the manufacturer's procedures

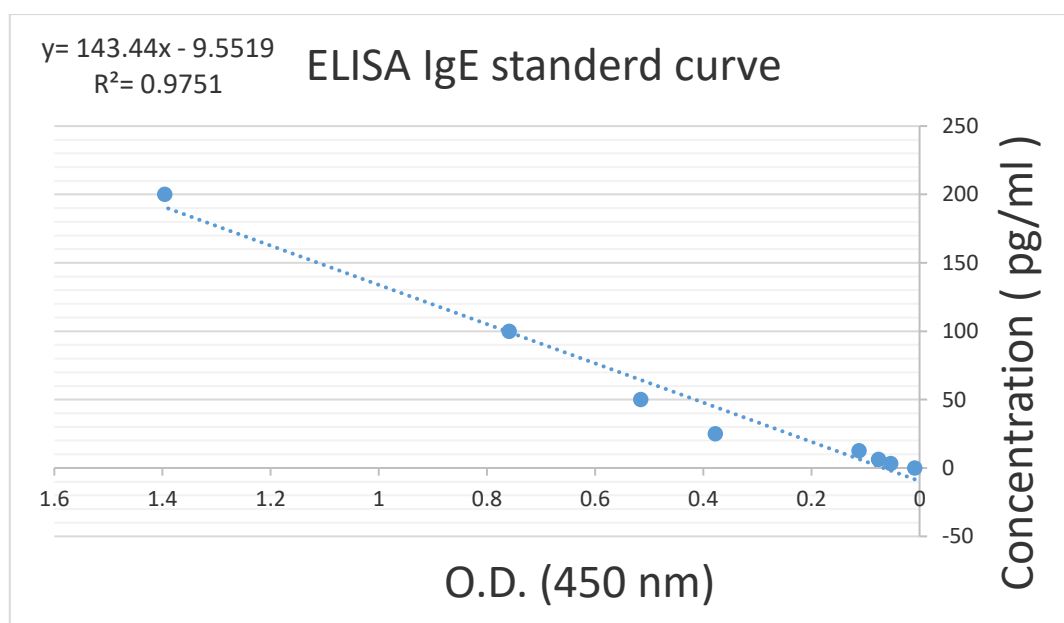
Calculation of IgE Results

Average duplicate readings for samples and standards. Plot a standard curve with the standard concentration on the x-axis and OD on the y-axis. If OD exceeds the standard curve limit, retest with an appropriate dilution.

Table 1: Calibration Sheet for IgE (IgE standers within the methods)

Standard	Mean O.D	Concentration (ng/ml)
ST. 1	1.396	200
ST. 2	0.759	100
ST. 3	0.516	50
ST. 4	0.378	25
ST. 5	0.112	12.5
ST. 6	0.076	6.25
ST. 7	0.054	3.13
ST. 8	0.009	0

Figure 1: Standard Curve of IgE (within the methods)



Complete Blood Count (CBC) detection

Complete Blood Count is tested automatically by transferring the blood sample placed in an EDTA tube. The hematology analyzer device draws approximately 150 μ L, and the result is printed after a few minutes.

Statistical analysis

Data were collected, summarized, analyzed and presented using statistical package for social sciences (SPSS) version 26 and Microsoft Office Excel 2010. Numeric data were presented as mean,

standard deviation after performance of Kolmogorov-Smirnov normality test and making decision about normally and non-normally distributed variables. Independent sample t-test was used to study difference in mean between any two groups provided that the variable is normally distributed. One way anova test was used to study difference in mean among more than two groups provided that the variable is normally distributed. Chi-square test was used to study association between any two categorical variables. The level of

significance was considered at P-value of less 0.05 and highly significant level at 0.01 or less [21].

Results:

Level of IgE antibodies

The infection in pet handlers of *Toxocara* spp. 13.1% (12/91) and *T. gondii* 24.1% (22/91), the results of total Immunoglobulin E (IgE) levels in patients compared to controls. *Toxocara* spp. patients exhibited markedly higher levels (120.3 ± 9.66) compared to controls (50.1 ± 4.88), with a highly statistically significant difference ($P=0.001$). IgE levels in *Toxoplasma gondii* infection were significantly elevated in patients (69.95 ± 7.89) compared to controls (56.25 ± 6.13), with statistically significant P-value ($P=0.004$) (Table 2).

Hematological Parameters in *Toxocara* spp. Infection

The results of White Blood Cells levels in patients 8.49 ± 0.75 ($10^3/\mu\text{l}$) was higher than 6.45 ± 0.81 ($10^3/\mu\text{l}$) in controls, and the difference was significant ($P=0.007$). Also the levels of Eosinophil's in patients 1.39 ± 0.27 ($10^3/\mu\text{l}$) was higher than 0.7 ± 0.08 ($10^3/\mu\text{l}$) in controls, and the difference was significant ($P=0.003$). The level of lymphocytes in patients 3.41 ± 0.39 ($10^3/\mu\text{l}$) was higher than 2.54 ± 0.11 ($10^3/\mu\text{l}$) in controls, the difference was significant ($P=0.007$). The levels of Hemoglobin in patients 10.97 ± 1.29 (g/dL) was lower than 12.98 ± 1.02 (g/dL) in controls, the difference was significant ($P=0.001$), also the levels of Hematocrit count in patients $33.44 \pm 5.55\%$ was lower than $38.35 \pm 5.9\%$ in controls, and the difference was significant ($P=0.008$). No statistically significant differences were observed in Monocytes, Neutrophils, Basophils, Red Blood Cells and Platelets between patients and controls ($P > 0.05$) (Table 3).

Hematological Parameters in *Toxoplasma gondii* Infection

The results of White Blood Cells levels in patients 8.26 ± 0.49 ($10^3/\mu\text{l}$) was higher than 6.22 ± 0.38 ($10^3/\mu\text{l}$) in controls, and the difference was significant ($P=0.001$). The levels of Eosinophil in patients 0.51 ± 0.099 ($10^3/\mu\text{l}$) was lower than 0.9 ± 0.11 ($10^3/\mu\text{l}$) the mean in controls, and the difference was significant ($P = 0.038$). But, the levels of Monocytes in patients 0.99 ± 0.11 ($10^3/\mu\text{l}$) was higher than 0.47 ± 0.022 ($10^3/\mu\text{l}$) in controls, the difference was significant ($P=0.001$). The level of lymphocytes in patients 2.73 ± 0.19 ($10^3/\mu\text{l}$) was slightly higher than 2.63 ± 0.13 ($10^3/\mu\text{l}$) in controls, while the difference was non-significant ($P=0.654$). The level of neutrophils in patients 3.92 ± 0.59 ($10^3/\mu\text{l}$) was higher than 2.02 ± 0.48 ($10^3/\mu\text{l}$) in controls, the difference was significant ($P=0.001$). The level of basophils in patients 0.062 ± 0.006 ($10^3/\mu\text{l}$) was slightly higher than 0.059 ± 0.003 ($10^3/\mu\text{l}$) in controls, while the difference was non-significant ($P=0.699$). The levels of Red Blood Cells count in patients 4.37 ± 0.61 ($10^6/\mu\text{l}$) was slightly higher than 4.25 ± 0.65 ($10^6/\mu\text{l}$) in controls, the difference was non-significant ($P=0.461$). The levels of Hemoglobin in patients 12.04 ± 1.69 (g/dL) was slightly lower than 12.93 ± 2.06 (g/dL) the mean in controls, while the difference was non-significant ($P=0.072$), also levels of Hematocrit in patients $35.9 \pm 5.39\%$ was lower than $38.28 \pm 6.18\%$ in controls, but the difference was non-significant ($P=0.101$). The levels of Platelets in p patients 242.86 ± 18.34 ($10^3/\mu\text{l}$) was lower than 262.33 ± 12.02 ($10^3/\mu\text{l}$) in controls, while the difference was non-significant ($P=0.414$).

Table 2: The Level of IgE in Patients and Controls.

IgE	+ve	-ve	P- value
	Mean± SE	Mean± SE	
<i>Toxocara</i> spp.	120.3 ± 9.66	50.1 ± 4.88	0.001*
<i>T. gondii</i>	69.95 ± 7.89	56.25 ± 6.13	0.004*

n: number of cases; SE: standard error; †: one-way ANOVA; *: significant at $P \leq 0.05$

Table 3: Levels of hematology parameters in *Toxocara* spp. infection.

Parameter	<i>Toxocara</i> spp. +ve	<i>Toxocara</i> spp. -ve	P-value
(WBC) White Blood Cells count ($10^3/\mu\text{l}$)			
Mean ± SD	8.49 ± 0.75	6.45 ± 0.81	0.007*
(Eos) Eosinophils count ($10^3/\mu\text{l}$)			
Mean ± SD	1.39 ± 0.27	0.7 ± 0.08	0.003*
(Mono) Monocytes count ($10^3/\mu\text{l}$)			
Mean ± SD	0.53 ± 0.08	0.61 ± 0.04	0.528 NS
(Lym) Lymphocytes count ($10^3/\mu\text{l}$)			
Mean ± SD	3.41 ± 0.39	2.54 ± 0.11	0.007*
(Neu) Neutrophils count ($10^3/\mu\text{l}$)			
Mean ± SD	3.0 ± 0.49	2.4 ± 0.18	0.240 NS
(Baso) Basophils count ($10^3/\mu\text{l}$)			
Mean ± SD	0.068 ± 0.007	0.058 ± 0.003	0.316 NS
(RBC) Red Blood Cells count ($10^6/\mu\text{l}$)			
Mean ± SD	3.99 ± 0.14	4.32 ± 0.11	0.099 NS
(HGB) Hemoglobin (g/dL)			
Mean ± SD	10.97 ± 1.29	12.98 ± 1.02	0.001*
(HCT) Hematocrit (%)			
Mean ± SD	33.44 ± 5.55	38.35 ± 5.9	0.008*
(PLT) Platelets count ($10^3/\mu\text{l}$)			
Mean ± SD	258.25 ± 28.39	257.53 ± 10.91	0.981 NS

*: significant at $P \leq 0.05$; NS: non-significant at $P > 0.05$

Table 4: Hematological Parameters in *Toxoplasma gondii* Infection

Parameter	<i>T. gondii</i> +ve	<i>T. gondii</i> -ve	P-value
(WBC) White Blood Cells count ($10^3/\mu\text{L}$)			
Mean $\pm$ SD	8.26 $\pm$ 0.49	6.22 $\pm$ 0.38	0.001*
(Eos) Eosinophils count ($10^3/\mu\text{L}$)			
Mean $\pm$ SD	0.51 $\pm$ 0.099	0.9 $\pm$ 0.11	0.038*
(Mono) Monocytes count ($10^3/\mu\text{L}$)			
Mean $\pm$ SD	0.99 $\pm$ 0.11	0.47 $\pm$ 0.022	0.001*
(Lym) Lymphocytes count ($10^3/\mu\text{L}$)			
Mean $\pm$ SD	2.73 $\pm$ 0.19	2.63 $\pm$ 0.13	0.654 NS
(Neu) Neutrophils count ($10^3/\mu\text{L}$)			
Mean $\pm$ SD	3.92 $\pm$ 0.59	2.02 $\pm$ 0.48	0.001*
(Baso) Basophils count ($10^3/\mu\text{L}$)			
Mean $\pm$ SD	0.062 $\pm$ 0.006	0.059 $\pm$ 0.003	0.699 NS
(RBC) Red Blood Cells count ($10^6/\mu\text{L}$)			
Mean $\pm$ SD	4.37 $\pm$ 0.61	4.25 $\pm$ 0.65	0.461 NS
(HGB) Hemoglobin (g/dL)			
Mean $\pm$ SD	12.04 $\pm$ 1.69	12.93 $\pm$ 2.06	0.072 NS
(HCT) Hematocrit (%)			
Mean $\pm$ SD	35.9 $\pm$ 5.39	38.28 $\pm$ 6.18	0.101 NS
(PLT) Platelets count ($10^3/\mu\text{L}$)			
Mean $\pm$ SD	242.86 $\pm$ 18.34	262.33 $\pm$ 12.02	0.414 NS

*: significant at $P \leq 0.05$; NS: non-significant at $P > 0.05$

Discussion

The elevation of IgE levels in patients of *Toxocara* spp. compared to controls consistent with Stoyanov (2024) study [22]. The observed increase can be mainly attributed to *Toxocara* infection, which stimulates a Th2-type immune response characterized by enhanced production of IL-4, IL-5, and IgE [23]. IgE levels were significantly higher in patients with *T. gondii* than in controls, it's agree with those reported in Matowicka-Karna (2009) study [24]. *T. gondii* predominantly induces a Th1 immune response, increased IgE concentrations may still occur in some infected individuals, indicating partial involvement of Th2 pathways or a generalized enhancement of humoral immune responses [24]. White blood cell was higher in patients with *Toxocara* spp. than in controls it's agree with Sabah and Jasim (2023) study [25]. Toxocariasis causes visceral larva migrans, and the

migration of larvae through different organs provokes a marked inflammatory response that stimulates increased production of white blood cells [26]. Patients with *T. gondii* showed a significantly higher WBC than controls, this observation is consistent with Mohamed (2020) study [15]. Infection with *T. gondii* activates a complex cellular immune response involving T-cell activation and IFN- γ secretion, thereby increasing the number of certain white blood cell populations during infection [27]. In *Toxocara* spp. infection, eosinophil was higher than in controls, it's agree with Kim (2017) study [28]. Eosinophils constitute an important component of the Th2 immune response and increase following helminth infection because cytokines such as IL-4, IL-5, and IL-13 promote eosinophil proliferation and activity [29]. Patients with *T. gondii* showed lower eosinophil levels than controls, it's consistent with Mohamed (2020) study [15]. Eosinophils are not major

effector cells in the immune response against protozoan parasites such as *T. gondii*, which predominantly induces a Th1-mediated response involving NK cells and IFN- γ -producing T lymphocytes rather than a Th2 response associated with eosinophilia [30]. Monocyte level in patients with *Toxocara* spp. lower than in controls. Patients with *T. gondii* exhibited higher monocyte level than controls, it's consistent with Abd El-Wahab (2025) study [31]. *T. gondii* infection strongly activates innate immune responses, including monocyte recruitment and activation [32]. The lymphocyte count was significantly elevated in patients with *Toxocara* spp. compared with controls, it's agree with Sabah and Jasim (2023) study [25]. The increase in lymphocytes may reflect the host immune response aimed at limiting larval migration within tissues and minimizing tissue damage [33]. In *T. gondii* patients, the lymphocyte was higher than in controls, it's agree with Hassen (2019) study [34]. In immunocompetent individuals, lymphocyte numbers may remain within normal ranges despite the presence of an effective immune response against the parasite [32]. Patients with *Toxocara* spp. had neutrophil level higher than in controls, it's consistent with Mazur-Melewska (2016) study [35]. The immune response in toxocariasis is mainly characterized by eosinophilia and elevated IgE levels, whereas neutrophil counts are not considered a primary diagnostic indicator [36]. In *T. gondii* infection, patients were increased compared with controls, it's agree with Abd El Wahab (2025) study [37]. Neutrophils play a crucial role in early innate immunity and contribute to parasite control through several mechanisms, while the parasite may also prolong neutrophil survival [38]. Basophil levels in *Toxocara* spp. patients were higher than in controls. Basophils often migrate from circulation to infected tissues; therefore, peripheral blood counts may not accurately reflect the severity of infection [39]. In *T. gondii* patients, basophil levels were higher than in controls, it's consistent with Mohamed (2020) study [15]. Basophils are not among the principal

cells involved in immunity against intracellular parasites, where IFN- γ -mediated Th1 responses predominate [40]. Patients with *Toxocara* spp. showed RBC higher than in controls, it's agreed with Salem (2023) study [41]. Since *Toxocara* larvae migrate through tissues and do not invade red blood cells, hemolysis is generally not observed [42]. For *T. gondii* infection, RBC levels showed no difference between patients and controls, which is in agreement with Hassen (2019) study [34]. *T. gondii* does not directly infect red blood cells and therefore exerts minimal direct influence on RBC counts [35]. The hemoglobin was lower in patients with *Toxocara* spp. compared with controls, it's consistent with Dar study (2013) [43]. Reduced hemoglobin levels may result from impaired nutrient absorption and tissue damage associated with larval migration, ultimately affecting erythropoiesis and contributing to anemia [44]. In *T. gondii* infection, hemoglobin levels were lower compared with controls, it's consistent with Mahdi (2020) study [45]. In immunocompetent individuals, toxoplasmosis is often latent or chronic, with tissue cyst formation occurring without substantial effects on erythrocyte production. As the parasite does not directly invade red blood cells, major alterations in hemoglobin levels are generally absent [46,47]. The hematocrit value was lower in patients with *Toxocara* spp. than in controls. This reduction may be associated with inflammatory and systemic consequences of larval migration, *Toxocara* larvae induce tissue inflammation and immune sensitization, factors that may contribute to anemia and reduced oxygen-carrying capacity [44]. In *T. gondii* infection, hematocrit values were lower compared with controls, it's agrees with Mohamed (2020) study [15]. Chronic infection may be associated with mild hematological alterations under certain immunological conditions [48]. Platelet in patients with *Toxocara* spp. were higher compared with in controls, it's consistent with Gouda (2024) study [49]. Hematological changes in toxocariasis are

mainly characterized by eosinophilia, whereas platelet counts usually remain within normal ranges or show only slight increases due to low-grade chronic inflammation [50]. patients with *T. gondii* had platelet counts lower compared with controls, it's agree with Salem study (2023) [41]. In immunocompetent hosts, toxoplasmosis is frequently mild or latent, and the regulated immune response generally prevents substantial alterations in platelet counts [51].

Conclusions:

This study demonstrated that pet handlers seropositive for *Toxocara* spp. and *T. gondii* exhibited significantly elevated total IgE levels compared with seronegative individuals. *Toxocara* spp. infection was associated with increased white blood cells, eosinophils, and lymphocytes, along with reduced hemoglobin and hematocrit levels, whereas *T. gondii* infection was characterized by increased neutrophils and monocytes and decreased eosinophil counts. These findings indicate that IgE levels and routine hematological parameters may serve as useful supportive markers in the assessment of zoonotic parasitic infections among individuals with frequent animal exposure.

Recommendations

Conduct studies with larger sample sizes and in different Iraqi provinces to confirm these findings. Include molecular diagnostic techniques alongside serological assays to improve diagnostic accuracy. Implement regular screening programs for pet handlers and other high-risk groups for zoonotic parasitic infections. Increase public awareness regarding hygienic practices and preventive measures to reduce transmission of *Toxocara* spp. and *T. gondii*. Further investigate the immunological mechanisms underlying hematological alterations associated with these infections.

Limitation

Sample size relatively small, diagnosis based on IgG ELISA, lack of PCR and absent of non-pet handler control group.

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