ORIGINAL ARTICLE

Seroprevalence of *Toxoplasma gondii* Infection in Children With Visual and/or Hearing Disability in Comparison With Healthy Children in Iraq

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ABSTRACT

Introduction: Infection with *Toxoplasma gondii* is very prevalent in Iraq. The aim of this study was to determine the seroprevalence of *T. gondii* infection among children with visual, hearing or both disabilities (VHDC) and among healthy children (HC) living in Diyala and Baghdad provinces in Iraq. **Methods:** For this study, 100 VHDC children (attending the Al-Amal Centers for Blind, Dumb and Deaf Children) and 100 age-matched healthy children were recruited. Blood was obtained from all disabled and healthy children and the sera were examined for the presence of the specific antibodies (IgG and IgM) of *T. gondii*. **Results:** Among VHDC children, the seropositivity of IgG antibodies (24.0%) was significantly higher (OR= 7.6; 95% CI= 2.5-22.8; P= 0.0003) than that in HC children (4.0%). Disabled boys (OR= 5.7; P= 0.009) and disabled girls (OR= 12.7; P= 0.0183) showed significantly higher seropositivity than healthy children. The greatest risk was in disabled children who are their mothers had one or more abortion (OR= 6.89; P= 0.0005), followed by children who have brother or sister with visual and/or hearing disabilities (OR= 5.6; P= 0.0039), children whose their mothers got infection during pregnancy (OR= 2.9; P= 0.0256), and then children whose their mothers have taken treatment (OR= 2.9; P= 0.0256). The presence of stray cats in the houses was identified as a risk factor (OR= 4.05; P= 0.0186). **Conclusion:** In children with visual and/or hearing disabilities, the seropositivity of IgG antibodies was significantly higher than that in healthy children.

Keywords: *Toxoplasma gondii*, Seropositivity, Visually and/or hearing disabled and healthy children, Iraq

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INTRODUCTION

Toxoplasmosis is a parasitic zoonotic disease caused by *Toxoplasma gondii* (*T. gondii*) which infects a very wide range of hosts, and no parasite can beat it in this capacity (1). This parasite needs two hosts to complete its life cycle, final host where the sexual cycle happens and all cat family (Felidae) animals can act as final hosts, and intermediate host where the asexual part of the life cycle occurs. In fact, cat family members act both final and intermediate hosts because both sexual and asexual parts of the life cycle happen inside their bodies (2, 3). The parasite has three infective stages, sporozoites (within the oocysts), bradyzoites (slowly dividing stages within tissue cysts) and tachyzoites (rapidly dividing stages) (2). In the intermediate hosts, the tissue cysts containing the bradyzoites were found in various body organs and tissues such as brain, eyes, heart, lungs, liver and kidneys (2, 4). In addition to the well-known classic routes of transmission of *T. gondii* (5-7), there are other routes such as organ transplantation, blood transfusion, laboratory acquired, and sexual contact (8, 9).

Although the infected cats do not exhibit any symptoms, even during acute infection, humans, especially the immunocompromised individuals, can exhibit serious symptoms that may be lethal (10). Moreover, it has been reported that if the infection happens during pregnancy, it may cause congenital toxoplasmosis, which can cause mild to severe congenital abnormalities (loss of vision, loss of hearing, hydrocephalus, retinochoroiditis, chorioretinitis, and mental retardation) and even death (11, 12). In contrast, most postnatal-acquired infections are asymptomatic but some manifestations of toxoplasmosis such as mild lymphadenopathy, headaches, muscle aches, and sore throat may be seen (11).

In Iraq, serologic studies revealed that toxoplasmosis is prevalent in Iraq and a wide variation in the prevalence rates (19.3-44.5%) of the infection has been reported (3, 13-15). In a recent study (16), our team explored the seroprevalence of specific antibodies of *T. gondii* using ELISA in hemodialysis patients and healthy control subjects to determine the potentially preventable risk factors and the results showed that the percentage of seropositivity for IgG antibodies in hemodialysis patients was 54.1% while it was 38.2% among the healthy subjects and the difference was significant between the two groups.

Therefore, this study aimed to determine the seroprevalence of the infection with *T. gondii* in healthy children and children with either visual, hearing, or both visual and hearing disabilities.

MATERIALS AND METHODS

The staff of the Institutes and the parents of all recruited children have been informed about the objectives and the procedures of this study. Written informed consent was obtained from the parents of the children. The Human Ethics Committee at the College of Sciences (University of Diyala) has approved this study (Protocol 1/2018).

Each child was anonymized using a specific ID number which enabled tracking of individuals throughout the study period. Questionnaires were given to the parents/ guardians of all participants regarding the demographic characteristics and some risk factors of the infection with *T. gondii*.

One hundred children with visual and/or hearing disability (DCH) and 100 apparently aged-matched healthy children (HCH) were recruited. The age range in both groups was 6-16 years for both genders, and then each group was subdivided into 3 subgroups; 6-9 years, 10 to 13 years, and 14 to 16 years (mean ± SE: was 9.6 ± 0.32 for healthy children and was 10.0 ± 0.26 for the disabled children). The inclusion criteria for the first group (disabled children) were male and female children who were either completely blind or blind and deaf at the time of obtaining blood samples. The inclusion criteria for the second group (healthy children) were apparently healthy male and female primary school children without visual and hearing problems. Children wearing medical glasses or hearing aids were excluded. The registered nurses working at Al-Amal Centers for Blind, Dumb and Deaf Children (Diyala and Baghdad Provinces, Iraq) collected the blood samples into sterile Vacationer glass tubes and the sera were separated by centrifugation, stored at -20°C until being used. By using the enzyme linked immunosorbent assay (ELISA) (Acon, San Diego, CA, USA), the sera were tested for anti-*T. gondii* specific antibodies, and the procedure was conducted according to the instructions of the manufacturer. The cut-off value has been calculated as previously described (16).

Statistical analysis

A Chi-square test (Bivariate test) was used to identify the possible link between the seropositivity of *T. gondii* infection and some risk factors. Odds ratios (OR) and 95% confidence intervals (CI) were also calculated to associate the potential variables. P-value ≤ 0.05 was considered statistically significant.

RESULTS

The percentage seropositivity of IgG antibodies among visually and/or hearing disabled children (24.0%) was significantly higher [OR= 7.6; 95% CI= 2.5-22.8; P= 0.0003] than that in healthy children (4.0%), while no subject from both groups was found seropositive for IgM antibodies (Table I).

Table I: Percentage seropositivity for anti-*Toxoplasma gondii* IgG and IgM antibodies in children with hearing and/or visual disability in comparison with apparently healthy children

Group	No. tested	No. positive		% seropositivity		Disabled vs. healthy children (IgG only)		
		IgG	IgM	IgG	IgM	Odds Ratio	95% CI	P-value
Disabled Children	100	24	0	24.0	0	7.58	2.5-22.8	0.0003
Healthy Children	100	4	0	4.0	0			

[a]ELISA was used to detect the anti- Toxoplasma gondii IgG and IgM antibodies. Odds ratio and 95% Confidence Interval (95% CI) have also been calculated.[a]

It can be seen from Table II that the statistical analysis did not show significant differences among age groups in disabled children, while in healthy children the age group 14-16 years showed significantly higher seropositivity rate (P= 0.0104) than the other age groups. In comparison with the healthy children, disabled children aged 6-9 years showed significantly higher seropositivity (OR= 41.9; 95% CI= 2.4-747.7; P= 0.011). Similarly, disabled children aged 10-13 years showed significantly higher seropositivity than their age-matched healthy children (OR= 8.4; 95% CI= 1.02-69.1; P= 0.0484).

Regarding the impact of the gender on the seropositivity of IgG antibodies, Table III showed that no significant

Table II: The impact of age on the seropositivity of anti-*Toxoplasma gondii* IgG among children with hearing and/or visual disability and healthy children

Age group (years)	Seroprevalence of *T. gondii* IgG antibodies: Disabled children (n=100)			Healthy children (n= 100)			Disabled vs. healthy children	
	NT*	NP* (%)	P-value	NT	NP (%)	P-value	Odds ratio (95% CI)	P-value
6-9	35	9 (25.7)	Reference	58	0 (0.0)	Reference	41.9 (2.4-747.7)	P= 0.0110
10-13	47	10 (21.2)	P= 0.6380	32	1 (3.1)	P= 0.2973	8.4 (1.02-69.1)	P= 0.0484
14-16	18	5 (27.8)	P= 0.8718	10	3 (30.0)	P= 0.0104	0.9 (0.16-4.9)	P= 0.9008

*NT= number tested; NP= number positive. Odds ratio and 95% Confidence Interval (95% CI) have also been calculated.

Table III: Gender and residency-related seropositivity of anti-*Toxoplasma gondii* IgG antibodies in children with hearing and/or visual disability and healthy children.

Variables	Seroprevalence of *T. gondii* IgG antibodies						Disabled vs. healthy children	
	Disabled children (n= 100)			Healthy children (n= 100)				
	NT*	NP* (%)	P-value	NT	NP (%)	P-value	Odds ratio (95% CI)**	P-value
Gender								
Males	57	15 (26.3)	Reference	51	3 (5.88)	Reference	5.7 (1.6-21.1)	P= 0.0090
Females	43	9 (20.9)	P= 0.5332	49	1 (2.04)	P= 0.3488	12.7 (1.5-105)	P= 0.0183
Total	100	24 (24.0)		100	4 (4.0)			
Residence region								
Rural	35	6 (17.1)	Reference	45	2 (4.4)	Reference	4.5 (0.8-23.6)	P= 0.0795
Urban	65	18 (27.7)	P= 0.2428	55	2 (3.6)	P= 0.8377	10.2 (2.2-46.1)	P= 0.0027
Total	100	24 (24.0)		100	4 (4.0)			

*NT= number tested; NP= number positive. ** 95% Confidence Interval. Odds ratio and 95% Confidence Interval (95% CI) have also been calculated.

differences were found among girls and boys either among disabled or healthy children, but disabled males showed significantly higher seropositivity than their age-matched healthy children (OR= 5.7; 95% CI= 1.6-21.1; P= 0.009). Similarly, disabled females showed significantly higher seropositivity than healthy children (OR= 12.7; 95% CI= 1.5-105.0; P= 0.0183).

Regarding the impact of the residential area on the seropositivity, Table III showed that disabled children living in urban areas showed significantly higher seropositivity than their counterparts healthy children (OR= 10.2; 95% CI= 2.2-46.1; P= 0.0027). In contrast, disabled children living in rural areas showed marginally higher seropositivity than their healthy counterparts, with a border-line significance (OR= 4.5; 95% CI= 0.8-23.6; P= 0.0795).

Various risk factors have been identified in children with visual and /or hearing disabilities (Table IV). The greatest risk was in disabled children who are their mothers had one or more abortion (OR= 6.89; 95% CI= 2.32-20.5; P= 0.0005), followed by children who have brother or sister with visual and/or hearing disability (OR= 5.6; 95% CI= 1.7-17.8; P= 0.0039), children whose their mothers acquired the infection during pregnancy (OR= 2.9; 95% CI= 1.1- 7.2; P= 0.0256), and then children whose their mothers have taken treatment (OR= 2.9; 95% CI= 1.1- 7.2; P= 0.0256).

In this study, the presence of stray cats in the houses has been recognized as a risk factor for toxoplasmosis as children with visual and/or hearing disabilities who usually found stray cats in their houses showed 4 times higher seropositivity than their counterparts who have not found stray cats in their houses (OR= 4.05; 95% CI= 1.26-12.97; P= 0.0186) (Table IV). However, the other variables were not found to be associated with the possibility of getting the infection with *T. gondii* (Table IV). In contrast, none of the above mentioned variables were identified to be significant risk factors in healthy children (Table V).

The comparison between children with visual and/or hearing disability and healthy children regarding the association between the selected risk factors and the infection with *T. gondii* (Table VI) revealed that only in three variables: the presence of stray cats (OR= 12.6; 95% CI= 2.8-57.1; P= 0.001), eating in resturants (OR= 5.9; 95% CI= 1.4-23.9; P= 0.0138), and the occurrence of abortion in their mothers (OR= 11.6; 95% CI= 2.5-54.3; P= 0.0018) showed significant differences between the two groups.

Table IV: Risk factors (Bivariate analysis) for seroprevalence of *T. gondii* IgG antibodies in 100 samples of children with visual and/or hearing disabilities

Variables	Prevalence N (%)	OR (95% CI)*	P-value
Any stray cats have seen at home?			
Yes (n= 62)	20 (32.2%)	4.05 (1.26 - 12.97)	0.0186
No (n= 38)	4 (10.5%)		
Consumption of undercooked meat			
Yes (n= 12)	3 (25.0%)	1.06 (0.26 - 4.29)	0.9311
No (n= 88)	21 (23.8%)		
Consumption unwashed vegetables			
Yes (n= 25)	4 (16.0%)	0.52 (0.16 - 1.71)	0.2850
No (n= 75)	20 (26.6%)		
Eating in restaurants			
Yes (n= 33)	8 (24.2%)	1.02 (0.39 - 2.7)	0.9682
No (n= 67)	16 (23.8%)		
Is there another child (brother or sister) with hearing or visual disability in the family?			
Yes (n= 56)	20 (35.7%)	5.56 (1.73 - 17.79)	0.0039
No (n= 44)	4 (9.09%)		
Did the mother get infection before or during the pregnancy?			
Yes (n= 26)	13 (50.0%)	2.87 (1.14 - 7.21)	0.0256
No (n= 74)	11 (14.8%)		
Did the infected mothers take any treatment?			
Yes (n= 26)	13 (50.0%)	2.86 (1.14 - 7.21)	0.0256
No (n= 74)	11 (14.8%)		
Has the mother ever had an abortion?			
Yes (n= 46)	19 (41.3%)	6.89 (2.32 - 20.54)	0.0005
No (n= 54)	5 (9.2%)		

* OR= Odds Rratio; 95% CI= 95% Confidence Interval

Table V: Risk factors (Bivariate analysis) for seroprevalence of *T. gondii* IgG antibodies in 100 samples of healthy children

Variables	Prevalence N (%)	OR (95% Cl)*	p-value
Any stray cats or their feces have been seen at home?			
Yes (n= 55)	2 (3.6%)	0.79 (0.107 - 5.86)	P = 0.8198
No (n= 45)	2 (4.4%)		
Consumption of undercooked meat			
Yes (n= 6)	1 (16.6%)	6.07 (0.53 - 69.31)	P = 0.1469
No (n= 94)	3 (3.19%)		
Consumption of unwashed vegetables			
Yes (n= 24)	1 (4.1%)	1.06 (0.11- 10.67)	P = 0.9619
No (n= 76)	3 (3.9%)		
Eating outside home (in restaurants)			
Yes (n= 58)	3 (5.17%)	2.24 (0.22 - 22.29)	P = 0.4926
No (n= 42)	1 (2.3%)		
Is there another child (brother or sister) with hearing or visual disability in the family?			
Yes (n= 5)	0	1.85 (0.09 - 38.87)	P = 0.6926
No (n= 95)	4 (4.1%)		
Did the mother get infection before or during the pregnancy?			
Yes (n= 12)	1 (8.3%)	2.58 (0.25 - 26.97)	P = 0.4298
No (n= 88)	3 (3.4%)		
Did the infected mothers take anti-*Toxoplasma* drugs ?			
Yes (n= 12)	1 (8.3%)	2.58 (0.25 - 26.97)	P = 0.4298
No (n= 88)	3 (3.4%)		
Has the mother ever had an abortion?			
Yes (n= 35)	2 (5.7%)	1.91 (0.26 - 14.17)	P = 0.5273
No (n=65)	2 (3.07%)		

* OR= Odds Ratio; 95% CI= 95% Confidence Interval

Table VI: Comparison between children with visual and/or hearing disabilities (VHDC) and healthy children (HC) regarding the association between the selected risk factors and the infection with *Toxoplasma gondii*.

Variables	No. tested		No. positive (%)		OR (95% CI)*	P-value
	DCH	HCH	DCH	HCH		
Any stray cats or their feces have been seen at home?	62	55	20 (32.2)	2 (3.6)	12.6 (2.8-57.1)	0.0010
Consumption of undercooked meat	12	6	3 (25.0)	1 (16.7)	1.7 (0.14-20.6)	0.6904
Consumption of unwashed vegetables	25	24	4 (16.0)	1 (4.1)	4.4 (0.45-42.4)	0.2021
Eating outside home (in restaurants)	33	58	8 (24.2)	3 (5.2)	5.9 (1.4-23.9)	0.0138
Is there another child (brother or sister) with hearing or visual disability in the family?	56	5	20 (35.7)	0 (0.0)	6.2 (0.33-17.5)	0.2256
Did the mother get infection before or during the pregnancy?	26	12	13 (50.0)	1 (8.3)	4.6 (0.45-39.5)	0.1628
Did the infected mothers take anti-*Toxoplasma* drugs ?	26	12	13 (50.0)	1 (8.3)	4.6 (0.45-39.5)	0.1628
Has the mother ever had an abortion?	46	35	19 (41.3)	2 (5.7)	11.6 (2.5-54.3)	0.0018

* OR= Odds Ratio; 95% CI= 95% Confidence Interval.

DISCUSSION

In this study the percentage seropositivity of specific IgG antibodies in children with visual, hearing or both disabilities was significantly higher than their age and gender-matched apparently healthy children. As far as we know, only three previous studies have studied the seroepidemiology of *T. gondii* in children with visual, hearing, or both disabilities. Saleh et al. (17) investigated the seroprevalence of infection with *T. gondii* in Yemeni children with visual, hearing, or both disabilities in comparison with healthy children and they found that the seropositivity rate was significantly higher in disabled children (32.5%) than that in healthy children (16.0%). The authors reported that seroprevalence rate was significantly higher among females than males in both groups and that the seroprevalence was increasing with age and this trend was observed in both groups. Tucci et al. (18) reported that 21.2% of the cases of hearing loss in Saudi Arabia were due to the infection with *T. gondii*. Alvarado-Esquivel et al (19) investigated the seroprevalence of infection with *T. gondii* in Mexico and reported that individuals with hearing disability had significantly higher seropositivity in comparison with their counterparts with normal hearing.

As far as we know, this is the first study in Iraq to explore the seroprevalence of infection with *T. gondii* in healthy children and those with visual, hearing, or both disabilities. In fact, the higher seropositivity among children with visual, hearing, or both disabilities was expected for many reasons as in these children, there are two possible sources of infection, mainly prenatal congenital and postnatal sources, while in healthy children the infection with *T. gondii* is more likely to happen postnatally. Consequently, the high seropositivity among disabled children in comparison with the healthy children is probably to be mostly due to congenital infection with *T. gondii* rather than postnatal infection. Similar findings have been reported in Yemen (17).

It is well known that the most important etiologic factor of visual, hearing or both disabilities is congenital toxoplasmosis (11, 17). It has been reported that 50% of congenital toxoplasmosis cases involve the eyes, 85% of which are chorioretinitis and visual defects, and infection with *T. gondii* accounts for 35% of all chorioretinitis cases in the USA, which may be due to either primary infection or via reactivation of congenital infection (20-22).

The other possible reason for the higher seropositivity rate for anti-*T. gondii* antibodies in disabled children may be attributed to the fact that these children receive less family care than healthy children. This finding agrees well with that of Saleh et al. (17) who attributed the higher seropositivity of specific *T. gondii* antibodies among disabled children when compared with healthy children to the lack of family care.

The compromised immunity in disabled children may be another possible reason behind the significant difference in the seropositivity between disabled and healthy children which paves the way for postnatal infection with *T. gondii*. Some studies showed that people suffering from visual, hearing, or both visual and hearing disabilities experience a very low level of confidence and self-esteem in comparison with their healthy counterparts (23-26) which means they are under stress and consequently their immunity is weak and this is another reason for the difference between the healthy and disabled children. Similarly, Saleh et al. (17) stated that the weak immunological status of disabled children could increase the chance of getting the infection postnatally. Moreover, Wang et al. (10) reported in his recent review that the immunocompromised patients are more prone to the infection with *T. gondii* than immunocompetent individuals.

Regarding the mechanism by which low self-esteem suppresses the immune system, Gruenewald et al. (27) investigated the association between social self-esteem, shame and the activity of cortisol (a hormone released by the adrenal gland) and reported that the levels of this hormone were higher in participants who experienced greater increments in shame and those with lower self-esteem. Cortisol is released in response to stress and reduced levels of blood-sugar and it is an immunosuppressive in function, and produces its immunosuppressive effects by down-regulating key inflammatory transcription factors, and up-regulating the suppressor of cytokines, which in turn weakens the pro-inflammatory response (28, 29).

Salviz et al. (30) reported that the hearing loss of toxoplasmosis is likely to be the result of a postnatal inflammatory response to the tachyzoite form of *T. gondii*. In addition, the authors reported that the otopathology revealed that the parasite may reside in a dormant cystic form (bradyzoite) within the stria vascularis, spiral ligament, saccular macula or internal auditory canal. Moreover, Clinical manifestations of ocular toxoplasmosis usually result from infection of the retina, with secondary involvement of the choroid in the most severe cases (31). Abu et al. (32) investigated the visual outcome in Ghanaian patients with ocular toxoplasmosis and reported that posterior pole and larger retinal lesions rather than multiple lesions were the major causes of reduced vision.

Regarding the seropositivity rate in apparently healthy children which was 4% is lower than that reported from Iran (33) and China (34, 35), and these differences between different countries may be attributed to difference in lifestyles and environmental con¬ditions, and/or due to using different biochemical assays. It is well known that the epidemiology of *T. gondii* infection depends on a number of behavioral factors, including contact with animals and eating habits (36).

It is important to mention that in addition to toxoplasmosis (17-19), there are so many other causes behind hearing loss and most of them are treatable or preventable, such as congenital rubella infection, measles, meningitis and viral infections (37, 38).

Regarding the impact of the gender on the seropositivity of IgG antibodies, this study revealed the absence of significant differences between boys and girls either among disabled or healthy children, but disabled males and disabled females showed significantly higher seropositivity than their gender-matched healthy children. Taylor et al. (39) investigated the seroprevalence of toxoplasmosis in primary and secondary schoolchildren living in Dublin, Ireland and found that 12.8% of children were seropositive with no difference between the two genders and the seropositivity rate was increasing with age. Sharif et al. (40) reported that 22% of Iranian schoolchildren were found seropositive for *T. gondii* and no significant differences were observed between boys and girls. Similarly, Xin et al. (36) did not observe significant differences regarding the seroprevalence of infection with *T. gondii* between male and female Chinese primary school children. In contrast, Zamani et al. (33) reported that 10% of Iranian healthy primary schoolchildren were found seropositive for *T. gondii* infection and that the seropositivity was significantly higher in male than in female children and it has been increased with age.

The lack of difference between the two genders may be attributed to the fact that girls and boys at this age may have exposed to similar routes for getting infection via frequent contact with various risk factors such as cats, contaminated soil, eating undercooked meat, and eating raw vegetables (36).

This study showed that the seropositivity of infection with *T. gondii* in healthy children increases with age. Some studies conducted in various countries have shown that the seroprevalence of *T. gondii* among primary schoolchildren increased with age and this increment reflect the fact that the exposure period increases when the children get older (34, 35, 39).

In Iraq, the number of stray cats has been found to increase rapidly in Iraq (16, 41). The current study identified the presence of stray cats in houses as a risk factor for toxoplasmosis as the children with visual and/or hearing disabilities who usually found stray cats in their houses showed 4 times higher seropositivity than their counterparts who have not found stray cats in their houses. Swizer et al. (41) investigated the seroprevalence of infection with *T. gondii* in stray cats in Iraq and found that the seropositivity rate was 30.4% and the authors attributed this high prevalence to the fact that stray cats have a higher chance to be infected via preying on rodents infected with *T. gondii*, or via drinking water contaminated with the oocysts of this parasite. Recently, Jung et al. (42) investigated the seroprevalence of infection with *T. gondii* among the owners of Korean cats and reported that owners of outdoor cats were significantly more prone to the infection with *T. gondii* than owners of indoor cats. Moreover, Ding et al. (43) conducted a very good systemic review on the seropositivity of toxoplasmosis in Chinese cats and found that the seropositivity in outdoor cats was significantly higher than that in pet cats.

The other selected variables such as eating in the restaurants, consumption of undercooked meat, and consumption of unwashed vegetables were not identified as risk factors for the infection with *T. gondii* under the conditions of the present study. In healthy children, none of the selected variables have been identified as a risk factor under the conditions of the current study.

In the present study, the comparison between healthy and disabled children regarding the risk factors revealed that eating away from home (in restaurants and fast food outlets) was a risk factor for the infection with *T. gondii*. In most Iraqi restaurants, kebab (grilled minced meat), tikka (grilled pieces of meat) and shawerma (thin slices of meat, stacked in a cone-like shape, and roasted), which are undercooked meat, are served and very popular. These meat products are very popular in many other countries. Recently, it has been reported that consumption of undercooked meat (kebab, sausages, koffta and shawerma) is an important factor for the transmission of *T. gondii* in Iran and Pakistan (44, 45).

CONCLUSION

This investigation revealed for the first time that seropositivity of *T. gondii* infection in children with visual, hearing or both disabilities was significantly higher than that recorded in healthy children in Iraq. Therefore, disabled children attending private and official centers should be monitored for infection with *T. gondii* and treat those with chronic infection to minimize the suffering of these socially-marginalized children. It is important to mention that the numbers of subjects recruited in the present study was low due to the lack of support from the majority of the parents of these children. Therefore, further studies with large numbers of children with visual and hearing disabilities are needed.

ACKNOWLEDGEMENTS

The kind support of the Dean of the College of Science and the Heads of the Departments of Biotechnology and Biology via providing the facilities to do this study is highly appreciated. We would also like to thank the staff at the Al-Amal Centers for Blind, Dumb and Deaf Children in Baghdad and Diyala Provinces for their kind support.

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