

Seroprevalence and Incidence of *Toxoplasma gondii* among Apparently Healthy and Visually or Hearing Disabled Children in Taiz City, Yemen

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Abstract: This cross sectional study was conducted in the city of Taiz, Yemen, during the period from August 2006 to August 2007 in order to investigate the seroprevalence and incidence of toxoplasmosis among apparently healthy children (AHC) and visually and/or hearing disabled children (DC). The seroprevalence was 16.0% among AHC compared to 32.5% among DC. The effect of gender was clear as the seroprevalence rate was significantly higher among females (18.3 and 43.8% for AHC and DC, respectively) than males (13.8 and 25% for AHC and DC, respectively). The seroprevalence was proportionally increased with the age, and the highest rates (20.9 and 53.0%) were reported among the oldest age group (> 10-14 years) for AHC and DC groups, respectively. The incidence rate was also higher (4.2%) in DC group compared to AHC group (2.4%) during 1 year period. These data indicate that the seroprevalence and incidence of toxoplasmosis are significantly higher in DC group than those of AHC group. We need to check further relationship between toxoplasmosis and visual and/or hearing disability.

Key words: *Toxoplasma gondii*, seroprevalence, incidence, healthy, disabled, Yemen

Toxoplasmosis, a parasitic disease caused by the tissue cyst-forming coccidium *Toxoplasma gondii*, is one of the most common zoonoses worldwide [1]. This expanded exposure spectrum is associated with the route of acquisition of the infection which is primarily through ingestion of cysts in infected, undercooked meat or oocysts that may contaminate soil, water, or food [2]. Recent studies have identified water as a potential source of infection in both humans and animals [3]. Epidemiological studies have identified many other risk factors for *T. gondii* infection [4,5]. Protective factors include adhering to a meat-free diet [6], living at a high altitude or in an arid climate [7], and living in a climate with frequent freezing and thawing [8].

Studies concerning the seroprevalence of toxoplasmosis among children, especially community-based studies, are very few. Indeed, the matter is complicated as the exposure to *T. gondii* in children might occur either prenatally (congenital) or postnatally (environmental). In congenital toxoplasmosis, there are 4 possible forms of clinical presentations: 1) symptomatic neonatal disease, in which chorioretinitis is the most common symptom, 2) mild to severe disease that manifests within the first month of life, 3) childhood or adolescent sequelae from previ-

ous undiagnosed infection, or 4) subclinical infection [9]. Thus, many of the apparently healthy children (AHC) might have acquired the disease congenitally but show no symptoms at the time of sample collection, or the infection, in the first place, is subclinical. The aims of the present study were; 1) to determine the seroprevalence of toxoplasmosis in AHC as well as visually and/or hearing disabled children (DC), 2) to estimate (hypothetically) the rate of congenital toxoplasmosis in DC compared to the rate in AHC, 3) to calculate and compare the incidence of acquired toxoplasmosis in AHC and DC, 4) to study the effects of age and gender on the seroprevalence and the incidence of toxoplasmosis in both AHC and DC.

Serum samples were collected from 2 children groups; 250 AHC (apparently healthy at the time of sampling who designated as "healthy") in which samples were randomly collected from different social communities in Taiz city, Yemen, and 120 DC (visually and/or hearing disabled children who were designated as "disabled" in which samples were collected from Sinnah Center for Disabled Children, the Association of Dumb and Deaf Children and the Yemeni-Swedish Hospital for Motherhood and Childhood. All members of this disabled group were either partially sighted, or completely blind or blind and deaf at the time of collecting samples. Samples were collected twice along a period of 12 months (from August 2006 to August

• Received 27 August 2009, revised 13 October 2009, accepted 31 October 2009.

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2007). The age range in both groups was 1-14 years for both genders, and accordingly, each main group was subdivided into 3 subgroups; less than 5 years, 5 to 10 years, and 10 to 14 years. A *Toxo*-latex diagnostic kit from BLOKIT (S.A, Barcelona, Spain) was used for serology in this study. The test is a qualitative one in which the results were interpreted as positive when agglutination was evident and negative when agglutination was not seen. According to the manufacturer's instruction for BLOKIT, the sensitivity, specificity, PPV, and NPV of the test were 100%, 84.2-95.8%, 91.2-99.4%, and 92.0-100%, respectively. Data were coded and entered on the computer using the MINITAB (version 12.1) statistical program. Then, association between different variables was calculated by logistic regression. The dependent variable was the stable infection (infected, seropositive/none infected, and seronegative); all other variables were considered independent.

The results showed that the seroprevalence of toxoplasmosis among DC was higher (32.5%) in comparison to that among AHC (16.0%), the difference being statistically significant ($P < 0.001$). The gender effects on the prevalence within the members of the same group (AHC) was also statistically significant ($P < 0.05$) as the rate was higher among females (18.3%) compared to males (13.8%). A similar result was noticed among the members of DC group (Table 1). According to the age, the rate was proportionally increased in both groups (Table 2). The

age-related prevalence was higher in DC group than in AHC group. Table 3 shows the incidence rate of seropositivity for toxoplasmosis among AHC and DC groups during 1 year period. It is obvious that this rate was higher (4.2%) among DC group compared to AHC group (2.4%) with a high statistical significance ($P = 0.005$) (Table 3).

The present study is the first in Yemen for estimating the seroprevalence of toxoplasmosis among AHC as well as DC. The higher seroprevalence was noticed among DC group compared to AHC group. Such results were expected for 3 simple reasons. First, the higher rate of toxoplasmosis among DC group is likely to have been originated from 2 different sources of exposures including prenatal congenital and postnatal environmental acquisition. In spite of being not the only cause, congenital toxoplasmosis is considered as one of the most important etiologies of visual and hearing disabilities that can develop during the first few years of life. Accordingly, the elevation of the seroprevalence among children with visual and hearing disabilities compared to AHC is presumed to be due to mostly congenital toxoplasmosis rather than acquisition of the disease postnatally. Similar results were reported in Norway, Korea, and Poland [10-12]. The second probable reason for the elevation of the seroprevalence among DC could be the lack of family care for this group compared to AHC as many of these DC are inmates in these centers and at higher exposure rate for the disease risk factors.

Table 1. Frequency of positive *Toxo*-latex test (prevalence) in apparently healthy children (AHC) and visually and/or hearing disabled children (DC) in Yemen according to their genders

Group	No. cases examined (%)			No. latex positive cases (%)			<i>P</i> value
	Males	Females	Total	Males	Females	Total	
Healthy children	130 (52)	120 (48)	250 (100)	18 (13.8)	22 (18.3)	40 (16)	0.05 0.001
Disabled children	72 (60)	48 (40)	120 (100)	18 (25)	21 (43.8)	39 (32.5)	0.005

Table 2. Frequency of positive *Toxo*-latex test (prevalence) in AHC and DC in Yemen according to their ages

Age	No. cases examined				No. latex positive cases (%)				<i>P</i> value
	< 5	5-10	>10-14	Total	< 5	5-10	>10-14	Total	
Healthy children	45	90	115	250	4/45 (8.9)	12/90 (13.3)	24/115 (20.9)	40/100 (16)	0.05 0.001
Disabled children	23	80	17	120	5/23 (21.7)	25/80 (31.3)	9/17 (53)	39/120 (32.5)	< 0.05

Table 3. The incidence of *Toxoplasma gondii* infection among AHC and DC groups during 1 year period

Group	No. latex positive cases (%)		No. of new positive cases/ Total cases examined (incidence)	<i>P</i> value
	1st reading	2nd reading ^a		
Healthy children	40 (16.0)	46 (18.4)	6/250 (2.4%)	0.005
Disabled children	39 (32.5)	44 (36.7)	5/120 (4.2%)	

^a12 months later.

The third reason could be associated with the immunological status of DC, which, in most occasions, is weak, and may play a role in predisposition for postnatal environmental acquisition of toxoplasmosis. The 16% of *Toxoplasma* seropositivity among AHC in this study was in an inconsistency or only partial consistency with the results of other studies as those conducted in Brazil (32.4%), Basra, Iraq (9.1-41.4%), and 12.8% in Dublin, UK [13-15]. Indeed, the seroprevalence is highly variable among children in different regions of the world that follows many risk factors which were not investigated in this study.

Usually, it is not common to detect a significant difference of seroprevalence between different sexes [16]. However, there were a few studies that pointed out that this rate is higher either in males [17] or females [18]. In the present study, the seroprevalence of toxoplasmosis was higher in girls than boys for both AHC and DC groups. The association between sexes and seropositivity was evident ($r = 0.125$; $P = 0.016$). This could be due a different exposure rate to the possible risk factors which were not investigated in this study.

The present study suggests that seropositivity increases in accordance with the age of the children ($r = 0.176$, $P = 0.022$). These results might reflect the overlapping status between the congenital toxoplasmosis and the postnatally acquired toxoplasmosis for DC. On the other hand, the natural history of cumulative acquisition of toxoplasmosis which is proportional to the increasing time of exposure to the infective stages of *T. gondii* might explain the increasing seroprevalence rate of toxoplasmosis with the age among AHC. Similar results were reported by others [13-15]. An annual incidence rate of 2.4% among AHC group, compared to 4.2% among DC group with a high statistical significance ($P = 0.005$) confirms the results and conclusions of the prevalence rate that were discussed above in this manuscript. To the best of our knowledge, this study was the first in comparing such parameters in toxoplasmosis.

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