

# Seroepidemiological study of *Toxoplasma gondii* infection in the human population in the Eastern Region

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## ABSTRACT

**Objective:** *Toxoplasma gondii* is an obligate intracellular protozoan parasite that causes toxoplasmosis. The infection is worldwide, particularly in warm and moist climates. Few studies have been conducted on the prevalence of subclinical or overt disease in Saudi Arabia. No population-based study was conducted or the seroprevalence of toxoplasmosis in humans in Saudi Arabia and this initiated the present study. The present study aimed at studying seroprevalence of *Toxoplasma* IgG and IgM antibodies in sera from 5 areas in the Eastern Region of Saudi Arabia.

**Methods:** A population based epidemiological approach, prevalence according to lifestyle (urban or rural), gender (male or female) occupation and age.

**Results:** Inactive toxoplasmosis (IgG levels) is of rather high prevalence in the human population in the Eastern

Region of Saudi Arabia (25%). On the other hand, active toxoplasmosis (acquired during pregnancy) is of rather low prevalence in this study (5%). Active toxoplasmosis (IgM levels) is positively related to the level of exposure, high in farmers and employees in village rural areas and low in children and students in urban areas.

**Conclusion:** Patients with active toxoplasmosis are to be treated and made aware of their situation. Hygienic conditions in areas of rather high prevalence of active toxoplasmosis are to be more strictly imposed to minimize transmission of the disease.

**Keywords:** *Toxoplasma gondii*, seroepidemiology.

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**T***Toxoplasma gondii* is an obligate intracellular protozoan parasite that causes toxoplasmosis. The infection is worldwide, particularly in warm and moist climates. Domestic cats are the definitive hosts of the parasite and are the main source of infection via oocysts passed in their faeces. Man, livestock and even rodents may act as intermediate hosts for the parasite. Human infection may be acquired by many routes, mainly via contact with infected cats, ingestion of tissue cysts (bradyzoites) in undercooked or raw livestock's meat.<sup>1-4</sup> Human infections in Kuwait were reported to be mainly due to eating or

handling desert rodents and goats infected with the parasite.<sup>5</sup> The disease may also be transmitted by blood transfusion.

Intrauterine (congenital) transmission may occur. This may result in hydrocephalus, intracranial calcification and mental retardation in infants born to infected mothers.<sup>6</sup> However, most of the toxoplasma infections in adult immunocompetent males or females are either asymptomatic or self-limiting. The infection is however, severe or fatal in foetus, (as described previously), in patients with acquired immunodeficiency syndrome (AIDS) and in patients

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receiving cytotoxic therapy. In patients with AIDS and seropositive for toxoplasma 25-50% develop cerebral toxoplasmosis.<sup>7</sup> The prevalence of toxoplasma ranges from 7.5-95% in different parts of the world: 7.5% in Scotland,<sup>8</sup> 50% in USA,<sup>9</sup> 54% in Kenya,<sup>10</sup> 47% in Nigeria,<sup>11</sup> 37% in Jordan,<sup>12</sup> and 95.5% in Kuwait.<sup>13</sup>

Few studies have been conducted on the prevalence of subclinical or overt disease in Saudi Arabia. The toxoplasmin skin test was employed in Riyadh and revealed an overall positivity of 21% in symptomatic and asymptomatic population.<sup>14</sup> A case of cerebral toxoplasmosis in an AIDS female patient in Riyadh was reported.<sup>15</sup> Recently a high prevalence of toxoplasma (37.5%) (36% of males and 2% females) using indirect hemagglutination test was recorded in blood donors in Al-Hassa area.<sup>16</sup> In the positive cases 35% of the males and 67% of females had a titre of 1/16. The highest seropositivity of antibodies in males were in the age group 21-30 years (48%), followed by the age group 18-20 (25%) and 31-40 years (21%). In females the highest seropositivity was in the age group 18-20 years (40%) followed by 21-30 years (27%) and 31-40 years (20%).

In Abha area, 52% of blood donors were positive for inactive *Toxoplasma* (IgG in serum) and 4% for active *Toxoplasma* (IgM).<sup>17</sup> Rodents in Riyadh area *Mus musculus* and *Rattus norvegicus*, were 12.5% and 42% positive for *Toxoplasma* antibodies.<sup>18</sup> Tissue cysts of *Toxoplasma gondii* were recorded in 38 camels' meat in Al-Ahsa area Eastern Region of Saudi Arabia<sup>19</sup> and produced an infection when fed to laboratory bred cats. No population-based study was conducted or the seroprevalence of toxoplasmosis in humans in Saudi Arabia and this initiated the present study. The present study aimed at studying seroprevalence of *Toxoplasma* IgG and IgM antibodies in sera from five areas in the Eastern Region of Saudi Arabia in a population based epidemiological approach: prevalence according to lifestyle (urban or rural), gender (male or female) occupation and age.

**Methods. Study population.** This study was conducted in the Eastern Region of Saudi Arabia. Almost 60% of the population live in rural areas in close contact with livestock and cats. Records of primary health care units in the area showed almost equal distribution between sexes.

**Study design.** The epidemiological study was population based (not hospital based thus differing from the previous studies of toxoplasmosis in Saudi Arabia). A cross sectional survey was conducted to estimate the seroprevalence of human toxoplasmosis in Eastern Saudi Arabia. Previous surveys of toxoplasmosis in Eastern Region of Saudi Arabia recorded prevalence rate of 37.5% (IgG) in Al-Hassa area,<sup>16</sup> 51% Inacute Inactive (IgG) in Abha area and

only 4% with acute, (active), infection (IgM) in Abha area.<sup>17</sup> Assuming equal distribution between sexes a sample size of 1000-1400 (0-5%) would be adequate for the study (Type I error A=0.05, B=0.2, difference 0.01 and confidence interval 99.9).

**Sampling method.** A multistage sampling technique was used. Five areas were selected at random: three rural: Al Jisha, Al-Qurain, Al-Nereiyah, and two urban: Al-Mubaraz and Al-Khafji (first stage in sampling). Stratified sampling was used to select at random from each of the five areas (according to population size) one or several segments of houses (second stage in sampling). A group of households were selected at random from each primary segment (selected in the second stage in sampling) and all members in each household were included in the study (third stage in sampling). A total of 1464 sera were collected in the study (804 males and 660 females) (Table 1). A total of 1464 human sera were examined.

**Data collection and analysis.** The direct blood collection was conducted by the help of trained medical teams (health officers, male and female nurses from the Primary Health Care units in each area of study) under supervision of members of the research team. Blood samples were collected by venepuncture from the subjects in study. A questionnaire was completed by interviewing each subject: age, sex and occupation. The blood samples were carried to the nearest primary health care center, serum prepared, and stored at -20°C for further analysis by the Microparticle Enzyme Immunoassay (MEIA) for IgG and IgM.<sup>20,21</sup> In this test IMX Toxo IgG assay results of less than 2.94 IU/mL were considered negative for IgG antibody to *T. gondii*. IMX Toxo IgG assay results of greater than or equal to 2.94 IU/mL were considered positive for IgG antibody to *T. gondii* and may indicate past inactive infection. Serum from subjects positive for IgG were tested for IgM using the same technique: IMX Toxo IgM (MEIA for IgM). IMX ToxoIgM assay indexes of less than 0.500 are negative for IgM antibody to *T. gondii*. IMX ToxoIgM assay indexes of greater than or equal to 0.500 are considered as positive for IgM antibody to *T. gondii* and indicate acute active infection.

**Methods of statistical analysis.** Descriptive statistics was used to describe the quantitative variables. Chi square test, T-test and ANOVA were used as appropriate p values were set to be < 0.05 throughout the study. SPSS version 6 and EPI version 6 were used for data analysis.

**Results.** The results for seroepidemiological survey of toxoplasmosis in five areas in the Eastern Region are presented in Tables 1-6 and in the following account:

**Overall seroprevalence of toxoplasmosis.** Of a total of 1464 sera examined from humans living in

Toxoplasmosis in the Eastern Region ... *Al-Qurashi et al*

**Table 1** - Sample size of the human sera examined for toxoplasmosis (IgG and (IgM) in all five areas of Eastern Region of Saudi Arabia).

| Age (Years)  | Al-Nereiyah |            | Al-Qurain  |            | Al-Khafji |            | Al-Jisha   |            | Al-Mubaraz |            |
|--------------|-------------|------------|------------|------------|-----------|------------|------------|------------|------------|------------|
|              | Sex         |            |            |            |           |            |            |            |            |            |
|              | Male No.    | Female No. | Male No.   | Female No. | Male No.  | Female No. | Male No.   | Female No. | Male No.   | Female No. |
| 1-10         | 23          | 23         | 25         | 25         | 20        | 18         | 22         | 22         | 48         | 66         |
| 11-20        | 20          | 20         | 25         | 25         | 16        | 24         | 26         | 22         | 50         | 70         |
| 21-30        | 21          | 20         | 24         | 25         | 19        | 20         | 26         | 22         | 44         | 76         |
| 31-40        | 20          | 20         | 24         | 25         | 20        | 19         | 26         | 22         | 50         | 70         |
| 41±          | 14          | 20         | 21         | 25         | 19        | 21         | 20         | 22         | 43         | 76         |
| <b>Total</b> | <b>98</b>   | <b>103</b> | <b>119</b> | <b>125</b> | <b>94</b> | <b>102</b> | <b>120</b> | <b>110</b> | <b>235</b> | <b>358</b> |

**Table 2** - Overall sample size of human sera examined for toxoplasmosis (IgG and IgM) from five areas in the Eastern Region of Saudi Arabia.

| Age (Years)  | Male            | Female          |             |
|--------------|-----------------|-----------------|-------------|
|              | No. (%)         | No. (%)         | No. (%)     |
| 1-10         | 132 (9)         | 154 (10.5)      | 286 (19.5)  |
| 11-20        | 137 (9)         | 160 (11)        | 297 (20)    |
| 21-30        | 134 (9)         | 178 (12)        | 312 (21)    |
| 31-40        | 140 (9.5)       | 151 (10)        | 291 (20)    |
| 41±          | 117 (8)         | 161 (11)        | 278 (19)    |
| <b>Total</b> | <b>660 (45)</b> | <b>804 (55)</b> | <b>1464</b> |

**Table 3** - Seroprevalence of toxoplasmosis (IgG and IgM) according to sex in human sera in five areas of study in the Eastern Region of Saudi Arabia.

| Area of study | No. (%) of sera positive for IgG |          | No. (%) of sera positive for IgM |         |
|---------------|----------------------------------|----------|----------------------------------|---------|
|               | Males                            | Females  | Males                            | Females |
| Al-Nereiyah   | 29 (14)                          | 24 (12)  | 1 (2)                            | 1 (2)   |
| Al-Qurain     | 30 (12)                          | 31 (13)  | 1 (2)                            | 2 (3)   |
| Al-Khafji     | 29 (15)                          | 24 (12)  | 1 (2)                            | 1 (2)   |
| Al-Jisha      | 34 (15)                          | 15 (6.5) | 4 (8)                            | 1 (2)   |
| Al-Mubaraz    | 59 (10)                          | 89 (15)  | 4 (3)                            | 4 (3)   |

**Table 4** - Seroprevalence of toxoplasmosis (IgG and IgM) according to age in human sera from Eastern Region.

| Area         | Type of antibody examined | No of sera examined | 1-10    | 11-20    | 21-30  | 31-40  | 41+     |
|--------------|---------------------------|---------------------|---------|----------|--------|--------|---------|
| Al-Nereiyah  | IgG                       | 201                 | 8 (4)   | 8 (4)    | 13 (6) | 13 (6) | 11 (5)  |
|              | IgM                       | 53                  | 0 (0)   | 0 (0)    | 2 (4)  | 0 (0)  | 0 (0)   |
| Al-Qurain    | IgG                       | 244                 | 6 (2)   | 6 (2)    | 15 (6) | 13 (5) | 21 (9)  |
|              | IgM                       | 61                  | 0 (0)   | 0 (0)    | 1 (2)  | 0 (0)  | 2 (3)   |
| Al-Khafji    | IgG                       | 196                 | 5 (2.5) | 7 (3.5)  | 10 (5) | 10 (5) | 21 (8)  |
|              | IgM                       | 53                  | 1       | 0 (0)    | 1 (2)  | 0 (0)  | 2 (0)   |
| Al-Jisha     | IgG                       | 230                 | 3 (1)   | 11 (5)   | 16 (7) | 8 (3)  | 11 (5)  |
|              | IgM                       | 49                  | 0 (0)   | 0 (0)    | 3 (6)  | 1 (2)  | 1 (2)   |
| Al-Mubaraz   | IgG                       | 593                 | 12 (2)  | 21 (3.5) | 28 (5) | 41 (7) | 46 (8)  |
|              | IgM                       | 148                 | 2 (1)   | 2 (1)    | 1 (1)  | 2 (1)  | 1 (1)   |
| From 5 areas | IgG                       | 1464                | 40 (3)  | 53 (4)   | 82 (6) | 85 (6) | 104 (7) |
|              | IgM                       | 364                 | 3 (1)   | 3 (1)    | 8 (2)  | 3 (1)  | 3 (1)   |

**Table 5** - Seroprevalence of toxoplasmosis (IgG and IgM) according to occupation.

| Area         | Type of antibody examined | No of sera examined | No. (%) of positive sera |         |           |                    |
|--------------|---------------------------|---------------------|--------------------------|---------|-----------|--------------------|
|              |                           |                     | Child                    | Student | Housewife | Employee & farmers |
| Al-Nereiyah  | IgG                       | 201                 | 5 (2)                    | 8 (4)   | 19 (9)    | 21 (10)            |
|              | IgM                       | 53                  | 0 (0)                    | 0 (0)   | 1 (2)     | 1 (2)              |
| Al-Qurain    | IgG                       | 244                 | 1 (0)                    | 7 (3)   | 29 (12)   | 24 (10)            |
|              | IgM                       | 61                  | 0 (0)                    | 0 (0)   | 2 (3)     | 1 (2)              |
| Al-Khafji    | IgG                       | 196                 | 3 (1.5)                  | 15 (10) | 18 (9)    | 1 (2)              |
|              | IgM                       | 53                  | 0 (0)                    | 1 (2)   | 1 (2)     | 17 (9)             |
| Al-Jisha     | IgG                       | 230                 | 2 (1)                    | 14 (6)  | 10 (4)    | 10 (4)             |
|              | IgM                       | 49                  | 0 (0)                    | 0 (0)   | 1 (2)     | 1 (2)              |
| Al-Mubaraz   | IgG                       | 593                 | 6 (1)                    | 26 (4)  | 72 (12)   | 72 (12)            |
|              | IgM                       | 148                 | 2 (1)                    | 2 (1)   | 2 (1)     | 2 (1)              |
| From 5 areas | IgG                       | 1464                | 22 (1.5)                 | 70 (5)  | 148 (10)  | 148 (10)           |
|              | IgM                       | 364                 | 2 (0.5)                  | 3 (1)   | 6 (2)     | 6 (2)              |

**Table 6** - A comparison of seroprevalence of toxoplasma (IgG and IgM) in human sera in five areas of study in the Eastern Region of Saudi Arabia.

| Area of study | Type of antibody examined |     | Type of antibody examined |        |
|---------------|---------------------------|-----|---------------------------|--------|
|               | IgG                       | IgM | IgG                       | IgM    |
| Al-Nereiyah   | 201                       | 53  | 53 (26)                   | 2 (4)  |
| Al-Qurain     | 244                       | 61  | 61 (25)                   | 3 (5)  |
| Al-Khafji     | 196                       | 53  | 53 (27)                   | 2 (4)  |
| Al-Jisha      | 230                       | 49  | 49 (21)                   | 5 (10) |
| Al-Mubaraz    | 593                       | 148 | 148 (25)                  | 8 (5)  |

the five areas 364 (25%) were positive for inactive toxoplasmas (IgG) and only 20 (5%) for active toxoplasmosis (IgM) (Table 1).

**Seroprevalence of toxoplasmosis according to lifestyle: rural (village) or urban (city).** The seroprevalence with inactive toxoplasmosis (IgG levels) was almost equal in the five areas of study (Table 2). The prevalence ranged from 21% - 27% with no significant difference ( $p > 0.05$ ). However, there was a statistically significant difference ( $p < 0.05$ ) in the seroprevalence with active toxoplasmosis (IgM) in the five areas of study: higher in areas with a rural (village) lifestyle (10-20% in Al-Jisha, 5% in Al-Mubaraz and 5% in Al-Qurain. The IgM seroprevalence was lower in the Nereiyah and Al-Khafji areas (4% in both areas) with a urban city lifestyle.

**Seroprevalence of toxoplasmosis according to gender.** The seroprevalence with toxoplasmosis was rather equal for both IgG (12% in males and 13% IN females) and IgM (3% for males and 2% in females). (Table 3). The statistical analysis shows no statistically significant difference, ( $p > 0.05$ ).

**Seroprevalence of toxoplasmosis according to occupation.** There was a marked statistical difference ( $p = 0.03$ ) in the seroprevalence with inactive IgG and active IgM toxoplasmosis in the different occupations. Low levels for IgG (1.5%) were recorded in children and (5%) in students compared to high levels in housewives (10%) and employees (9%). (Table 5). The same trend was recorded for active toxoplasmosis (IgM) being low in children (0-55%) and student(s) (0.1%) and high in housewives (2%) and employees (2%).

**Seroprevalence of toxoplasmosis according to age.** (Table 4). There was a gradual increase in seroprevalence with inactive toxoplasmosis (IgG) with increase in age of the patient: from 3% in the age group 1-10 years to 7% in the age group 41+ years. This marked difference was statistically significant ( $p < 0.001$ ). As to active toxoplasmosis IgM values, very low levels (0.1% were recorded in the age group 1-20 years) and an increase in the age group 21-30 years (2%) and the difference was statistically significant ( $p < 0.01$ ).

**Discussion.** The results of the present study of toxoplasmosis in the Eastern Region of Saudi Arabia indicate a rather comparable seroprevalence of inactive toxoplasmosis in the five areas examined. These prevalence rates are rather less than those recorded in previous studies from Al-Hassa area, (37.5%)<sup>16</sup> or the high prevalence of 51% in Abha area.<sup>17</sup> The present studies differ from those previously conducted in that a population-based approach (the first of such studies on toxoplasmosis in Saudi Arabia was followed in collection of

samples. However, previous studies in Al-Hassa area and in Abha were hospital based, mainly from blood donors thus not representative of the community in the area. Various epidemiological factors govern the sero-prevalence with toxoplasmosis as indicated in the present study. The prevalence increased with age (considering the pattern of life cycle of the parasite) in the present study and these results are comparable to those in other areas ie. Kuwait.<sup>8,13,22,23</sup> The seroprevalence of toxoplasmosis in the present study seems to be also affected by the level of exposure to infection (occupation) since housewives, employees and farmers are more prevalent than children and students. Prevalence with active toxoplasmosis has also been shown well in this study to be related to the degree of life style (urban or rural) and exposure to infection. Similar data was recorded in other endemic areas. Gender does not seem to affect seroprevalence in the areas studied since all five areas and both sexes thus have an equal chance of exposure to infection. Active transmission of *Toxoplasma* by cats and consumption of bradyzoites in livestock meat is well reported in Al-Hassa area.<sup>19</sup> Meat samples from 38 camels in Al-Hassa area fed to four laboratory bred cats resulted in their infection all with toxoplasmosis: oocysts of *T. gondii* were recorded in their faeces from 9-11 days later and *Toxoplasma* infection occurred in mice fed on oocysts.

In conclusion, inactive toxoplasmosis (IgG levels) is of rather high prevalence in the human population in the Eastern Region of Saudi Arabia. On the other hand Active toxoplasmosis (acquired during pregnancy) is of rather low prevalence in this study. Active toxoplasmosis (IgM levels) is positively related to the level of exposure, high in farmers, employees in village rural areas and low in children, students in urban areas. Patients with active toxoplasmosis are to be treated and made aware of their situation. Hygienic conditions in areas of rather high prevalence of active toxoplasmosis are to be more strictly imposed to minimize transmission of the disease.

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