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Seroepidemiology of *Toxoplasma gondii* IgG and IgM among butchers in southwest of IranMasoume Mardani¹, Mehdi Tavalla^{2*}¹Student Research Committee, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran²Department of Parasitology, School of Medicine, Infectious & Tropical Diseases Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

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ABSTRACT

Objective: To test for immunoglobulin G (IgG) and immunoglobulin M (IgM) antibodies in butchers in the province of Khuzestan in Iran and compare them with a control group from the general population.**Methods:** Blood samples were taken from 110 butchers in five cities of Khuzestan, southwest of Iran to test for the incidence of *Toxoplasma*. The participants were accepted and tested on the basis of age, work experience, engagement in animal husbandry, and positive or negative *Toxoplasma* IgM and IgG results.**Results:** The results showed that the seroprevalence of *Toxoplasma* IgG was 41.8% (56 cases) among the group of butchers in Khuzestan and 28.8% in the control group. The seroprevalence of *Toxoplasma* IgM was 1 case (2.2%) among butchers, while none in the control group.**Conclusions:** A comparison of results indicated that butchers in Khuzestan were at the risk of toxoplasmosis. The greatest frequency was 17.6% (20 cases) in the group with age ranging from 35 to 44 years. In terms of work experience, the greatest frequency was 16.5% (18 cases) among butchers having 9–17 years of work experience.

1. Introduction

Toxoplasma belongs to the class Sporozoa and is an obligate intracellular parasite affecting blood and tissue. Toxoplasmosis is one of the most common parasitic infections in humans and other warm-blood animals. It was first discovered by Nicolle and Manceaux in 1908[1].

Toxoplasmosis is the third most common food- and water-borne disease[2]. Its global seroprevalence in humans and animals varies by country. For example, it is 6.7% in Korea and 68.6% in Brazil; the difference is the result of geographic location, lifestyle, organ transplants, and blood transfusion[3,4]. In Norway, the consumption of raw or undercooked meat has increased the incidence of toxoplasmosis in pregnant women[5]. Symptoms of infection are not evident in individuals with normal immune function. Complications from toxoplasmosis are acute and dangerous among immunosuppressed patients, such as individuals with AIDS, organ transplant recipients and people with cancer[6,7].

Previous studies by the authors have reported a seroprevalence of 40% to 70% in the general population of Iran[8]. *Toxoplasma gondii* can be transmitted in the environment through the food and water

contaminated with *Toxoplasma* oocysts, by consumption of raw or undercooked infected tissue, and through the placenta from one host to another. In individuals with healthy immune systems, the infection is asymptomatic, while in immunosuppressed patients, the parasite can quickly spread and cause severe toxoplasmosis[9-11]. When *Toxoplasma* is compatible with the host body, the parasite can live in the body for long periods in parasitic cysts located in the brain and muscles[12]. The high incidence of toxoplasmosis makes it a serious threat to human health[13]. *Toxoplasma* can cause severe congenital malformation and abortion in the host interface, which makes it an important issue in medicine and veterinary medicine[14].

Toxoplasmosis cannot be diagnosed solely by reliance on clinical findings. Serological evaluation and parasitological confirmation are required for definitive diagnosis[15]. Serological methods such as the ELISA and indirect immunofluorescence should be considered for the detection of toxoplasmosis. ELISA is the gold standard for the diagnosis of *Toxoplasma* immunoglobulin G (IgG) and immunoglobulin M (IgM) antibodies[16]. The present study tested for IgG and IgM antibodies of butchers in Khuzestan Province, Iran and compared them with those of control group from the general population.

2. Materials and methods

2.1. Study area and objects

The study was carried out in Khuzestan (Southwest Iran) in 2014. The target cities were in the north (Dezful), south (Abadan),

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east (Behbahan), west (Dasht-e Azadegan) and center (Ahvaz) of Khuzestan Province.

This was a case-control study on individuals working with raw meat. The study population consisted of butchers who sold raw meat in shops, while the control group was selected from the general population and was matched for age, gender and place of residence with the group of butchers. A total of 110 butchers and 110 individuals matched for the defined characteristics were selected.

The study objectives and methodology were explained to all participants. The characteristics of participants were obtained and recorded by using a standardized questionnaire. The demographic data included age, gender, place of birth, place of residence, and level of education. Information related to work experience, the most common types of animal slaughtered, and the regular use of safety practices at work (use of gloves, masks, and goggles) were also evaluated.

2.2. Sampling collection and serology

A sample of 5 mL blood was taken from each person and immediately transferred to the laboratory. After centrifugation, the serum was stored individually in a freezer at -20 °C until testing. After the desired number of samples was collected, ELISA was carried out. The serum sample was first removed from the freezer and allowed to reach room temperature. The antibodies on the plates were counted and subsequently separated into IgG and IgM groups according to the guidelines provided in the Atobio Toxo ELISA kit.

2.3. Statistical analysis

SPSS software (version 16) was used for statistical analysis. The *t*-test was used to compare mean age and work experience among butchers with positive and negative IgG results. The *Chi*-square test was applied to compare the prevalence of IgG among butchers.

3. Results

The incidence of *Toxoplasma* IgG and IgM antibodies among butchers was given in Tables 1, 2 and 3. Table 1 shows that of 110 butchers, the prevalence of *Toxoplasma* IgG was 42.7%. By age, it broke down to 4.5% for the 16–24 years, 10.0% for 25–34 years, 18.1% for 35–44 years, 5.54% for 45–54 years, and 4.5% for over 55 years. The 35–44 years group showed the greatest incidence of positive IgG (20 cases). Out of 110 butchers, only one case (1.1%) tested positive for *Toxoplasma* IgM. This case fell into the 16–24 age range. There was no significant difference at the 95% confidence level for mean age of those testing positive and negative for *Toxoplasma* IgG among butchers in Khuzestan.

Table 1
Prevalence of *Toxoplasma* IgG in butchers in Khuzestan vs. age. *n* (%).

Age range	Positive	Negative	Total
16–24 years	5 (4.5)	11 (10.0)	16 (14.5)
25–34 years	11 (10.0)	25 (22.7)	36 (32.7)
35–44 years	20 (18.1)	7 (6.4)	27 (24.5)
45–54 years	6 (5.5)	14 (12.7)	20 (18.2)
≥ 55 years	5 (4.5)	6 (5.5)	11 (10.0)
Total	47 (42.7)	63 (57.3)	110 (100.0)

Table 2 shows that the prevalence of *Toxoplasma* IgG among the butchers was 41.8%. Of these, 10.0% had 0–8 years of work experience, 16.4% had 9–17 years, 10.0% had 18–26 years, 4.5% had 27–34 years, and 0.9% had 35–42 years. The greatest frequency of *Toxoplasma* antigens occurred in butchers having 18–26 years of work experience (11 of 22 cases). There was no significant difference in the work experience of those testing positive and negative for

Toxoplasma IgG at the 95% confidence level. Only one butcher (0.9%) with 35–42 years of work experience tested positive for *Toxoplasma* IgG.

Table 2

Prevalence of *Toxoplasma* IgG in butchers of Khuzestan vs. work experience. *n* (%).

Work experience	Positive	Negative	Total
0–8 years	11 (10.0)	19 (17.2)	30 (27.2)
9–17 years	18 (16.4)	23 (20.9)	41 (37.3)
18–26 years	11 (10.0)	11 (10.0)	22 (20.0)
27–34 years	5 (4.5)	7 (6.4)	12 (10.9)
35–42 years	1 (0.9)	4 (3.7)	5 (4.6)
Total	46 (41.8)	64 (58.2)	110 (100.0)

Table 3 shows that of the 110 butchers with *Toxoplasma* IgG, 16.4% lived in Ahvaz, 9.0% in Behbahan, 4.5% in Dasht-e Azadegan, 10.0% in Dezful, and 1.8% in Abadan. While, of 53 butchers testing negative for *Toxoplasma* IgG, 20.9% lived in Ahvaz, 11.0% in Behbahan, 12.7% in Dasht-e Azadegan, 4.5% in Dezful, and 9.0% in Abadan. As seen, the greatest incidence rate of *Toxoplasma* IgG occurred in Dezful (11 of 16 cases). Only two (2.2%) butcher tested positive for *Toxoplasma* IgM in Abadan.

Table 3

Prevalence of *Toxoplasma* IgG in butchers of Khuzestan vs. city. *n* (%).

City	Positive	Negative	Total
Ahvaz	18 (16.4)	23 (20.9)	41 (37.3)
Behbahan	10 (9.0)	12 (11.0)	22 (20.0)
Dasht-e Azadegan	5 (4.5)	14 (12.7)	19 (17.2)
Dezful	11 (10.0)	5 (4.5)	16 (14.5)
Abadan	2 (1.8)	10 (9.2)	12 (11.0)
Total	56 (41.7)	64 (58.3)	110 (100.0)

In the control group, the prevalence of *Toxoplasma* IgG was 28.8% and for IgM was zero. There was no significant difference for age and personal hygiene practices in this group. No significant association was observed between incidence of the antibodies and the use of gloves as well as the habit of washing hands before eating. The increase in prevalence among butchers could result from their close proximity to slaughtered animals and consumption of undercooked meat. A secondary possible reason was the large number of cats in these regions.

4. Discussion

The Sabin-Feldman dye test is the gold standard for detection of human *Toxoplasma* antibodies; however, its high cost makes it unfeasible for epidemiological studies. The difference in *Toxoplasma* serum could result from differences in the characteristics for work and social behavior in butchers of different countries. In reality, most butchers do not regularly wear gloves. This increases the probability of injury during work, which is another possible source of infection[11,17,18].

The results of this study showed that the occupational exposure to raw meat in Khuzestan increased the prevalence of *Toxoplasma* IgG antibodies. The seroprevalence of *Toxoplasma* IgG was 41.8% among butchers in the current study, which was not consistent with the results reported from Brazil, Saudi Arabia, Bangladesh, Japan, Poland and Tanzania (33%–80%)[19]. Of the 47 workers studied in a sausage production plant in Londrina, Finland, a prevalence of 59.5% and 25% was reported overall and among 159 butchers, respectively. A study from Egypt reported 52.4% of 21 slaughterhouse workers were infected[20].

The risk of toxoplasmosis is high among people working in slaughterhouses and kitchens, and among veterinarians and butchers.

In China, the consumption of pork is high, which accounts for the very high prevalence of toxoplasmosis. The prevalence varied by province from 16.9% to 53.4% [21,22]. The risk of prevalence has been reported to be high among butchers in Finland [20], Egypt and Brazil [22,23]. The prevalence in the USA was 2.7%, Germany was 4.1%, and Mexico was 12.7%.

In China, educational programs promoting a change in food habits, such as avoiding consumption of uncooked meat, testing of meat before distribution, and suitable health conditions in slaughterhouses have been suggested [22]. In the present study, the frequency indicated that the higher *Toxoplasma* IgG antibodies in humans was the result of the frequent consumption of cooked red meat, working as a butcher, and improper washing of hands before meals and working with meat. In the USA, a significant percentage of toxoplasmosis results from the consumption of contaminated raw or undercooked meat [21].

A study in slaughterhouses in Iraq shows a high prevalence of toxoplasmosis (42%) in workers in the meat industry because of their close proximity to animals, especially cats. A significant increase in the toxoplasmosis has also been reported to correlate with an increase in age in Iraq [24]. The rate of infection with toxoplasmosis was higher in the present study than what has been reported in neighboring countries of Saudi Arabia (32.7%) and the United Arab Emirates (25%). The results of the present study in Iran are consistent with the results of the research carried out in Iraq, which suggests the similarity of weather conditions and customs are factors.

In Finland, the prevalence of toxoplasmosis was reported to be 59.9% (47 cases) among workers in the meat industry; in Egypt, it was reported to be 52.4% in slaughterhouse [25]. A survey conducted on workers in the meat industry in Kashan, Iran reported a prevalence of 50%. Some of the increase could result from weather conditions, adequacy of hygiene, and the consumption of raw or undercooked meat [26].

The results of this study showed that there was a significant difference between the prevalence of toxoplasmosis among butchers (41.8%) in Khuzestan and of individuals in the general population (28.8%). These differences in different areas could result from the diversity of locations, climatic conditions, type of nutrition, and different health practices among different countries.

Conflict of interest statement

We declare that we have no conflict of interest.

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