



Research Article

***Toxoplasma gondii* seroprevalence at a tertiary care hospital in Makkah, Saudi Arabia**Dina A. Zagloul^{1,2*}, Mohammed El-Bali³, Hani S. Faidah^{1,4}, Saeed A. Al-Harhi³¹*Al-Noor Specialist Hospital, Makkah, Saudi Arabia.*²*Medical Parasitology Department, Assiut University, Assiut, Egypt.*³*Faculty of Medicine, Medical Parasitology Department, Umm Al-Qura University, Makkah, Saudi Arabia.*⁴*Faculty of Medicine, Microbiology Department, Umm Al-Qura University, Makkah, Saudi Arabia.*

Abstract: Human toxoplasmosis is a cosmopolitan infection with a wide-ranging prevalence. The prevalence of *Toxoplasma gondii* infection is variable and depends on different eco-epidemiological factors. Both, active serological screenings and retrospective analytical methods are usually used for the investigation of toxoplasmosis seroprevalence in different populations. We conducted a two-year retrospective database search at a major tertiary care hospital to determine the prevalence of toxoplasmosis and its distribution in relation to gender and age among Makkah's population. In total, 806 females and 118 males with 33.1±9.1 years, mean age (±SD) were tested for anti-*T. gondii* antibodies in the last two years. Laboratory results revealed 229 seropositive subjects indicating 24.8% overall toxoplasmosis seroprevalence. Infection rate was significantly higher among male subjects (33.9%) than female subjects (23.4%). Seroprevalence increased considerably with age; from 9.7% in children less than 10 years old to 37.4% and 40.5% among adults between 40 and 49 and over 50 years, respectively. Only two anti-*T. gondii* IgM seropositive cases were recorded along this period, indicating possible active infection. In conclusion, overall *T. gondii* seropositivity rate is relatively low among Makkah's population, but moderate in adult males. Further investigations are required to determine the risk factors associated with toxoplasmosis transmission in the area. Also, adequate screening for anti-*T. gondii* specific antibodies are recommended, especially for immunocompromised patients and during pregnancy, in order to minimize prospective complications.

Keywords: *Toxoplasma gondii*, Seroprevalence, Makkah, Saudi Arabia.

1. Introduction

Toxoplasmosis is a cosmopolitan parasitic infection caused by *Toxoplasma gondii*, obligatory intracellular protozoa that can infect almost all warm-blooded animals, including humans and many animals of economic importance [1]. Individuals become infected mostly after ingesting food or water contaminated with oocysts that develop in felids intestines and are excreted in their feces, or by eating undercooked meat containing viable *T. gondii* tissue cysts. Transmission can occur also, but less frequently, by transplacental passage of tachyzoites if a primary infection happens during pregnancy, after organ transplantation from infected donors, transfusion of contaminated blood, and inhalation of contaminated dust [2-4]. Nearly a third part of the world population has been infected with *T.*

gondii parasites, but most of the infections remain asymptomatic [5]. Immunocompetent people may experiment during active toxoplasmosis, usually after one to two weeks of incubation, some mild and transient influenza-like illness symptoms including; malaise, fever, and lymphadenopathy [6]. Nonetheless, severe symptoms may occur during acute infection or by reactivation of latent infections in individuals under immunosuppressive conditions such as in patients with acquired immunodeficiency syndrome and individuals on immunosuppressive therapy [7,8]. Toxoplasmosis may lead to serious individual health consequences because of the major clinical abnormalities and problems that affect vulnerable patients like blindness, hearing loss, and intellectual disabilities [9,10]. Consequently, toxoplasmosis represents an important

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public health impact in terms of socioeconomic issues and costs of caring for patients [11,12].

Diagnosis of toxoplasmosis is made according to the subject immune background and on the observed signs and symptoms. But, because the infection is generally asymptomatic, screening policies rely on indirect serological methods for detection of anti-*T. gondii* antibodies of different isotypes [13-15]. Seroprevalence investigation of anti-*T. gondii* IgG and IgM antibodies offer an efficient method for estimating the incidence and prevalence of the infection within a studied group in particular but also reflects the spread of the infection among the general society [16].

This study was conducted to evaluate and update *T. gondii* seroprevalence among Makkah's population. For this purpose, laboratory data of individuals who attended a major tertiary care hospital and were examined for toxoplasmosis during the last two years were collected and statistically analyzed.

2. Subjects and Methods

This is a retrospective cross-sectional data analysis of laboratory records at a major tertiary health hospital in Makkah province, Saudi Arabia. The study targeted all individuals who attended inpatient and outpatient clinics of the hospital during the last two years and were examined for anti-*T. gondii* total antibodies and/or anti-*T. gondii* specific IgM in order to estimate the rate of *T. gondii* infection among Makkah population and the proportion of acute cases.

Records of serology results were collected in parallel with age and gender of all examined subjects. Relative seroprevalence rates were calculated by gender groups and compared. Subjects were divided into 10 year age groups to assess the progression of *T. gondii* infection rate with age. Statistical analysis was performed using Microsoft Excel software on a personal computer.

The study protocol was approved by our institutional review board. We declare that we have no financial or personal relationship which may have inappropriately influenced us in writing this paper.

3. Results

Out of 924 persons who visited the tertiary health hospital during the last two years and were examined for anti-*T. gondii* total antibodies, 229 (24.8%) were found seropositive and 695 negatives, indicating a non-previous exposure to the parasite. Only two cases were found seropositive for anti-*T. gondii* IgM specific antibodies out of 643 individuals examined for IgM, showing a 0.3% prevalence of possible recent or active toxoplasmosis (Table 1). In total, 806 females and 118 males with 33.1±9.1 average age (±SD) were tested. The average age among male individuals was 35.2 years old (±16.4 SD), while in the female group the average age was 32.7 years (±7.2 SD). Toxoplasmosis

seroprevalence analysis by gender showed statistically significant sex difference ($P<0.01$); calculated seroprevalence was 33.9% among male subjects and 23.4% among female subjects (Table 2). Infection rate increased considerably with age; from 9.7% in children less than 10 years old to 16.6%, 17.1%, 24.3%, and 37.4% progressively among the subsequent 10 year age groups, to 40.5% among persons over 50 years (Fig. 1).

Table 1. Seroprevalence of anti-*T. gondii* total antibodies and anti-*T. gondii* specific IgM at a tertiary health care center in Makkah, Saudi Arabia.

Serological test	Subjects	Positives	Relative Seroprevalence
Total antibodies anti- <i>T. gondii</i>	924	229	24.8%
IgM anti- <i>T. gondii</i>	643	2	0.3%

Table 2. Relationship between gender and *Toxoplasma gondii* seroprevalence at a tertiary health care center in Makkah, Saudi Arabia.

Gender	Examined subjects	Mean age ±SD	Seropositive subjects	Seroprevalence
Females	806	32.7 ± 7.2	189	23.4%
Males	118	35.2 ± 16.4	40	33.9%
overall	924	33.1 ± 9.1	229	24.8%

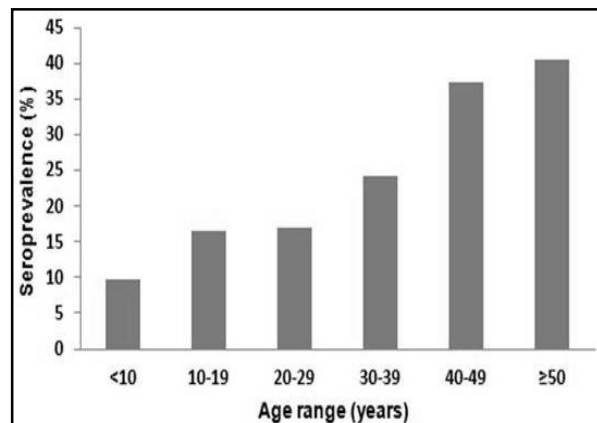


Fig. 1. Toxoplasmosis seroprevalence according to 10-year age groups at a tertiary health care center in Makkah, Saudi Arabia.

4. Discussion

Toxoplasmosis is a widespread infection with significant public health impact in terms of consequent socioeconomic problems and elevated costs of caring for patients who suffer serious clinical conditions, generally of ocular and neurological nature [12,17,18]. Nearly a third part of the world population has been infected with *T. gondii* parasites and most of them remain asymptomatic [5]. Toxoplasmosis prevalence varies considerably among different regions and populations throughout the world [15]. This discrepancy has been linked to different kind of factors: immunological, educational, occupational,

socioeconomic, cultural, environmental, and others [19,20].

The current study, carried out in Makkah city in Saudi Arabia, western region, revealed an overall toxoplasmosis seroprevalence of 24.8%. Toxoplasmosis infection rates less than 30% are considered as relatively low [15]. Similarly, low seroprevalence rates have been observed in other countries like in; Japan 10.3%, USA 13.2%, China 16.8%, UK 17.3%, and Thailand 28.3% [21-25]. By other hand, moderate (30-50%) and high (>50%) infection rates were reported in many countries; 30.1% in Turkey, 45.8% in Colombia, 55% in Germany, 68.8% in Brazil, and 92.5% in Ghana [26-30]. In Saudi Arabia, different regional seroprevalence rates of toxoplasmosis were lately reported; 24.1% in Jazan, 28.5% in Dhahran, 38% in Riyadh, 38.8% in southwestern region, and 51.4% in Al-Ahsa [31-35]. It has been reported that toxoplasmosis seroprevalence is influenced by socioeconomic and educational status of each population, but also, it is directly associated with the level of exposure to *T. gondii* parasites which are higher in rural areas and small villages than urban areas in Saudi Arabia [36].

Toxoplasmosis seroprevalence was found higher in men's group compared to women, 33.9% versus 23.4%, respectively, with a statistically significant gender difference ($P<0.01$). It is agreed that the occurrence of toxoplasmosis is relatively influenced by the gender of the hosts; more likely due to gender-associated differences consisting of lower immune resistance to parasites in men with a higher exposure risk due to occupational activities [37,38]. In addition, we should mention that the average age of male subjects were higher than female group in this study, 35.2 versus 32.7 years. The infection rate increased significantly as the age of hosts increased, from 9.7% in children less than 10 years old to 37.4% and 40.5% among 40 to 49 age range and persons above 50 years, respectively. Thus the age was a determinant factor in the distribution toxoplasmosis seroprevalence among the studied population. It has been reported as an evidentiary fact that *T. gondii* seroprevalence increases with age in almost all established communities [39-41].

Only two cases were found seropositive for anti-*T. gondii* IgM specific antibodies during the period of the study. Serological examination for anti-*T. gondii* IgM is usually the approach for primary active toxoplasmosis screening but since anti-*T. gondii* IgM antibodies may persist in peripheral blood for long periods of development, their detection is not completely confirmative of recent or acute infection [42,43]. As well, natural antibodies of IgM class may occasionally be present in non-infected persons and react with the parasite antigens in serological tests [44, 45]. Seropositive anti-*T. gondii* IgM cases necessitate more investigations to confirm or discard acute form of toxoplasmosis.

5. Conclusion

A relatively low toxoplasmosis overall seroprevalence (24.8%) was found among individuals who visited a tertiary care hospital at the Makkah city during the last two years. Seropositivity rate was higher in men than women, indicating a higher infection risk for male population. Further investigations are required to determine the risk factors associated with toxoplasmosis transmission in the area.

References

- [1]. Montoya, J.G., Boothroyd, J.C. & Kovacs, J.A. (2010). *Toxoplasma gondii*. In: Mandell, G.L., Bennett, J.E., Dolin, R., editors. Principles and Practice of Infectious Diseases. Seventh edition. Philadelphia, USA: Churchill Livingstone, pp. 3485–3526.
- [2]. Teutsch, S.M., Juranek, D.D., Sulzer, A., Dubey, J.P. & Sikes, R.K. (1979). Epidemic toxoplasmosis associated with infected cats. *N. Engl. J. Med.*, 300(13): 695-699.
- [3]. Montoya, J.G. & Liesenfeld, O. (2004). Toxoplasmosis. *Lancet*, 363: 1965-1976.
- [4]. Dubey, J.P. & Jones, J.L. (2008). *Toxoplasma gondii* infection in humans and animals in the United States. *Int. J. Parasitol.*, 38: 1257-1278. doi: 10.1016/j.ijpara.2008.03.007.
- [5]. Tenter, A.M., Heckeroth, A.R. & Weiss, L.M. (2000). *Toxoplasma gondii*: from animals to humans. *Int. J. Parasitol.*, 30(12-13): 1217-1258.
- [6]. Weiss, L.M. & Dubey, J.P. (2009). Toxoplasmosis: A history of clinical observations. *Int. J. Parasitol.*, 39: 895-901. doi: 10.1016/j.ijpara.2009.02.004.
- [7]. Hill, D.E., Chirukandoth, S. & Dubey, J.P. (2005). Biology and epidemiology of *Toxoplasma gondii* in man and animals. *Anim. Health Res. Rev.*, 6(1): 41-61.
- [8]. Hoffmann, C. (2005). Opportunistic infections. In HIV Medicine. Edited by C. Hoffmann, J.K. Rockstroh & B.S. Kamps. Paris: Flying Publisher.
- [9]. Vutova, K., Peicheva, Z., Popova, A., Markova, V., Mincheva, N. & Todorov, T. (2002). Congenital toxoplasmosis: eye manifestations in infants and children. *Ann. Trop. Paediatr.*, 22(3): 213-218.
- [10]. Torrey, E.F. & Yolken, R.H. (2003). *Toxoplasma gondii* and Schizophrenia. *Emerg. Infect. Dis.*, 9(11): 1375-1380. <https://dx.doi.org/10.3201/eid0911.030143>.
- [11]. Roberts, T., Murrell, K.D. & Marks, S. (1994). Economic losses caused by foodborne parasitic diseases. *Parasitol. Today*, 10(11): 419-23.
- [12]. Stillwaggon, E., Carrier, C.S., Sautter, M. & McLeod, R. (2011). Maternal serologic screening to prevent congenital toxoplasmosis: a decision-

- analytic economic model. *PLoS Negl. Trop. Dis.*, 5(9):e1333. doi: 10.1371/journal.pntd.0001333.
- [13]. Bobić, B., Sibalić, D. & Djurković-Djaković, O. (1991). High levels of IgM antibodies specific for *Toxoplasma gondii* in pregnancy 12 years after primary toxoplasma infection. *Gynecol. Obstet. Invest.*, 31(3): 182-184.
- [14]. Joynson, D.H.M. & Guy, E.C. (2001). Laboratory diagnosis of toxoplasma infection. In: Joynson, D.H.M., Wreghitt, T.G., editors. *Toxoplasmosis: a Comprehensive Clinical Guide*. Cambridge, UK: Cambridge University Press. pp. 296–318.
- [15]. Robert-Gangneux, F. & Dardé, M.L. (2012). Epidemiology of and diagnostic strategies for toxoplasmosis. *Clin. Microbiol. Rev.*, 25(2): 264-296. doi: 10.1128/CMR.05013-11.
- [16]. Frenkel, J.K. (1990). Toxoplasmosis in human beings. *J. Am. Vet. Med. Assoc.*, 196: 240-248.
- [17]. Lopez, A., Dietz, V.J., Wilson, M., Navin, T.R. & Jones, J.L. (2000). Preventing congenital toxoplasmosis. *MMWR Recomm. Rep.*, 49(RR-2): 59-68.
- [18]. Jones, J.L. & Holland, G.N. (2010). Annual burden of ocular toxoplasmosis in the United States. *Am. J. Trop. Med. Hyg.*, 82: 464-465.
- [19]. Jones, J.L., Kruszon-Moran, D., Wilson, M., McQuillan, G., Navin, T. & McAuley, J.B. (2001). *Toxoplasma gondii* infection in the United States: seroprevalence and risk factors. *Am. J. Epidemiol.*, 154: 357-365.
- [20]. Furtado, J.M., Smith, J.R., Belfort, R., Gattey, D. & Winthrop, K.L. (2011). Toxoplasmosis: a global threat. *J. Glob. Infect. Dis.*, 3: 281-284.
- [21]. Sakikawa, M., Noda, S., Hanaoka, M., Nakayama, H., Hojo, S., Kakinoki, S., Nakata, M., Yasuda, T., Ikenoue, T. & Kojima, T. (2012). Anti-Toxoplasma antibody prevalence, primary infection rate, and risk factors in a study of toxoplasmosis in 4,466 pregnant women in Japan. *Clin. Vaccine Immunol.*, 19(3): 365-367. doi: 10.1128/CVI.05486-11.
- [22]. Jones, J.L., Kruszon-Moran, D., Rivera, H.N., Price, C. & Wilkins, P.P. (2014). *Toxoplasma gondii* seroprevalence in the United States 2009-2010 and comparison with the past two decades. *Am. J. Trop. Med. Hyg.*, 90(6): 1135-1139. doi: 10.4269/ajtmh.14-0013.
- [23]. Cong, W., Dong, X.Y., Meng, Q.F., Zhou, N., Wang, X.Y., Huang, S.Y., Zhu, X.Q. & Qian, A.D. (2015). *Toxoplasma gondii* Infection in Pregnant Women: A Seroprevalence and Case-Control Study in Eastern China. *BioMed Res. Int.*, Article ID 170278. Doi: 10.1155/2015/170278.
- [24]. Flatt, A. & Shetty, N. (2013). Seroprevalence and risk factors for toxoplasmosis among antenatal women in London: a re-examination of risk in an ethnically diverse population. *Eur. J. Public Health*, 23(4): 648-652. doi: 10.1093/eurpub/cks075.
- [25]. Nissapatorn, V., Suwanrath, C., Sawangjaroen, N., Ling, L.Y. & Chandeying, V. (2011). Toxoplasmosis-serological evidence and associated risk factors among pregnant women in southern Thailand. *Am. J. Trop. Med. Hyg.*, 85(2): 243-247. doi: 10.4269/ajtmh.2011.10-0633.
- [26]. Ertug, S., Okyay, P., Turkmen, M. & Yuksel, H. (2005). Seroprevalence and risk factors for Toxoplasma infection among pregnant women in Aydin province, Turkey. *BMC Public Health*, 5: 66. doi:10.1186/1471-2458-5-66
- [27]. Rosso, F., Les, J.T., Agudelo, A., Villalobos, C., Chaves, J.A., Tunubala, G.A., Messa, A., Remington, J.S. & Montoya, J.G. (2008). Prevalence of infection with *Toxoplasma gondii* among pregnant women in Cali, Colombia, South America. *Am. J. Trop. Med. Hyg.*, 78: 504-508.
- [28]. Wilking, H., Thamm, M., Stark, K., Aebischer, T. & Seeber, F. (2016). Prevalence, incidence estimations, and risk factors of *Toxoplasma gondii* infection in Germany: a representative, cross-sectional, serological study. *Sci. Rep.*, 6: 22551. doi: 10.1038/srep22551.
- [29]. Sroka, S., Bartelheimer, N., Winter, A., Heukelbach, J., Ariza, L., Ribeiro, H., Oliveira, F.A., Queiroz, A.J., Alencar, C. Jr., Liesenfeld, O. (2010). Prevalence and risk factors of toxoplasmosis among pregnant women in Fortaleza, Northeastern Brazil. *Am. J. Trop. Med. Hyg.*, 83(3): 528-533. doi: 10.4269/ajtmh.2010.10-0082.
- [30]. Ayi, I., Edu, S.A., Apea-Kubi, K.A., Boamah, D., Bosompem, K.M. & Edoh, D. (2009). Seroprevalence of toxoplasmosis amongst pregnant women in the greater Accra region of Ghana. *Ghana Med. J.*, 43(3): 107-114.
- [31]. Aqeely, H., El-Gayar, E.K., Perveen Khan, D., Najmi, A., Alvi, A., Bani, I., Mahfouz, M.S., Abdalla, S.E., & Elhassan, I.M. (2014). Seroprevalence of *Toxoplasma gondii* amongst Pregnant Women in Jazan Province, Saudi Arabia. *J. Trop. Med.*, vol. 2014: 913950. doi: 10.1155/2014/913950.
- [32]. Elsafi, S.H., Al-Mutairi, W.F., Al-Jubran, K.M., Abu Hassan, M.M. & Al Zahrani, E.M. (2015). Toxoplasmosis seroprevalence in relation to knowledge and practice among pregnant women in Dhahran, Saudi Arabia. *Pathog. Glob. Health*, 109(8): 377-382. doi: 10.1080/20477724.2015.1103502.
- [33]. Almogren, A. (2011). Antenatal screening for *Toxoplasma gondii* infection at a tertiary care hospital in Riyadh, Saudi Arabia. *Ann. Saudi Med.*, 31(6):569-572. doi: 10.4103/0256-4947.87090.
- [34]. Almushait, M.A., Dajem, S.M., Elsherbiny, N.M., Eskandar, M.A., Al Azraqi, T.A. & Makhlof, L.M. (2014). Seroprevalence and risk factors of *Toxoplasma gondii* infection among pregnant

- women in south western, Saudi Arabia. *J. Parasit. Dis.*, 38(1): 4-10. doi: 10.1007/s12639-012-0195-z.
- [35]. Al-Mohammad, H.I., Amin, T.T., Balaha, M.H. & Al-Moghannum, M.S. (2010). Toxoplasmosis among the pregnant women attending a Saudi maternity hospital: seroprevalence and possible risk factors. *Ann. Trop. Med. Parasitol.*, 104(6):493-504. doi: 10.1179/136485910X12786389891443.
- [36]. Al-Qurashi, A.R., Ghandour, A.M., Obeid, O.E., Al-Mulhim, A. & Makki, S.M. (2001). Seroepidemiological study of *Toxoplasma gondii* infection in the human population in the Eastern Region. *Saudi Med. J.*, 22: 13-18.
- [37]. Kim, Y.H., Lee, J., Ahn, S., Kim, T.S., Hong, S.J., Chong, C.K., Ahn, H.J. & Nam, H.W. (2017). High Seroprevalence of Toxoplasmosis Detected by RDT among the Residents of Seokmo-do (Island) in Ganghwa-Gun, Incheon City, Korea. *Korean J. Parasitol.*, 55(1): 9-13. doi: 10.3347/kjp.2017.55.1.9.
- [38]. Alvarado-Esquivel, C., Rascón-Careaga, A., Hernández-Tinoco, J., Corella-Madueño, M.A., Sánchez-Anguiano, L.F., Aldana-Madrid, M.L., Velasquez-Vega, E., Quizán-Plata, T., Navarro-Henze, J.L., Badell-Luzardo, J.A., Gastélum-Cano, J.M. & Liesenfeld, O. (2016). Seroprevalence and Associated Risk Factors for *Toxoplasma gondii* Infection in Healthy Blood Donors: A Cross-Sectional Study in Sonora, Mexico. *Biomed Res. Int.*, 2016: 9597276. doi: 10.1155/2016/9597276.
- [39]. Cavalcante, G.T., Aguilar, D.M., Camargo, L.M., Labruna, M.B., de Andrade, H.F., Meireles, L.R., Dubey, J.P., Thulliez, P., Dias, R.A. & Gennari, S.M. (2006). Seroprevalence of *Toxoplasma gondii* antibodies in humans from rural Western Amazon, Brazil. *J. Parasitol.*, 92(3): 647-649.
- [40]. Gargaté, M.J., Ferreira, I., Vilares, A., Martins, S., Cardoso, C., Silva, S., Nunes, B. & Gomes, J.P. (2016). *Toxoplasma gondii* seroprevalence in the Portuguese population: comparison of three cross-sectional studies spanning three decades. *BMJ Open*, 6(10): e011648. doi: 10.1136/bmjopen-2016-011648.
- [41]. Mahdy, M.A., Alareqi, L.M., Abdul-Ghani, R., Al-Eryani, S.M., Al-Mikhlaflay, A.A., Al-Mekhlafi, A.M., Alkarshy, F. & Mahmud, R. (2017). A community-based survey of *Toxoplasma gondii* infection among pregnant women in rural areas of Taiz governorate, Yemen: the risk of waterborne transmission. *Infect. Dis. Poverty.*, 6(1): 26. doi: 10.1186/s40249-017-0243-0.
- [42]. Liesenfeld, O., Press, C., Montoya, J.G., Gill, R., Isaac-Renton, J.L., Hedman, K. & Remington, J.S. (1997). False-positive results in immunoglobulin M (IgM) toxoplasma antibody tests and importance of confirmatory testing: the Platelia Toxo IgM test. *J. Clin. Microbiol.*, 35: 174-178.
- [43]. Dhakal, R., Gajurel, K., Pomares, C., Talucod, J., Press, C.J. & Montoya, J.G. (2015). Significance of a Positive Toxoplasma Immunoglobulin M Test Result in the United States. *J. Clin. Microbiol.*, 53(11): 3601-3605. doi: 10.1128/JCM.01663-15.
- [44]. Konishi, E. (1987). A pregnant woman with a high level of naturally occurring immunoglobulin M antibodies to *Toxoplasma gondii*. *Am. J. Obstet. Gynecol.*, 157: 832-833.
- [45]. Sensini, A. (2006). *Toxoplasma gondii* infection in pregnancy: opportunities and pitfalls of serological diagnosis. *Clin. Microbiol. Infect.*, 12: 504-512.