

SEROPREVALENCE AND RISK FACTORS OF TOXOPLASMOSIS AMONG UNDERGRADUATE FEMALE STUDENTS OF UNIVERSITY OF DUHOK

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ABSTRACT

Toxoplasmosis is a zoonotic infection caused by *Toxoplasma gondii* parasite. University female students are at the age of childbearing and their status of *T. gondii* infection is important. Thus, early detection and therapy are of extraordinary importance. Therefore, this study aimed to find out the seroprevalence of *Toxoplasma gondii* infection among undergraduate female students of University of Duhok. A cluster stratified sampling procedure was used for each college in Duhok University and a proportionate number pulled from each stratum as a simple random sampling procedure. So, the four hundred ninety-six (496) serum samples were collected from November 2017 to February 2018. A questionnaire was used to collect socio-demographic and risk factors-related data. The venous blood specimens were examined for anti-*Toxoplasma gondii* antibodies by using Enzyme-linked Immunosorbent assay to detect Anti-Immunoglobulin G and M related to *Toxoplasma gondii*. Analyzing data were done through the application of SPSS software (Version 23 IBM). The finding of the present study revealed that the mean age of respondents was 21 years (SD \pm 1.668). Besides, 220 (44.4%) were found out to be seropositive for *Toxoplasma gondii* Anti-Immunoglobulin G and 55 (11.1%) for Anti-Immunoglobulin M antibodies. In addition, the more dominant risk factors that rose throughout the present study were among those they do not have information regarding toxoplasmosis and took raw or undercooked meat. Likewise, the prevalence of *Toxoplasma gondii* infection was high in female students at University of Duhok.

KEYWORDS: Seroprevalence, Risk Factors, Toxoplasma Gondii, Undergraduate Female Students

1. INTRODUCTION

Toxoplasmosis has been considered one of the most important zoonotic diseases resulted from exposure to protozoan known as *Toxoplasma gondii* (*T. gondii*) (Jilo and Adem, 2016). This disease has distribution along the world. The humans' exposure to this parasite around one-third, while the great variance of seroprevalence among countries and population group (Hadi *et al.*, 2016). Many warm-blooded animals such as humans, rodents and birds can act as intermediate host. But domestic cat acts as a main (Ebrahimzadeh *et al.*, 2013).

Different types of factors have been involved in toxoplasmosis transmission; the ingestion of meat (beef, mutton or pork) in different parts of the world which contain parasite cysts is the important common source of human infection. Many studies reported the higher prevalence among women at childbearing age and college

student as mentioned by Obaidat *et al.*, (2014) in Jordon, Al-Sadoon *et al.*, (2018) in Basra province in Iraq that have shown a different prevalence rate of toxoplasmosis among female students 66.5% and 11.3% respectively., although children are more exposed to the sources of transmission of this parasite (Avelino *et al.*, 2004).

Toxoplasma passes through three stages during its life cycle, at the acute stage of the infection Tachyzoite develops and multiply in the cell, through latent period of infection Bradyzoite produce the tissue cysts as a second stage, as a third stage the sporozoite develop in the mature Oocyst to resist environmental conditions (Al-Hadraawy and Hadi, 2017).

Human is one of the mammals that can be infected with toxoplasmosis. Often it is through three ways. The first way is through food. Where a person is infected by eating uncooked meat or cooked incorrectly and contaminated with

parasites cyst. The second method is transmission from animal to human. The infection occurs when a person ingest oocysts during direct contact with the cat feces or contaminated soil and food or water contaminated with such oocysts. The third way is through mother-fetus transmission (Alzaheb and Al-Amer, 2017).

People with immunocompetent, toxoplasmosis are generally asymptomatic, while symptomatic infections usually cause a low-grade fever, malaise, headache and cervical lymphadenopathy. A Severe manifestations are rare such as (myocarditis, encephalitis, pneumonia, and hepatitis) but they can increase complication of acute toxoplasmosis (Bassad and Al-Aboody, 2015; Sadoogian *et al.*, 2017).

Presenting of paramount strategy for prevention of congenital toxoplasmosis can be through detection of maternal-fetal infection. Diagnosis of disease can achieved through serological screening, it is preferable to detect *T.gondii* IgG and IgM antibodies. Vertical transmission risk and consequence of disease on the newborn can be reduced by early diagnosis and appropriate management (Paul, 2017).

Spontaneous abortion occurs as a result of infection during pregnancy and many other complications, including intrauterine death, amniotic fluid disorders, hydropsfoetalis, and hydrocephalus in addition to neurological disorders such as blindness, chorioretinitis, and mental retardation (Oboro *et al.*, 2016). Wherefore, in the pregnant women, early detection of acquired infection is critical for clinical management for both mother and her fetus (Bakre, 2016).

Worldwide, different countries reported that seroprevalence in women within the age of childbearing distributed between four to 100%. Such as, Obaid *et al.*, (2017) in Kirkuk city in Iraq; Al Kadassy *et al.*, (2018) in Yemen; Alzahib and Al-Amer (2017) which shown a different prevalence rate of toxoplasmosis among female students 11%, 14.5% and 9.4% respectively. Moreover, in Iraq and many countries of Middle Eastern and North African, the information related to *T.gondii* infection is scanty. In these countries, toxoplasmosis as a zoonotic disease is omitted, that's why the level of infection among female of childbearing age is unknown (Obaidat *et al.*, 2014). The current study aimed to find out the seroprevalence of

Toxoplasma gondii infection among undergraduate female students of University of Duhok.

2. SUBJECT AND METHODS

2.1. Study design

The cross-sectional study design was to achieve the aim and objectives of this study at all the colleges of University of Duhok.

2.2. Sample of the study

The general population of the present study was (10008) undergraduate female students in the University of Duhok, while the total number was (496) female students which included in the study were selected depending on their agreement to participate in the present study.

2.3. Sampling of the study

A probability method was used for sampling them as a cluster, All female students (10008) classified in to (58) categories then 5% of the available female students was taken from each strata by simple random sampling the names of all students and colleges had been written in a paper and from which simple random samples where used to choose female students.

2.4. The period of performing the study

All clusters are gathered from 27th through November 2018 28th February 2019. The 496 blood samples were collected from undergraduate female students at University of Duhok. This period included visits to all colleges in the University of Duhok and interviewing participants.

2.5. Tools of data collection

The tools of data collection which were used for the benefit of the current study were as follow: The questionnaire used for students' data collection was constructed throughout the review of relative kinds of literature which covers two parts. The first part deals with the socio-demographic information as (age, college, class, marital status, residency and religion) and the other part concerns with female students' risk factors related to toxoplasmosis, which includes 9 questions. The instruments were used for blood sample collection, equipment's and also ELISA kits in order to detecting the seroprevalence of *Toxoplasma gondii*.

2.6. Data collection procedure

The process of data collection was through applying two techniques, the first one was direct

interview technique to obtain the student-related information and the second one was through getting a blood sample to detect the female student seroprevalence of toxoplasmosis. 3 ml of venous blood was taken in a 5 ml sterile disposable syringe were drawing from the radial vein of each person by using disposable syringes. The blood sample was placed in a plain tube and labeled, with full information named (code number and college name-department) the blood samples were transported to the clinical laboratory at the directorate of veterinary by cool boxes. Serum was separated from blood by centrifugation for 10 minutes at 3000 rpm at room temperature. And then sera were dispensed into 1ml Eppendorf-tubes by using micropipette and stored at -20°C until being screened for *Toxoplasma* antibodies. The detection of *T. gondii* antibodies was achieved by using the Automated Enzyme-linked Immunosorbent Assay (ELISA). This work was performed in the Directorate of Veterinary Laboratory.

2.7. Validity of the questionnaire

The validity of the study questioner was approved and determined through the utilization of the panel of (6) experts from different related specialists.

2.8. Data analysis

All collected data related demographic information and laboratory test results were entered to SPSS statistics software version 23 IBM. These data were analyzed through the application of Descriptive statistics as frequency, percentage, mean and standard deviation. And inferential statistics as Chi-square and Fisher Exact Test to find out the association between students' demographic variables with their

seroprevalence results of *Toxoplasma gondii* at $P. \text{Value} \leq 0.05$.

2.9. Limitation of the study

The limitation that the researcher faced at first, the period of sampling of the study was extended because of summer vacation and also the process of data collection was stopped between December, 18th 2018 through January, 6th 2019 because the students were engaged in the midterm exam and Christmas vacation. In addition to above The ELISA kits that used for detecting *Toxoplasma gondii* infection were expensive.

2.10. Ethical consideration

This study had approved by the Scientific Committee of Nursing College in University of Duhok as well it approved by the University of Duhok. Finally, this research had been approved by the Research Ethical Committee in the General Directorate of Health in Duhok governorate. Document informed consent was obtained from female students to participate in the present study after taken it from their colleges in University of Duhok.

3. Results of the study

A total of 496 undergraduate female students in different classes of college were enrolled in this study and according to data analysis of the present study table (1) shows that the main age group of the subjects was 17-21 years 328 (66.1%). Most of the students 391 (78.8%) were from the urban area,

while 105 (21.2%) were from rural areas, 445 (89.7%) were single, compared to 51 (10.3%) were married, and 442 (89.1%) of the participants were Muslim.

Table (1): Distribution of undergraduate female student's socio-demographic characteristics

Socio-demographic characteristics		Freq. (%)	Mean (\pm SD)
Age of the Students	17-21 years	328 (66.1)	21.03(1.668)
	22-26 years	163 (32.9)	
	27-more years	5 (1)	
Students' Class	First Class	105 (21.2)	
	Second Class	157 (31.7)	
	Third Class	119 (24.0)	
	Fourth Class	104 (21.0)	
	Fifth Class	8 (1.6)	
	Sixth Class	3 (.6)	
Marital status of the students	Single	445 (89.7)	
	Married	51 (10.3)	
Students' residential area	Urban	391 (78.8)	
	Rural	105(21.2)	

Students' religion	Muslim	442 (89.1)
	Christian	9 (1.8)
	Yazidis	45 (9.1)

Table (2) shows that more than two third of the participants 343 (69.2%) have been heard and seen information about toxoplasmosis, and did not have a cat or kitten at home 396 (79.8%). Out of total participants, the majority of them ate beef meat 449 (90.5%), However, More than half of them did not took raw or undercooked

meat and raw or unwashed fruit or vegetables 284 (57.3%) for both, took fresh unpasteurized or un-boiled animal milk 259 (52.2%), and did not had contact with garden soil 274 (55.2%). In addition to all above, only 1 (.2%) made organ transplantation and 13 (2.6%) received blood.

Table (2): Distribution of risk factors related toxoplasmosis among undergraduate female students

Risk Factors		Freq. (%)
Have you ever heard or seen Information about toxoplasmosis	No	153 (30.8)
	Yes	343 (69.2)
Having cat or kitten	No	396 (79.8)
	Yes without close contact	28 (5.6)
	Yes with close contact	72 (14.5)
Eating meat	No	41 (8.3)
	Beef	449(90.5)
	Mutton meat	2 (0.4)
	Goat meat	4 (0.8)
Raw or undercooked meat	No	284 (57.3)
	Sometimes	84 (16.9)
	Yes	128 (25.8)
fresh unpasteurized or un-boiled animal Milk	No	237 (47.8)
	Yes	259 (52.2)
Raw or unwashed Fruit or vegetables	No	284 (57.3)
	Yes	212 (42.7)
Contact with garden Soil	No	274 (55.2)
	Yes	222 (44.8)
Organ transplant	No	495 (99.8)
	Yes	1 (0.2)
Received blood	No	483 (97.4)
	Yes	13 (2.6)

Table (3) indicates that out of 496 undergraduate female students showed a positive reaction to anti-*Toxoplasma* test as 220 (44.4%)

for IgG with mean and SD 26.11 (32.506), and 55 (11.1) for IgM with mean and SD 0.832 (0.482).

Table (3): Distribution of female students by their Seroprevalence test

Seroprevalence test		Freq. (%)	Mean (±SD)
IgG	Negative (< 9 U/ml)	272 (54.8)	26.11 (32.506)
	Equivocal (9-10 U/ml)	4 (0.8)	
	Positive (> 10 U/ml)	220 (44.4)	
IgM	Negative (< 0.9)	340 (68.5)	0.832 (0.482)
	Equivocal (0.9-1.1)	101 (20.4)	
	Positive (> 1.1)	55 (11.1)	

Table (4) presents the no-significant association between students' age, residential area and religion with anti-*Toxoplasma gondii* IgG test, the study showed that the prevalence of acute *T.*

gondii infection was more prevalent in students who were married (60.8%) compared to those who were single(42.5%).

Table (4): Association of students' certain socio-demographic variables with anti-*Toxoplasma gondii* antibodies IgG

Socio-demographic Variables	Sample No.	IgG			P. Value
		Negative (%)	Equivocal (%)	Positive (%)	
Age	17-21	328	182 (55.5)	2 (0.6)	0.097**
	22-26	163	90 (55.2)	2 (1.2)	
	27-More	5	0 (0)	0 (0)	
Marital status	Single	445	252 (56.6)	4 (0.9)	0.044**
	Married	51	20 (39.2)	0 (0)	
Residential area	Urban	391	217(55.6)	3 (0.76)	0.725**
	Rural	105	55 (52.4)	1 (0.9)	
Religion	Muslim	442	243 (55.0)	3 (0.7)	0.315**
	Christian	9	3 (33.4)	0 (0)	
	Yazidis	45	26 (57.8)	1 (2.2)	

* Chi Square

** Fisher Exact Test

** Fisher Exact Test

Table (5) depicts a highly significant association between students' residential area and religion with anti-*Toxoplasma gondii* IgM.

While a no-significant association between their age and marital status with such test.

Table (5): Association of students' certain socio-demographic variables with anti-*Toxoplasma gondii* antibodies IgM

Socio-demographic Variables	Sample No.	IgM			P. Value
		Negative (%)	Equivocal (%)	Positive (%)	
Age	17-21	328	232 (70.7)	66 (20.1)	0.249**
	22-26	163	105 (64.4)	34 (20.8)	
	27-More	5	3 (60)	1 (20)	
Marital status	Single	445	307 (69)	93 (20.9)	0.108*
	Married	51	33(64.7)	8 (15.7)	
Residential area	Urban	391	288 (73.7)	76(19.4)	≤ 0.001*
	Rural	105	52 (49.6)	25(23.8)	
Religion	Muslim	442	311 (70.4)	91(20.6)	0.001**
	Christian	9	6 (66.7)	0 (0)	
	Yazidis	45	23 (51.1)	10 (22.2)	

* Chi Square

** Fisher Exact Test

4. DISCUSSION OF THE RESULTS

This study assessed the seroprevalence of *T. gondii* infection and associated risk factors among undergraduate female students at University of Duhok.

According to the present study results, out of 496 female university students from different ages enrolled in this study.

The current study revealed that the seroprevalence rate of *T.gondii* infection was 44.4% 220 out of 496

undergraduate female students by ELISA test, which shows a positive result for anti-*Toxoplasma gondii* antibodies (IgG) and indicates previous exposure to *T.gondii*. The results of the current study disagree with the results of Al-Atroshi and Mero (2013) in Duhok governorate who reported the low seroprevalence rate 27.7% among 1146 females within the childbearing age. Another study was done in Erbil province in Kurdistan by Hamad and Kadir (2013) found that 37.5% of 208 female within child-bearing age had *T.gondii*

infection. Further study by Al-Kadassy *et al.*, (2018) estimated that about 14.5% of 90 women of childbearing age at the Faculty of Medicine and Health Sciences, were had positive *T.gondii* IgG infection test in Al-Hodeida City Yemen. On the other hand, studies that have shown a high prevalence rate of anti-*Toxoplasma gondii* antibodies (IgG) in other countries compared to the results of the current study. Additional study was applied on 202 undergraduate university female students in Jordan and found that carrier rate was 66.5% (Obaidat *et al.*, 2014), Also In North of Portugal, the prevalence of *T. gondii* by IgG test among 401 women through their childbearing years was about 93.9 % seropositive for IgG (Lopes *et al.*, 2012). Moreover, Gebremedhin *et al.*, (2013) recorded the high seroprevalence rate of 78.4% of 425 childbearing age women in central Ethiopia.

Among all tested female students' sera of University of Duhok, anti-*T.gondii* IgM seroprevalence was 11.1% 55 out of 496. The significance of the seropositive *T.gondii* IgM antibodies indicates recent exposure to *T.gondii* among female students. This result coincides with results reported in different cities in Iraq. A study by Obaid (2017) investigated 190 undergraduate university students in Kirkuk, detected positive *T.gondii* IgM in 11% of them. Moreover, the result of the current study roughly consistent with the result found out by Hamad and Kadir (2013) when they determined the prevalence of *Toxoplasma gondii* through using different techniques among 208 women of child-bearing age in Erbil governorate followed by ELISA IgM 9.13%. However, the present result is lower than the results which were reported in Romania 57.6 % of 184 participants (Olariu *et al.*, 2008). Besides, in Yemen, the seroprevalence of *Toxoplasma gondii* was about 14.4 % of 90 childbearing age women (Al-Kadassy *et al.*, 2018). On the other hand, the current study result is higher than the results reported by several researchers in many countries. Al-Sadoon *et al.*, (2018) conducted a study on 177 female students in Basra Province, and they found the prevalence of IgM antibodies was 1.13% among them. Furthermore, Passos *et al.*, (2018) investigated 970 adults in a small Brazilian city,

and they detected 2.5% *T.gondii* IgM antibodies among them.

This result represents the real situation of the endemic in our country with the present of many risk factors and poor preventive measures. The reason of the higher rate in the current study could be associated with: the nutritional habits that have taken place in this region during the last few years, the wide access to fast-foods and pre-prepared meals, including frozen meat meals, and the decreasing number of home-prepared meals, may have contributed to the overall exceeds in *T. gondii* acquisition among younger women; the lack of awareness of disease sources of transmission is a crucial factor in the risk of infection; the climatic factors, seroprevalence may also depend on the appropriate conditions for sporulation and oocysts survival in the environment, as oocysts maturation and transmission to a new host is faster at mild and wet climates; and the release of legislation for *T.gondii* infection concerning sanitary inspection in the slaughterhouses .

Considering marital status and its association with the distribution of seropositive of *Toxoplasma gondii* antibodies, a statistical association was found with IgG antibodies while not found with IgM antibodies. This study contradicts with the study has been done by Hamad and Kadir (2013) in Erbil, Kurdistan region among women and Alzahib and Al-Amer (2017) in Saudi Arabia related to (seroprevalence and risk factors of Toxoplasmosis among university student female) they observed a significant relationship between marital status and prevalence of *T.gondii* seropositivity. The high rate of seroprevalence of IgG antibodies in married students may be due to more responsibility of married students about, gestation, birth and child rearing which affect their health and lower their immunological status which make them more susceptible to infection.

5. CONCLUSION

Throughout the study progression, data analysis and discussion, the current study concluded that: The higher prevalence rate of IgM was found in the sample study of the college students who were include in this study. The study found the statistically significant higher prevalence of IgG in married students.

6. RECOMMENDATION

Establishing an educational program related to preventive measure for toxoplasmosis and its consequence at all levels of community especially the targeted information should be crucially provided to childbearing and pregnant women by the health professionals such as Doctors, public health specialists, veterinarians, and even wildlife biologists regarding consumption of uncooked or cured meat, raw vegetables, contaminated drinking water and should know to caution the public to always wash hands after working in any soil where cat feces may be found. There is no approved vaccine to prevent human or animal toxoplasmosis; therefore, primary prevention is the major tool to prevent the infection in the general population, mainly in high-risk individuals, such as immunocompromised, pregnant and childbearing women. Besides these primary prevention measures, there are several actions that will determine the prevention and control of *T. gondii* infection, including the governmental inspection of slaughterhouses and food production industries, the improvement of hygienic standards of abattoirs, the promotion of public educational schemes and *Toxoplasma gondii* screening test should be included with investigations for premarital screening. Considering the outcome and health implications of this investigation, there is the need for further studies to determine the prevalence of toxoplasmosis among groups of people such as pregnant women and women of childbearing age and the general population.

REFERENCES

- Al Rashada, N., Alqarash, Z., Alshehri, F., Alkhamees, L., Alshqaqeeq, A. (2016). Toxoplasmosis among Saudi female students in Al-Ahssa, Kingdom of Saudi Arabia: Awareness and risk factors. *Open Journal of Preventive Medicine*; 6, 187-195. Available from: <http://dx.doi.org/10.4236/ojpm.2016.68018>.
- Al-Atroshi, A.A., Mero, W.M. (2013). Seroprevalence of Anti-*Toxoplasma* Antibodies Among Women of Child Bearing Age in Duhok Province. *Science Journal of University of Zakho*; 1(1):44-49.
- Al-Hadraawy, S. K., Hadi, F.A. (2017). Immunological and Molecular Study of *Toxoplasma gondii* in Al-Najaf Governorate-Iraq. *International Journal of Pharmacognosy and Phytochemical Research*; 9(4):482-492. Available from: DOI: 10.25258/phyto.v9i2.8118
- Al-Kadassy, A.M., Baraheem, O.H., Bashanfer, S.A. (2018). Prevalence of *Toxoplasma gondii* infection in women of child-bearing age in faculty of Medicine and health sciences Hodeida City, Yemen. *The Pharma Innovation Journal*; 7(9):256-261.
- Al-Sadoon, M.A., Nasir M.A., Yasir, E.T., Khalaf, A.O., Kadim, S.J. (2018). Toxoplasmosis and risk factors among female students of medical colleges at Basra University, Iraq. *Biomedical and Pharmacology Journal*; 11(4): 2117-2122. Available from: <http://biomedpharmajournal.org/?p=24295>.
- Alzaheb, R. A., Al-Amer, O. (2017). The seroprevalence and risk factors of toxoplasmosis among female undergraduate University students in Saudi Arabia. *Oman med J*; 32(6): 486-491. Available from: DOI: 10.5001/omj.2017.93
- Avelino, M.M., Campos Júnior, D., Parada, J.B., Castro, A.M. (2004). Risk factors for *Toxoplasma gondii* infection in women of childbearing age. *Brazilian Journal of Infectious Diseases*; 8(2):164-174. Available from: <http://dx.doi.org/10.1590/S1413-86702004000200007>
- Bakre, H.M. (2016). Serological tests and polymerase chain reaction for detection of *Toxo-plasma gondii* infection in women attending for premarital examination. *Zanco J Med Sci*; 20(3):1476-1484. Available From: <http://dx.doi.org/10.15218/zjms.2016.0047>
- Bassasd, Al-AboodyA. (2015). Prevalence Study of Toxoplasmosis among Males. *Impact Journals*; 3(11): 73-82. Available from: <http://oaji.net/articles/2015/491-1449836795.pdf>.
- Ebrahimzadeh, A., Mohammadi, S., Salimi-Khorashad, A., Jamshidi, A. (2013). Seroprevalence of Toxoplasmosis among pregnant women referring to the reference laboratory of Zahedan, Iran. *ZJRMS*; 15(12): 32-35. Available from: <https://www.researchgate.net/publication/264042933>
- Galván-Ramírez, M.L., Pérez, L.R., Agraz, S. Y., Ávila, L.M., Ruíz, A.S, Corella, D.B. et al. (2010). Seroepidemiology of toxoplasmosis in high-school students in the metropolitan area of Guadalajara, Jalisco, Mexico, *ScientiaMedica*; 20(1): 59-63.

- Gebremedhin, E.Z., Abebe, A.H., Tessema, T.S., Tullu, K.D., Medhin, G., Vitale, M. *et al.* (2013). Seroepidemiology of *Toxoplasma gondii* infection in women of child-bearing age in central Ethiopia. *BMC Infectious Diseases*; 13(1): 101.
- Hadi, H.S., Kadhim, R.A., Al-Mammori, R.T. (2016). Seroepidemiological aspects for *Toxoplasma gondii* infection in women of Qadisiyah province, Iraq. *IJ PRIF*; 9(11): 252-259. Available from: <https://www.researchgate.net/publication/311693295>
- Hamad, N.R., Kadir, M.A. (2013). Prevalence and comparison between the efficiency of different techniques for diagnosis of *Toxoplasma gondii* among women in Erbil province- Iraqi Kurdistan. First Annual International Interdisciplinary Conference, Azores, Portugal.
- Jilo, K., Adem, J. (2016). Toxoplasmosis and its Current Status in Ethiopia: A Review. *Global Veterinaria*; 17(2): 35-141. Available from: DOI: 10.5829/idosi.gv.2016.17.02.10432
- Kalantari, N., Ghaffari, S., Bayani, M., Nouri, M., Yahyapour, Y. (2017). Evaluation of seroprevalence and seroconversion rates of *Toxoplasma gondii* infection in female students at Babol University of Medical Sciences, Babol, Iran. *Caspian Journal of Reproductive Medicine*; 3(1):12-17. Available from: <http://casprjrm.ir/article-1-108-en.html>.
- Lopes, A.P., Dubey, J.P., Moutinho, O., Gargaté, M. J., Vilares, A., Rodrigues, M. *et al.* (2012). Seroepidemiology of *Toxoplasma gondii* infection in women from the North of Portugal in their childbearing years. *Epidemiology & Infection*; 140(5):872-877. Available from: DOI: 10.1017/S0950268811001658.
- Obaid, H.M. (2017). Survey study on toxoplasmosis among Kirkuk university students. *Journal of Kerbala University*; 15(1):253-259.
- Obaidat, M.M., Al-Sheyab, N.A., Salman, A.B. Lafi, S.Q. (2014). Seroepidemiology and risk factors of *Toxoplasma gondii* infection in undergraduate university female students in Jordan. *Epidemiology & Infection*; 143(9):1898-1903. Available from: DOI: <https://doi.org/10.1017/S0950268814003604>
- Oboro, I.L., Obunge, O.K., Wariso, K.T. (2016). Sero-epidemiology of Toxoplasmosis among pregnant women in the University of Port Harcourt Teaching Hospital, Nigeria. *Nigerian Health Journal*; 16(1). Available From: <https://www.ajol.info/index.php/nhj/article/download/149473/138977>
- Olariu, T.R., Darabus, G.H., Cretu, O., Jurovits, O., Giura, E., Erdelean, V. *et al.* (2008). Prevalence of *Toxoplasma gondii* antibodies among women of childbearing age in Timis County. *Lucrări Stiințifice Medicină Veterinară*; 41:367-371.
- Passos, A.D., Bollela, V.R., Furtado, J.M., Lucena, M.M., Bellissimo-Rodrigues, F., Paula, J.S. *et al.* (2018). Prevalence and risk factors of toxoplasmosis among adults in a small Brazilian city. *Revista da Sociedade Brasileira de Medicina Tropical*; 51(6):781-787. Available from: <http://dx.doi.org/10.1590/0037-8682-0214-2017>.
- Paul, E. (2017). Sero-prevalence and risk factors for *Toxoplasma gondii* infection among pregnant women attending antenatal clinic at Kilimanjaro Christian Medical Centre in Northern Tanzania. M.Sc. thesis. Tumaini University Makumira Kilimanjaro.
- Sadooghian, S., Mahmoudvand, H., Mohammadi, A. M., Sarcheshmeh, N. N., Kareshk, A. T., Kamiabi, H. *et al.* (2017) Prevalence of *Toxoplasma gondii* infection among healthy blood donors in Northeast of Iran. *Iran J Parasitol*; 12(4): 554-562. Available From: <http://ijpa.tums.ac.ir>