



Investigating the Toxoplasmosis Seroprevalence in Pregnant Women from Turkey by Pool Analyses Method

Türkiye'deki Gebelerde Toxoplasmosis Seroprevalansının Havuz Analiz Yöntemiyle Araştırılması

Emine Kübra Dindar Demiray¹, Sevil Alkan², Adnan Barutcu³, Alper Tahmaz⁴

¹Bitlis State Hospital, Department of Infection Diseases and Clinical Microbiology, Turkey

²Çanakkale Onsekiz Mart University, School of Medicine, Department of Infection Diseases and Clinical Microbiology, Turkey

³Çukurova University Faculty of Medicine, Department of Pediatrics, Department of Social Pediatrics, Adana, Turkey

⁴University of Health Sciences, Antalya Training and Research Hospital, Turkey

ABSTRACT

Aim: Toxoplasmosis in pregnancy may cause ophthalmologic and neurological sequelae in the fetus. However, this screening is not clearly included in routine screening protocols in our country. Therefore, there is no general information about the exact prevalence of the disease. In this study, it was aimed to evaluate the toxoplasmosis seroprevalence studies conducted in Turkey during pregnancy using the pool analysis method and to highlight the difference in disease seroprevalence between regions.

Material and Method: Published literature in English and Turkish language on toxoplasmosis seroprevalence in pregnancy from Turkey in last 30 years were evaluated. Four international databases were scanned by using the keywords "Toxoplasmosis" OR "*Toxoplasma gondii*" OR "TORCH" and "seroprevalence" OR "IG G" and "pregnant women" OR "pregnancy" OR "pregnant" and "Turkey" or "Turkish". The publications were evaluated in terms of the general frequency, city, region, year, sample size, diagnostic method. Conference papers were not included in the study. Studies involving refugee women in the sample group were excluded.

Results: A total number of 58 studies and 256612 test results were included. ELISA (n=22) was the most preferred laboratory diagnostic method. The average Anti-Toxo IgG seroprevalence rate in the pregnant population in Turkey was found to be 36.76%. And the average of Anti-Toxo IgM rate was found to be 2.91%. As a result of our study, the highest Anti-Toxo IgG test results were; It was found in studies conducted in Southeastern Anatolia (59.43%), Mediterranean (43.95%) and Eastern Anatolia (40.89%). The regions with the lowest Anti-Toxo IgG test results are respectively; Aegean Region (30.25%), Marmara Region (31.21%) and Black Sea Region (31.80%). Anti-Toxo IgM ratios are highest respectively; It was detected in Aegean Region (5.65%), Mediterranean Region (2.77%) and Southeastern Anatolia (2.21%).

Conclusion: It has been determined that western Turkey (Aegean Region) is riskier in terms of congenital toxoplasmosis due to its high susceptibility to *Toxoplasma* infection associated with low toxoplasma seroprevalence compared to the east, and it is considered important to perform at least region-based prenatal toxoplasma screening to prevent this.

Keywords: *Toxoplasma gondii*, Toxoplasmosis, Turkey, seroprevalence

ÖZ

Amaç: Gebelikteki toxoplasmozis fetüste nörolojik sekellere neden olabilir. Ancak ülkemizde bu tarama rutin olarak yapılmamaktadır. Bu nedenle hastalığın net prevalansına dair bir genel bilgi mevcut değildir. Bu çalışmada ülkemizden yapılan gebelikte toxoplasmozis seroprevalans çalışmalarını havuz analiz yöntemi ile değerlendirmeyi ve bölgeler arasındaki hastalık seroprevalans farkını gözler önüne koymak amaçlandı.

Gereç ve Yöntem: Türkiye'de son 30 yılda gebelikte toksoplazmoz seroprevalansı ile ilgili İngilizce ve Türkçe yayınlanmış literatür değerlendirildi. "Toxoplasmosis" veya "*Toxoplasma gondii*" veya "TORCH" ve "seroprevalans" VEYA "IG G" ve "hamile kadınlar" veya "gebelik" veya "hamile" ve "Türkiye" anahtar kelimeleri kullanılarak dört uluslararası veritabanı tarandı. Yayınlar genel prevalans, şehir, bölge, yıl, örneklem büyüklüğü, tanı yöntemi açısından değerlendirildi. Konferans bildirileri çalışmaya dahil edilmemiştir. Mülteci kadınların örneklem olduğu çalışmalar hariç tutuldu.

Bulgular: Toplam 58 çalışma ve 256612 test sonucu dahil edildi. ELISA (n=22) en çok tercih edilen laboratuvar tanı yöntemiydi. Türkiye'deki gebe popülasyonda ortalama Anti-Toxo IgG seroprevalans oranı %36,76 olarak bulundu. Anti-Toxo IgM oranı ise ortalama %2,91 olarak bulundu. Çalışmamız, en yüksek Anti-Toxo IgG testi sonucu; Güneydoğu Anadolu (%59,43), Akdeniz (%43,95) ve Doğu Anadolu (%40,89) bölgelerinde saptandı. Anti-Toxo IgG test sonuçları en yüksek olan bölgeler; Ege Bölgesi (%30,25), Marmara Bölgesi (%31,21) ve Karadeniz Bölgesi (%31,80) idi. Anti-Toxo IgM test sonuçları en yüksek olan bölgeler ise; Ege Bölgesi (%5,65), Akdeniz Bölgesi (%2,77) ve Güneydoğu (%2,21) Anadolu Bölgesi olarak saptandı.

Sonuç: Türkiye'nin batısında (Ege Bölgesi), doğuya kıyasla düşük toksoplazma seroprevalansı ile ilişkili yüksek toksoplazma enfeksiyonu duyarlılığı nedeniyle, konjenital toksoplazmoz riskini önleme amaçlı, en azından bölge tabanlı prenatal toksoplazma taraması yapılmalıdır.

Anahtar kelimeler: *Toxoplasma gondii*, Toxoplasmosis, Türkiye, seroprevalans

Corresponding Author: Emine Kübra DİNDAR DEMİRAY

Address: Bitlis State Hospital, Department of Infection Diseases and Clinical Microbiology, Turkey

E-mail: e.kubradindar@hotmail.com

Başvuru Tarihi/Received: 23.11.2021

Kabul Tarihi/Accepted: 5.01.2022



INTRODUCTION

Toxoplasma gondii infection is a common zoonosis globally. Toxoplasmosis, which has a latent course in individuals with a healthy immune system, is an indirectly life-threatening disease in patients with pregnancy and immunodeficiency (1). It is more common in hot and humid places than in dry places. Infection in humans is most commonly seen congenitally by consuming raw or undercooked meat containing tissue cysts, consuming water and foods contaminated with oocysts, or by transplacental route from mothers infected during pregnancy (1,2). The risk of mother-to-child transmission of *T. gondii* during pregnancy is much higher in women exposed to primary *T. gondii* infection (toxoplasmosis) after conception, compared to those exposed to infection before conception (1,2-7).

In the United States, approximately 1 in 10,000 live births will develop congenital toxoplasmosis. Although multifactorial in etiology, maternal infection is primarily attributed to the consumption of contaminated meat or water. Infection and transmission to the fetus can cause devastating neurological disorders. Screening methods should be applied to all pregnant women in routine antenatal care (3-7). However, this screening is not routinely performed in our country. Therefore, there is no general information on the net prevalence of the disease.

The published studies are local studies. In this study, it was aimed to evaluate the studies on toxoplasmosis seroprevalence in pregnancy with the pool analysis method and to highlight the difference in disease seroprevalence between regions.

MATERIAL AND METHOD

Published literature in English and Turkish language (full text articles or detailed abstracts) on toxoplasmosis seroprevalence in pregnancy from Turkey in last 30 years were evaluated.

Pubmed, Google Scholar, The Web of Science, The Scopus databases were scanned by using the keywords "Toxoplasmosis" OR "*Toxoplasma gondii*" OR "TORCH" and "seroprevalence" OR "IG G" and "pregnant women" OR "pregnancy" OR "pregnant" and "Turkey" OR "Turkish". The publications were evaluated in terms of the general frequency, city, region, year, sample size, diagnostic method. Conference papers were not included in the study. Studies in which refugee women were samples were excluded.

The data obtained were analyzed using Statistical Package for the Social Sciences (SPSS) for Windows Version 23.0 software (SPSS Inc., Chicago, IL, USA). Data

were reported as mean ± standard deviation values, number and percentage. Descriptive statistics were used in the statistical evaluation.

Ethics approval: Since the literature research study was used in the research, ethics committee approval is not required.

RESULTS

A total number of 58 studies and 256612 test results were included according to search criteria (6-85). The average number of tests were 4501.96.

In two of the studies the number of testes were less than 100, in 7 of the studies was between 100-500, in 6 of the was between 501-1000, 15 of them between 1001-2000, 15 of them 2001-5000, four of them 5001-10000, 8 of them above 10001.

Enzyme-linked immunosorbent assay (ELISA) (n=22) was the most preferred laboratory diagnostic method. Immunofluorescence (IFA) (n=2), Chemiluminescent immunoassay (CLIA) (n=9), Enzim Immun Assay (EIA) (n=5), Micro ELISA (n=6), Microparticle enzyme immunoassay (MEIA) (n=1), Automated Vitros ECIQ system (n=1), competitive enzyme linked fluorescence assay (ELFA) (n=4), chemiluminescent microparticle immunoassay (CMIA) (n=5), Electrochemiluminescence Immunoassay (ECLIA) (n=2), otomated analyser (n=2) also macro ELISA (n=2) were used for diagnosis.

Most of the publications (70.68%) were published between the years 2011-2021. Most of the studies (18.96%) were from the Aegean region. Number of publications according to geographical regions were summarized in **Table 1**.

Table 1. Studies according to geographical regions in Turkey (n=58)

Geographical region	n	%
Aegean	11	18.96
Marmara	10	17.24
Eastern Anatolia	10	17.24
Central Anatolia	9	15.52
Mediterranean	9	15.52
Black Sea	6	10.34
Southeast Anatolia Region	3	5.18

The average Anti-Toxo IgG seroprevalence rate in the pregnant population in Turkey was found to be 36,76%. The details of the studies have been summarized in **Table 2**.

The average of Anti-Toxo IgM rate in the pregnant population in Turkey was found to be 2.91%. The details of the studies have been summarized in **Table 3**.

**Table 2. The Anti-Toxo IgG Seroprevalence Rates Performed in the Pregnant Population in Turkey (8-65)**

Year	City	Anti-Toxo IgG Frequency (%)
1991-2000	Diyarbakır	61.3
	Eskişehir	2.6
2001-2010	Malatya	37.1
	İzmir	26.9
	İstanbul	26.1
	Van	36
	Aydın	30.1
	Şanlıurfa	60.4
	Kayseri	33.42
	Kayseri	33.9
	Adıyaman	48.4
	Hatay	52.1
	Kocaeli	48.3
	Ankara	94.6
	Şanlıurfa	69.5
	Afyon	30.7
İstanbul	26.1	
2011-2021	Isparta	28.4
	Adapazarı	25.9
	Zonguldak	43.9
	Kahraman Maraş	64.6
	Adana	46.3
	Antalya	31
	Tokat	32
	Hatay	48.7
	Ordu	27.6
	Erzurum	31
	İzmir	34.3
	Kars	44.8
	Malatya	37.5
	Uşak	18.3
	Bursa	49.8
	Mersin	44.2
	Malatya	25.7
	Canakkale	28.8
	Rize	33.46
	Artvin	30.3
	Denizli	37
İstanbul	23.1	
Mugla	18.8	
Amasya	23.39	
Ankara	26.9	
Bingöl	63	
İstanbul	31	
Diyarbakır	34.9	
Hatay	57	
Van	37.6	
Yozgat	36.9	
İstanbul	24.2	
Uşak	41.1	
Ankara	25.5	
Afyonkarahisar	23.4	
İzmir	32.3	
İzmir	39.9	
Erzurum	31	
Edirne	31.95	
Kars	44.48	
Mersin	23.3	

Table 3. The Anti-Toxo IgM Seroprevalence Rates Performed in the Pregnant Population in Turkey (8-65)

Year	City	Anti-Toxo IgM Frequency (%)
1991-2000	Diyarbakır	0.9
	Eskişehir	0.6
2001-2010	Malatya	1.3
	İzmir	26.9
	İstanbul	0.6
	Van	0.3
	Aydın	not tested
	Şanlıurfa	3
	Kayseri	2.95
	Kayseri	2.5
	Adıyaman	0.65
	Hatay	0.54
	Kocaeli	0.4
	Ankara	5.4
	Şanlıurfa	3
	Afyon	not tested
İstanbul	2.8	
2011-2021	Isparta	1.8
	Adapazarı	0.6
	Zonguldak	0
	Kahraman Maraş	2.5
	Adana	4.8
	Antalya	1.8
	Tokat	0.5
	Hatay	1.1
	Ordu	3.9
	Erzurum	1.6
	İzmir	0.6
	Kars	not tested
	Malatya	0
	Uşak	33.3
	Bursa	3
	Mersin	10.8
	Malatya	7.66
	Canakkale	1.7
	Rize	2.7
	Artvin	0.83
	Denizli	1.3
İstanbul	1.4	
Mugla	0.4	
Amasya	3.7	
Ankara	1.02	
Bingöl	1	
İstanbul	0.2	
Diyarbakır	2	
Hatay	0	
Van	1.1	
Yozgat	3.6	
İstanbul	1.1	
Uşak	0.1	
Ankara	0.7	
Afyonkarahisar	4.3	
İzmir	0.3	
İzmir	1.5	
Erzurum	1.9	
Edirne	2.5	
Kars	0.97	
Mersin	0.4	

The regional seroprevalence of the Anti-Toxo IgG was as follows: 31.21% in the Marmara region, 31.80% in the Aegean region, 34.85% in Central Anatolia region, and 43.95% in the Mediterranean region (Figure 1).

59.43% in Southeastern Anatolia region, 30.25% in the Aegean region, 34.85% in Central Anatolia region, and 43.95% in the Mediterranean region (Figure 1).



Figure 1. The Anti-Toxo IgG Frequency rates by geographical regions in Turkey.

The regional seroprevalence of the Anti-Toxo IgM was as follows: 1.71 % in the Marmara region, 1.39% in the Black Sea region, 4.23 % in Eastern Anatolia region, 2.21% in Southeastern Anatolia region, 5.65% in the Aegean region, 1.76 % in Central Anatolia region, and 2.77 % in the Mediterranean region (**Figure 2**).

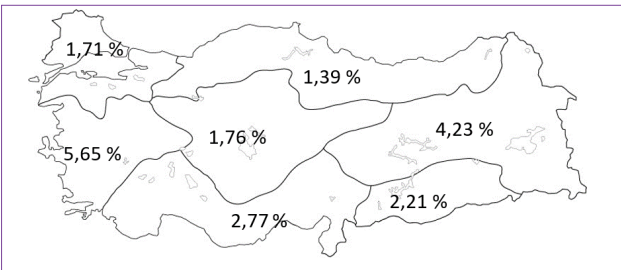


Figure 2. The Anti-Toxo IgM Frequency rates by geographical regions in Turkey.

DISCUSSION

Toxoplasma gondii infection is one of the more prominent zoonotic disease in recent years especially in pregnancy and immunosuppressives. The importance of infant deaths and malformations is being investigated more due to decreasing maternity, globally. Although a few causes of malformations have been identified, most of them have not been explained (6). However, it is known that *T. gondii* infection causes fetal ophthalmologic and neurological malformations in randomized studies. The transmission of maternal infection to the fetus occurs vertically. With congenital infection that develops in the early weeks of pregnancy. The clinical course of toxoplasmosis is severe and the probability of sequelae is high (1-6).

Several environmental, behavioral, socio-demographic and obstetric factors have been suggested as important risk factors for *T. gondii* infections such as geographical location, average age of the population, diet, consuming food or drinking water contaminated with cat faeces containing *T. gondii* oocysts, consumption of undercooked meat, presence of cats in the home, exposure to contaminated soil (through barehand farming or gardening), history of spontaneous abortion, and later conception (1,4). Again in recent years, the

trend of consuming chickens that move freely in nature increases the rate of transmission of *T. gondii* oocysts from infected chickens to humans (7). The fact that this disease differs in terms of seropositivity by regions should be examined with a wide range of socio-demographic factors. There is no study conducted in this context across Turkey. In this study, it was aimed to evaluate the toxoplasmosis seroprevalence studies conducted in Turkey during pregnancy using the pool analysis method and to show the differences between seroprevalence rates by regions.

The seroprevalence of toxoplasmosis in the world varies between 12-90% (14). In pregnant women in Yemen, Anti-*T. gondii* IgG seroprevalence 12.9%, anti-*T. gondii* IgM seroprevalence was reported as 1.2% (4). Identification, early diagnosis and treatment of toxoplasmosis, which is one of the infections that can cause fetal damage in pregnant women, is very important. However, the necessity of routine screening for toxoplasma infection during pregnancy is controversial. The Republic of Turkey Ministry of Health, General Directorate of Public Health, Department of Women and Reproduction 2018 Antenatal Care Management Guidelines (ACMG) recommends only hepatitis B virus antigen screening in pregnant women (15). While ACMG does not recommend routine screening in countries such as North America, Austria, France and Slovenia implement a national screening program for toxoplasma in pregnant women (8). However, it is important to know the seropositivity rates of that region, especially in order to determine the necessity of routine screening (3,4).

In a meta-analysis study evaluating the seroprevalence of toxoplasmosis in pregnant women in Benin, the overall prevalence of toxoplasma-specific IgG was 47% (CI 95: 40-53) and that of specific IgM was 2% (CI 95: 1-3) (5). In our study, the average of toxoplasma-specific IGM was found to be 2.91 and the mean of toxoplasma-specific IgG was found to be 36.76% across Turkey. In the results of our study, while the rate of having this disease beforehand was lower, IgM results found to be close. However, in our country with a wide geography, these rates vary between regions.

As a result of the study, the highest Anti-Toxo IgG test results were; in the studies conducted in Southeastern Anatolia (59.43%), Mediterranean (43.95%) and Eastern Anatolia (40.89%). The regions with the lowest Anti-Toxo IgG test results were respectively; in the Aegean Region (30.25%), Marmara Region (31.21%) and Black Sea Region (31.80%). Anti-Toxo IgM ratios were highest respectively in Aegean Region (5.65%), Mediterranean Region (2.77%) and Southeastern Anatolia (2.21%). The study shows that pregnant women lives in Aegean Region are more susceptible to toxoplasmosis.

CONCLUSION

It has been determined that western Turkey (Aegean Region) is at a higher risk for congenital toxoplasmosis due to its high susceptibility to toxoplasma infection associated with low toxoplasma seroprevalence compared to the east, and it is considered important to perform at least region-based prenatal toxoplasmosis screening to prevent this. In this regard, it is thought that it is necessary to make a decision to screen for the detection of toxoplasma seroprevalence and to increase the awareness of pregnant women in terms of this zoonotic disease.

ETHICAL DECLARATIONS

Ethics Committee Approval: No ethics approval is needed as it is not human or animal study.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

- Saadatnia G, Golkar M. A review on human toxoplasmosis. *Scand J Infect Dis* 2012;44(11):805-14.
- Teimouri A, Mohtasebi S, Kazemirad E, Keshavarz H. Role of *Toxoplasma gondii* IgG Avidity Testing in Discriminating between Acute and Chronic Toxoplasmosis in Pregnancy. *J Clin Microbiol* 2020;58(9):e00505-20.
- Hampton MM. Congenital Toxoplasmosis: A Review. *Neonatal Netw* 2015;34(5):274-78.
- Al-Adhroey AH, Mehrass AAO, Al-Shammakh AA, Ali AD, Akabat MYM, Al-Mekhlafi HM. Prevalence and predictors of *Toxoplasma gondii* infection in pregnant women from Dhamar, Yemen. *BMC Infect Dis* 2019;19:1089.
- Tonouhewa ABN, Amagbégnon R, Atchadé SP, Hamidović A, Mercier A, Dambun M, et al. Séroprévalence de la toxoplasmose chez les femmes enceintes au Bénin: méta-analyse et régression multivariée [Seroprevalence of Toxoplasmosis among Pregnant Women in Benin: Meta-Analysis and Meta-Regression]. *Bull Soc Pathol Exot* 2019;112(2):79-89.
- Toufaily MH, Westgate MN, Lin AE, Holmes LB. Causes of congenital malformations. *Birth Def Res* 2018;110(2):87-91.
- Edelhofer R, Prossinger H. Infection with *Toxoplasma gondii* during pregnancy: Seroprevalence studies in Austria. *Zoonoses Public Health* 2010;57:18-26.
- Akpınar O, Akpınar H, Şendil-Keskin E. Seroprevalence of *Toxoplasma gondii* among Pregnant Women in Isparta Province, Turkey. *DÜ Sağlık Bol Enst Derg* 2017;7(3):133-6.
- Alaçam S, Bakır A, Karatas A, Yolburun B, Uzunkaya Ö, Aktaş F, et al. Investigation of Seroprevalence of Toxoplasma, Rubella and Cytomegalovirus in Pregnant Population in Istanbul. *Journal of Anatolian Medical Research* 2020;5(3):19-24.
- Aycan ÖM, Miman Ö, Atambay M, Karaman Ü, Çelik T, Daldal N. Hastanemizdeki son yedi yıllık *Toxoplasma gondii* seropozitifliğinin araştırılması. *Journal of Turgut Ozal Medical Center* 2008;15(3):199-201.
- Aydemir Ö, Karakeçe E, Köroğlu M, Altındış M. Kadın Doğum Polikliniklerine Başvuran Kadınlarda *Toxoplasma gondii* Seroprevalansının Değerlendirilmesi. *Türk Mikrobiyoloji Cemiyet Derg* 2018;48:125-9.
- Aynioğlu A, Aynioğlu O, Altunok ES. Seroprevalence of *Toxoplasma gondii*, rubella and cytomegalovirus among pregnant females in north-western Turkey. *Acta Clin Belg* 2015;70(5):321-4.
- Bahar İH, Karaman M, Kırdar S, Yılmaz Ö, Celiloğlu M, Mutlu D. Gebelikte Toxoplasmosis Tanısında Anti-*Toxoplasma gondii* IgM, IgG, IgA Antikor ve IgG Avidite Testlerinin Birlikte ve Önemi. *Türkiye Parazit Derg* 2005;29(2):76-9.
- Bakacak M, Serin S, Aral M, Ercan Ö, Köstü B, Kireççi A, et al. Kahramanmaraş Yöresindeki Yerleşik Türk Gebelerle Suriyeli Mülteci Gebeler Arasında Toxoplasma Seroprevalans Farklılıkları [Seroprevalence Differences of Toxoplasma Between Syrian Refugees Pregnants and Indigenous Turkish Pregnants in Kahramanmaraş]. *Türkiye Parazit Derg* 2015;39:94-7.
- Prusa A-R, Kasper DC, Sawers L, Walter E, Hayde M, Stillwaggon E. Congenital toxoplasmosis in Austria: Prenatal screening for prevention is cost-saving. *PLoS Negl Trop Dis* 2017;11(7):e0005648.
- Bayhan G, Suay A, Atmaca S, Yayla M. Gebelerde toksoplazma seropozitifliği. *Türkiye Parazit Derg* 1998;22:359-61.
- Bozok T. Adana Bölgesindeki Gebelerde 2014-2016 Yıllarında *Toxoplasma gondii* Seroprevalansı. *FLORA* 2017;22(2):67-72.
- Çalgın MK, Çetinkol Y, Altunçekiç Yıldırım A. Ordu İlindeki Gebelerde *Toxoplasma gondii* Seroprevalansının Değerlendirilmesi. *Jinekoloji Obstetrik ve Neonatoloji Tıp Derg* 2017;14(1):22-4.
- Çekin Y, Kızılateş F, Gür N, Şenol Y. Investigation of *Toxoplasma gondii* Seropositivity in Pregnant Women Attending the Antalya Training and Research Hospital for the Last Four Years. *Türkiye Parazit Derg* 2011;35:181-4.
- Çeltik NY, Tetikçok R, Günel Ö, et al. Türkiye'nin Orta Karadeniz Bölgesi'nde Gebelerde Rubella, CMV ve Toksoplazmozis Seroprevalansı. *Gaziosmanpaşa Üniversitesi Tıp Fakültesi Derg* 2014;6(1):54-62.
- Çetin M, Çetin S. Age-related prevalence of toxoplasmosis among pregnant women in Hatay: Estimation depending on model. *Mikrobiyoloji Bülteni* 2017;51:361-9.
- Çınar Tanrıverdi E, Göktuğ Kadioğlu B, Alay H, Özkurt Z. Retrospective Evaluation of Anti-*Toxoplasma gondii* Antibody Among First Trimester Pregnant Women Admitted to Nenehatun Maternity Hospital between 2013-2017 in Erzurum. *Türkiye Parazit Derg* 2018;42(2):101-5.
- Çökmez H, Aydın Ç. Gebelerde toksoplazma antikor seroprevalansı: Tarama yapalım mı? *Ortadoğu Tıp Derg* 2019;11(4):415-21.
- Diñçgez Çakmak B, Dündar B, Bayram F, Özgen G. *Toxoplasma gondii* seropositivity in pregnancies with normal delivery and complicated with abortion. *The European Research Journal* 2018;4:275-9.
- Doğan K, Kafkaslı A, Karaman U, Atambay M, Karaoğlu L, Colak C. Gebelerde Toksoplazma Enfeksiyonunun Seropozitiflik ve Serokonversiyon Oranları. *Mikrobiyol Bul* 2012;46:290-4.
- Doğan Toklu G. Gebelerde Toksoplazma, Rubella virüs ve Sitomegalovirüs'e karşı oluşan antikorların sıklığı. *J Clin Anal Med* 2013;4:38-40.
- Duran İ, Nazik S, Nazik H, Duran Ş. Gebelikte Toksoplazma ve Rubella Seropozitifliğinin Değerlendirilmesi. *Balikesir Med J* 2017;1(1):22-5.
- Durukan H, Çevikoğlu Kılıç M. Retrospective Evaluation of the Seropositivity Rate of Toxoplasmosis and Clinical Results in Pregnant Women That were Admitted to a Tertiary Health Institution Between 2012 and 2017 in Turkey. *Türkiye Parazit Derg* 2019;43(3):106-10.
- Dündar Ö, Çelik S, Tütüncü L, Ergür AR, Atay V, Müngen E. 2000-2005 Yılları Arasında Klinikimizde Doğum Yapan Gebelerde Hepatit B, Hepatit C, HIV, Toksoplazma ve Rubella Prevalansının Araştırılması. *Zeynep Kâmil Tıp Bülteni* 2009;40(1):1-9.
- Efe Ş, Kurdoğlu Z, Korkmaz G. Van Yöresindeki Gebelerde Sitomegalovirüs, Rubella ve Toksoplazma antikorlarının seroprevalansı. *Van Tıp Derg* 2009;16:1.
- Erdoğan E, Erdoğan MM, Altındağ MM. Seroprevalence of toxoplasmosis in women admitted to an education and research hospital in eastern anatolia after the syrian crisis. *Ann Med Res* 2020;(27)2:545-50.

32. Ertug S, Okyay P, Turkmen M, Yuksel H. Seroprevalence and risk factors for Toxoplasma infection among pregnant women in Aydin province, Turkey. BMC Public Health.2005;5:66.
33. Gencer M, Cevizci S, Saçar S, et al. Çanakkale Onsekiz Mart Üniversitesi Tıp Fakültesi Hastanesi Obstetri Polikliniğine Müracaat Eden Gebelerde Anti-*Toxoplasma gondii* Antikorlarının Dağılımı ve Risk Faktörlerinin İrdelenmesi. Türkiye Parazit Derg 2014;38:76-80.
34. Gonca S, Serin MS, Halepliler S, Erden Ertürk S. Seroprevalence of *Toxoplasma gondii* in Pregnant Women Admitted to a State Hospital in Mersin, 2019. Türkiye Parazit Derg 2021;45(3):176-80.
35. Gurlek B, Colak S. Antenatal *Toxoplasma gondii*, rubella and cytomegalovirus infection screening among pregnant women attending tertiary university hospital. Gynecol Obstet Reprod Med 2019;25(2):74-80.
36. Harma M, Gungen N, Demir N. Toxoplasmosis in pregnant women in Sanliurfa, Southeastern Anatolia City, Turkey. J Egypt Soc Parasitol 2004;34:519-25.
37. İnci A, Yener C, Güven D. Bir devlet hastanesinde gebe kadınlarda toksoplazma, rubella ve sitomegalovirüs seroprevalansının araştırılması. Pamukkale Tıp Dergisi 2014;(2):143-6.
38. İnci M, Yağmur G, Aksebzeci T, Esmâ K, Yazar S. Kayseri'de kadınlarda *Toxoplasma gondii* seropozitifliğinin araştırılması. Türkiye Parazitoloji Derg 2009;33:191-4.
39. Kafkaslı A, Uryan İ, Buhur A, Köroğlu M, Durmaz R. Kliniğimize başvuran gebelerde toxoplasmosis serolojisi. Perinatoloji Derg 1996;4:94-6.
40. Karabulut A, Polat Y, Türk M, Isik Balci Y. Evaluation of rubella, *Toxoplasma gondii* and cytomegalovirus seroprevalences among pregnant women in Denizli province. Turk J Med Sci 2011;41(1):159-64.
41. Karacan M, Batukan M, Cebi Z, et al. Screening cytomegalovirus, rubella and toxoplasma infections in pregnant women with unknown pre-pregnancy serological status. Arch Gynecol Obstet 2014;290(6):1115-20.
42. Kasap B, Öner G, Küçük M, et al. Muğla'daki Gebelerin Toksoplazma, Rubella, Sitomegalovirüs ve Hepatit Prevalansının Değerlendirilmesi. Tepecik Eğit ve Araşt Hast Derg 2017;27:31-6.
43. Kayman T, Kayman M. Seroprevalence of toxoplasmosis among pregnant women in Kayseri. Perinatol J 2010;18:92-6.
44. Kılınc Ç, Güçkan R, Aydın O ve ark. Amasya bölgesindeki gebelerde toksoplazma ve sitomegalovirüs seroprevalansı. Eur J Health Sci 2015;1(2):72-5.
45. Kölgelir S, Demiraslan H, Katarş B, Güler D. Gebelerde *Toxoplasma gondii* seroprevalansı. Dicle Tıp Derg 2009;36:170-2.
46. Madendağ Y, Eraslan Şahin M, Çöl Madendağ İ, Şahin E, Açmaz G, Müdderris İ. Investigation of toxoplasma, cytomegalovirus and rubella seroprevalence in pregnant women admitted to our hospital. Perinat J 2018;26(1):7- 10.
47. Mumcuoğlu I, Toyran A, Cetin F, et al. Gebelerde toksoplazmoz seroprevalansının değerlendirilmesi ve bir tanı algoritmasının oluşturulması. Mikrobiyol Bul 2014;48:283-91.
48. Numan O, Vural F, Aka N, Alpay M, Coskun AD. TORCH seroprevalence among patients attending Obstetric Care Clinic of Haydarpasa Training and Research Hospital affiliated to Association of Istanbul Northern Anatolia Public Hospitals. North Clin Istanbul 2015;2(3):203-9.
49. Obut M, Doğan Y, Bademkiran MH, et al. Diyarbakır ilindeki Gebe Kadınlarda Toksoplazma, Rubella ve Sitomegalovirus Seroprevalansı. Dicle Tıp Derg 2019;46(2):189-94.
50. Ocak S, Zeteroğlu S, Ozer C, Dolapcioglu K, Gungoren A. Seroprevalence of *Toxoplasma gondii*, rubella and cytomegalovirus among pregnant women in southern Turkey. Scand J Infect Dis 2007;39:231-4.
51. Okyay AG, Karateke A, Yula E, İnci M, Şilfeler DB, Köksaldı Motor V. Seroprevalence of Toxoplasma IgG among pregnant women in the province of Hatay and contribution of avidity test to the diagnose. J Turk Soc Obstet Gynecol 2013;10:160-4.
52. Parlak M, Çim N, Nalça Erdin B, Güven A, Bayram Y, Yıldızhan R. Seroprevalence of Toxoplasma, Rubella, and Cytomegalovirus among pregnant women in Van. Turk J Obstet Gynecol 2015;12(2):79-82.
53. Satılmış ÖK, Yapça ÖE, Duygu Yapça D, Çatma T. Sorgun Devlet Hastanesine başvuran gebelerde rubella, sitomegalovirüs ve toksoplazma antikorlarının seroprevalansı. İKSST Derg 2014;6:90-6.
54. Selek MB, Bektöre B, Baylan O, Özyurt M. Üçüncü Basamak Bir Eğitim Hastanesinde 2012-2014 Yılları Arasında Gebelerde ve Toksoplazmosis Şüpheli Hastalarda *Toxoplasma gondii*'nin Serolojik Olarak Araştırılması. Türkiye Parazit Derg 2015;39:200-4.
55. Şentürk Ş, Kağıtçı M, Balık G, et al. Bir üniversite hastanesine başvuran gebe kadınlarda *Toxoplasma gondii* seroprevalansı. Ege Tıp Dergisi 2015;54:163- 6.
56. Şevki C, Ayla S, Ayşe C, et al. Seroprevalence of *Toxoplasma gondii* and rubella among pregnant women in central Turkey. African J Microbiol Res 2013;7: 2524-9.
57. Şimşek M, Keşli R, Demir C, Çetinkaya Ö, Arıöz DT. Investigation seroprevalence of toxoplasma, rubella, cytomegalovirus and herpes simplex virus type 2 in pregnant women followed in the application and research hospital, Afyon Kocatepe University. Ortadogu Med J 2016;8(1):1-6.
58. Sirin MC, Agus N, Yılmaz N, et al. Seroprevalence of *Toxoplasma gondii*, rubella virus and cytomegalovirus among pregnant women and the importance of avidity assays. Saudi Med J 2017;38(7):727-32.
59. Tamer GS, Dunder D, Caliskan E. Seroprevalence of *Toxoplasma gondii*, rubella and cytomegalovirus among pregnant women in western region of Turkey. Clin Invest Med 2009;32(1):43-7.
60. Tanyuksel M, Guney C, Araz E, Saracli MA, Doganci L. Performance of the immunoglobulin G avidity and enzyme immunoassay IgG/IgM screening tests for differentiation of the clinical spectrum of toxoplasmosis. J Microbiol 2004;42:211-5.
61. Tekay F, Özbek E. Çiğ Köftenin Yaygın Tüketildiği Şanlıurfa İlinde Kadınlarda *Toxoplasma gondii* Seroprevalansı. Türkiye Parazit Derg 2007;31:176-9.
62. Uysal A, Cüce M, Tañer CE, Uysal F, Atalay S, Göl B, Köse S. Prevalence of congenital toxoplasmosis among a series of Turkish women. Rev Med Chil 2013;141(4):471-6.
63. Varol FG, Sayın NC, Soysuren S. Seroprevalence of *Toxoplasma gondii* antibodies in antenatal population of Trakya Region. J Turk Soc Obstet Gynecol 2011;8:93-9.
64. Yılmaz M, Altındaş M, Cevrioğlu S, Fenkci V, Aktepe O, Sırthan E. Afyon Bölgesinde yaşayan gebe kadınlarda toksoplazma, sitomegalovirus, rubella, hepatit B, hepatit C seropozitiflik oranları. Kocatepe Tıp Derg 2004;5:49-53.
65. Yücel A, Bozdayı B, İmir T. Seroprevalence of TORCHE antibodies among pregnant women in Gazi University Hospital. Turk J Infect 2002;16(3):279-83.