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Investigation of *Toxoplasma gondii* Seropositivity in Pregnant Women in Kastamonu Province, Turkey

Kastamonu İlindeki Gebelerde Toxoplasma gondii Seropozitifliğinin Araştırılması

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ABSTRACT

Objective: *Toxoplasma gondii* (*T. gondii*) is a protozoan parasite that infects most warm-blooded animal species and causes toxoplasmosis. Especially infections that occur during pregnancy can lead to serious clinical symptoms. This study retrospectively revealed the *T. gondii* seroprevalence of pregnant women in Kastamonu province, Turkey.
Methods: Anti-*T. gondii* IgM and IgG positivity of 1.294 pregnant women between the ages of 15-44 years who applied to the Obstetrics and Gynecology Outpatients of Kastamonu Training and Research Hospital from January 2018 to January 2022 were investigated retrospectively. The IgG avidity test was performed for both anti-*T. gondii* IgM and IgG positivity.
Results: Anti-*T. gondii* IgM and IgG seropositivity were determined as 1.1% (n=14) and 20.3% (n=263), respectively. Anti-*T. gondii* IgM and IgG positivity were detected together in 11 pregnant women. IgG avidity test results of only six pregnant women could be reached, two pregnant had high IgG avidity, and four pregnant had low IgG avidity. Anti-*T. gondii* IgG positivity rate increased with increasing age (p=0.039).
Conclusion: The number of seronegative pregnant women was considered high in Kastamonu. It is significant for expectant mothers to know about prevention methods in order not to acquire toxoplasmosis.
Keywords: Pregnancy, IgG, IgM, seroprevalence, *Toxoplasma gondii*

ÖZ

Amaç: *Toxoplasma gondii* (*T. gondii*), çoğu sıcakkanlı hayvan türünü enfekte eden ve toksoplazmoza neden olan bir protozoon parazitidir. Özellikle gebelik esnasında ortaya çıkan enfeksiyonlar ciddi klinik tablolara yol açabilir. Bu çalışmada, Kastamonu ilindeki gebe kadınlarda *T. gondii* seroprevalansının retrospektif olarak ortaya konulması amaçlanmıştır.
Yöntemler: Ocak 2018-Ocak 2022 yılları arası Kastamonu Eğitim ve Araştırma Hastanesi Kadın Hastalıkları ve Doğum Polikliniği'ne başvuran 15-44 yaş arasındaki 1,294 gebenin serum örneklerinde anti-*T. gondii* IgM ve IgG pozitifliği retrospektif olarak araştırılmıştır. Anti-*T. gondii* IgM ve IgG birlikte pozitif olan olgularda IgG avidite testi çalışılmıştır.
Bulgular: Anti-*T. gondii* IgM ve IgG seropozitifliği sırasıyla %1,1 (n=14) ve %20,3 (n=263) olarak tespit edilmiştir. On bir hastada ise anti-*T. gondii* IgM ve IgG birlikte pozitif olarak saptanmıştır. Anti-*T. gondii* IgG avidite test sonuçlarına ulaşılan altı gebeden dördünde düşük avidite, iksinde ise yüksek avidite belirlenmiştir. Anti-*T. gondii* IgG için, yaş artışı ile birlikte pozitiflik oranının arttığı tespit edilmiştir (p=0,039).
Sonuç: Kastamonu'da seronegatif gebe sayısı yüksek oranda bulunmuştur. Bu nedenle ilimizdeki anne adaylarının Toksoplazmoza yakalanmamaları adına enfeksiyondan korunma yöntemleri hakkında bilgi sahibi olmaları önem arz etmektedir.
Anahtar Kelimeler: Gebelik, IgG, IgM, seroprevalans, *Toxoplasma gondii*

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Türkiye PARAZİTOLOJİ Dergisi

INTRODUCTION

Toxoplasma gondii (*T. gondii*) is a protozoan parasite that infects most warm-blooded animal species and causes toxoplasmosis. Felines act as definitive hosts and other animals as intermediate hosts in the life-cycle of the parasite. Humans are accidental intermediate hosts (1,2).

Humans become infected by consuming the oocysts of the parasite (not washing hands after contact with contaminated cat litter or soil, consuming contaminated fruits and vegetables without washing) or the undercooked meat of intermediate hosts (poultry, cattle, sheep, goat, etc.) that have bradyzoite. In addition, *T. gondii* can be transmitted from person to person by contaminated blood or tissue transplantation, as well as transplacental from mother to fetus (1,2).

Toxoplasmosis is usually asymptomatic in immunocompetent individuals (3). However, it can cause serious clinical symptoms in immunocompromised individuals and congenital toxoplasmosis (4). Congenital toxoplasmosis occurs when the mother is infected during pregnancy. The incidence and severity of congenital toxoplasmosis vary based on the period of pregnancy. Especially infections occurring in the first trimester of pregnancy may result in abortion. On the other hand, newborns are usually asymptomatic in infections occurring in the later stages of pregnancy. However, pathologies such as hydrocephalus, intracranial calcifications, chorioretinitis, hepatitis, pneumonia, myocarditis, and mental retardation may occur in the future (5).

Rapid and accurate diagnosis of toxoplasmosis in pregnant can reduce the incidence of congenital toxoplasmosis. Detection of antibodies specific to *T. gondii* in the serum samples is the primary diagnostic method used to detect toxoplasmosis (6). For example, IgM positivity alone or seroconversion in IgG titers suggests acute toxoplasmosis. Since IgG can persist for years, detecting IgG positivity alone suggests a past infection. On the other hand, since IgM positivity can persist in serum for up to one year after acute infection, the IgG avidity test should be performed when IgG and IgM are positive together. High IgG avidity indicates that the agent was encountered at least 3-4 months ago, while low IgG avidity may mean acute toxoplasmosis, and the result should be confirmed in a reference laboratory (2).

Knowing the *T. gondii* seroprevalence of pregnant women in a province can provide information about the risk of acquiring toxoplasmosis in pregnant candidates in that province (7). There is no data in the literature about *T. gondii* seroprevalence of pregnant women in Kastamonu province, Turkey. This study aimed to investigate the *T. gondii* seroprevalence of pregnant women who applied to the Obstetrics and Gynecology Outpatients of Kastamonu Training and Research Hospital (TRH).

METHODS

Study Population

The population of the study consisted of pregnant women between the ages of 15 and 44 years who applied to Kastamonu TRH the Obstetrics and Gynecology Outpatients for routine pregnancy control between January 1, 2018, and January 1, 2022. *T. gondii*-specific IgG and IgM-type antibody values of these patients were analyzed retrospectively. The first serological results belonging to the same person were evaluated.

Serological Test

Anti-*T. gondii* IgM, anti-*T. gondii* IgG and IgG avidity were determined by the chemiluminescent microparticle immunoassay method. The tests were performed using Abbott Architect i2000SR instrument (Chicago, IL, USA) per the manufacturer's instructions. The following values were considered to be negative, gray zone, and positive, respectively, in the tests: for IgM, <0.5 index, ≥0.5 - <0.6 index, and ≥0.6 index; for IgG <1.6 IU/mL, 1.6 - <3.0 IU/mL, and ≥3.0 IU/mL; for IgG avidity <50%, ≥50% - <59.9%, and ≥60%.

Statistical Analysis

The pregnant women were divided into three age groups: 15-24, 25-34, and 35-44. The distribution of seropositivity by age groups was evaluated using the Pearson chi-square test in SPSS 23.0 for Windows (IBM Inc., Armonk, NY, USA). The statistical significance was admitted as $p<0.05$.

RESULTS

A total of 1294 pregnant women aged between 15-44 years were included in this study. The mean age of the patients was 27.6±5.5. The distribution of pregnant women by age group was as follows: 407 pregnants (31.5%) in the 15-24 age group; 732 pregnants (56.5%) in the 25-34 age group; 155 (12%) pregnants in the 35-44 age group. Anti-*T. gondii* IgM and anti-*T. gondii* IgG were positive in 14 (1.1%) and 263 (20.3%) pregnant women, respectively. Anti-*T. gondii* IgM and anti-*T. gondii* IgG positivities were detected together in 11 pregnant women (Table 1). IgG avidity test results of only six pregnant women could be reached, two pregnants had high IgG avidity and four pregnants had low IgG avidity. The anti-*T. gondii* IgG positive rate increased with age groups (p=0.039). The highest rate of anti-*T. gondii* IgG positivity (27.7%) was in the 35-44 age group (Table 2).

DISCUSSION

Toxoplasmosis is a parasitic zoonosis that threatens public health. In particular seronegative pregnant women are at risk due to *T. gondii* being a teratogenic pathogen. Serological tests are used in

Table 1. Seroprevalence of anti-*T. gondii* IgM and IgG in 1294 pregnants

Parameter	Positive	Gray zone	Negative
IgM	14 (1.1%)	3 (0.2%)	1277 (98.7%)
IgG	263 (20.3%)	25 (1.9%)	1006 (77.7%)
IgM+IgG	11 (0.9%)	0 (0.0%)	1283 (99.1%)

Table 2. The distribution of seropositivity in pregnant based on age groups

Parameter	Age group		
	15-24 (n=407)	25-34 (n=732)	35-44 (n=155)
	n (%)	n (%)	n (%)
IgM	6 (1.5%)	6 (0.8%)	2 (1.3%)
IgG	74 (18.2%)	146 (19.9%)	43 (27.7%)
IgM+IgG	5 (1.2%)	5 (0.7%)	1 (0.6%)

the diagnosis and follow-up of toxoplasmosis (8,9). Anti-*T. gondii* IgG is permanent for life and provides acquired immunity (2). If the anti-*T. gondii* IgG seronegativity is high in pregnant women in a region or a province, future cases of congenital toxoplasmosis may be inevitable unless necessary protective measures (giving importance to hand hygiene after contact with raw meat, soil, pets, and stray cats, consuming well-cooked meats and sanitizing vegetables and fruits, etc.) are handled (10). In particular, pet ownership or stray cat feeding can pose a risk for pregnant women. For instance, Karakavuk et al. (11) stated that more than 14.0% of stray cats were infected with *T. gondii* and they would be acted as reservoirs for humans and other warm-blooded animals in İzmir province, Turkey.

Anti-*T. gondii* IgG seropositivity in pregnant women has been reported to be about 32.9% worldwide. The highest seropositivity (45.2%) was reported from the Americas and the lowest seropositivity (11.2%) was from the western pacific region (12). *T. gondii* seroprevalence studies among pregnant women in the last ten years conducted in Turkey are summarized in Table 3. Briefly, anti-*T. gondii* IgG seropositivity has been reported in the range of 14.5-47.1% in Turkey (13-36). Anti-*T. gondii* IgG seropositivity was found at 20.3% in the presented study. The findings showed that anti-*T. gondii* IgG seropositivity seropositivity rate was lower than most studies reported in Turkey. The low rate of seropositivity in Kastamonu might be attributed to socio-cultural and socio-economic distinctions such as dietary habits as well as geographical location (37). Moreover, the anti-*T. gondii* IgG seropositivity was determined to increase with age in the current study, which was consistent with the literature (15,18,23,30,33,34). This result can be attributed to the fact that individuals are more in contact with the outdoors with increasing age, thus increasing the possibility of consuming contaminated food or being exposed to infective oocysts.

Anti-*T. gondii* IgM is used in the diagnosis of acute toxoplasmosis (2). Anti-*T. gondii* IgM seropositivity in pregnant women has been reported to be about 1.9% worldwide. The highest seropositivity (4.1%) was reported from the Eastern Mediterranean region and the lowest seropositivity (1.1%) was from the Americas (12). The anti-*T. gondii* IgM seropositivity has been reported in the range of 0.0-3.7% in studies conducted in Turkey in the last ten years (13-36). The anti-*T. gondii* IgM positivity was detected at a rate of 1.1% in this study. The results showed that the anti-*T. gondii* IgM seropositivity rate was similar to most studies reported in Turkey. However, anti-*T. gondii* IgM test may give false results in favor of acute toxoplasmosis due to its low specificity. For this, the patient's serum sample should be redrawn two weeks after the first, and it should be investigated whether there is an increase in anti-*T. gondii* IgG titers. If there is indeed an acute infection, anti-*T. gondii* IgG will begin to be detected two weeks after the first test (2). Only three patients had anti-*T. gondii* IgM positivity alone in the current study. Unfortunately, there is no information about the fate of these patients does not exist in Kastamonu TRH.

On the other hand, anti-*T. gondii* IgM can persist in serum for a long time (up to 1 year) after acute toxoplasmosis. Therefore anti-*T. gondii* IgM and anti-*T. gondii* IgG positivities can be detected at the same time. Then, the IgG avidity test should be done to determine the time of infection. Detection of high IgG avidity in the first trimester of pregnancy can exclude that the toxoplasmosis occurred during pregnancy. However, the

Table 3. *T. gondii* seroprevalence in pregnant women in various provinces of Turkey in the last ten years (2012-2022)

Research	IgM %	IgG %	Period	Province	Method
Gencer et al. (13)	2.7	28.8	2012-2013	Çanakkale	ELISA
Kiriş Satılmış et al. (14)	0.2	36.9	2012-2013	Yozgat	ELFA
Bakacak et al. (15)	2.3	47.1	2012-2014	Kahramanmaraş	Microelisa
Selek et al. (16)	1.9	37.0	2012-2014	İstanbul	CMIA
Akpınar et al. (17)	1.8	28.4	2013-2014	Isparta	Macroelisa
Çalgın et al. (18)	1.6	27.6	2013-2014	Ordu	ECLIA/ CMIA
Kılınç et al. (19)	1.0	23.4	2013-2014	Amasya	CMIA
Çınar Tanrıverdi et al. (20)	0.6	31.0	2013-2017	Erzurum	Macroelisa
Altunal et al. (21)	0.2	26.3	2014-2015	İstanbul	Microelisa
Kasap et al. (22)	3.7	18.8	2014-2015	Muğla	NA
Bozok (23)	1.8	46.3	2014-2017	Adana	ELISA
Aydemir et al. (24)	0.0	25.9	2015-2018	Sakarya	CMIA
Esenkaya Taşbent et al. (25)	2.7	42.4	2015-2019	Konya	ELFA
Obut et al. (26)	1.1	34.9	2016-2018	Diyarbakır	EIA
Şay Coşkun and Yılmaz Doğru (27)	2.9	23.7	2016-2018	Tokat	CMIA
Kahraman and Savcı (28)	1.0	18.9	2016-2021	Çorum	ECLIA/ CMIA
Madendag et al. (29)	1.0	28.9	2017-2018	Kayseri	ELISA
Alver et al. (30)	1.7	37.9	2017-2019	Bursa	ELFA
Eroglu and Asgin (31)	0.0	14.5	2018-2018	Karabük	CMIA
Çubuk et al. (32)	1.3	26.7	2018-2019	Sivas	EIA
Demirci and Mor (33)	0.3	44.8	2018-2019	Kars	Microelisa
Ceylan and Benli (34)	2.2	28.9	2018-2020	Muş	ELFA
Gonca et al. (35)	0.7	28.7	2019-2020	Mersin	ELFA
Takmaz et al. (36)	0.5	18.1	2019-2020	İstanbul	CMIA
In this study	1.1	20.3	2018-2022	Kastamonu	CMIA

CMIA: Chemiluminescent microparticle immunoassay method, ECLIA: Electrochemiluminescence immunoassay, EIA: Enzyme immunassay, ELFA: Enzyme linked fluoresent asssay, ELISA: Enzyme linked immunosorbent assay, NA: Not available

detection of low avidity may consider a recent toxoplasmosis, and specimens should be sent to a reference laboratory for further testing (2). Anti-*T. gondii* IgM and anti-*T. gondii* IgG were positive together in 11 pregnant women in this study. However, the IgG avidity test results of six pregnant women were reached. Of these, four pregnant women had low IgG avidity, and two pregnant women had high IgG avidity.

CONCLUSION

Kastamonu TRH is the central hospital of the province. Therefore, the data of this study reflect the Kastamonu province. Based on the results, the number of seronegative pregnant women was considered high in Kastamonu. Therefore, expectant mothers need to know the prevention methods for toxoplasmosis. Also, routine examination of *T. gondii* serology of all women of childbearing age is recommended.

*Ethics

Ethics Committee Approval: The study was permitted by the Kastamonu University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (date: 09.03.2022 and decision number: 2022-KAEK-17).

Informed Consent: Retrospective study.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.U., Concept: M.Y.D., Ç.K., Design: Ç.K., Data Collection or Processing: M.Y.D., B.Ç., Ç.K., A.U., Analysis or Interpretation: E.F.T., M.Y.D., B.Ç., Literature Search: E.F.T., B.Ç., Writing: E.F.T.

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REFERENCES

1. WHO Estimates of the Global Burden of Foodborne Diseases. 2015. Available from URL: www.euro.who.int/_data/assets/pdf_file/0011 Accessed: February 18, 2022
2. Centers for Disease Control and Prevention. Toxoplasmosis *(Toxoplasma gondii)*. Available from URL: http://www.cdc.gov/dpdx/toxoplasmosis/index.html Accessed: June 24, 2022
3. Dubey JP. Outbreaks of clinical toxoplasmosis in humans: five decades of personal experience, perspectives and lessons learned. Parasit Vectors 2021; 14: 263.
4. Wang ZD, Liu HH, Ma ZX, Ma HY, Li ZY, Yang ZB, et al. *Toxoplasma gondii* infection in immunocompromised patients: A systematic review and meta-analysis. Front Microbiol 2017 9; 8: 389.
5. McAuley JB. Congenital toxoplasmosis. J Pediatric Infect Dis Soc 2014; 3(Suppl 1): S30-5.
6. Ybañez RHD, Ybañez AP, Nishikawa Y. Review on the current trends of Toxoplasmosis serodiagnosis in humans. Front Cell Infect Microbiol 2020; 10: 204.
7. Mumcuoğlu İ, Toyran A, Çetin F, Çoskun FA, Baran I, Aksu N, et al. Evaluation of the Toxoplasmosis Seroprevalence in Pregnant Women and Creating a Diagnostic Algorithm. Mikrobiyol Bul 2014; 48: 283-91.
8. Chaudhry SA, Gad N, Koren G. Toxoplasmosis and pregnancy. Can Fam Physician 2014; 60: 334-6.
9. Torrey EF, Yolken RH. Toxoplasma oocysts as a public health problem. Trends Parasitol 2013; 29: 380-4.
10. Mwambe B, Mshana SE, Kidenya BR, Massinde AN, Mazigo HD, Michael D, et al. Sero-prevalence and factors associated with *Toxoplasma gondii* infection among pregnant women attending antenatal care in Mwanza, Tanzania. Parasit Vectors 2013; 6: 222.
11. Karakavuk M, Can H, Selim N, Yeşilşiraz B, Atlı E, Atalay E, et al. Investigation of the role of stray cats for transmission of toxoplasmosis to humans and animals living in İzmir, Turkey. J Infect Dev Ctries 2021; 15: 155-62.
12. Bigna JJ, Tochie JN, Tounouga DN, Bekolo AO, Ymele NS, Youda EL, et al. Global, regional, and country seroprevalence of *Toxoplasma gondii* in pregnant women: a systematic review, modelling and meta-analysis. Sci Rep 2020; 10: 12102.
13. Gencer M, Cevizci S, Saçar S, Vural A, Çakır Güngör AN, Uysal A, et al. [Evaluation of anti-Toxoplasma gondii antibody distribution and risk factors among pregnant women admitted to obstetrics polyclinic of Canakkale Onsekiz Mart University Hospital]. Turkiye Parazitol Derg 2014; 38: 76-80.
14. Kiriş Satılmış Ö, Yapça ÖE, Yapça D, Çatma T. Seroprevalance of Rubella, Cytomegalovirus and Toxoplasma Antibodies Among Pregnant Women that Referred to Sorgun State Hospital. IKSST Derg 2014; 6: 90-6.
15. Bakacak M, Bostancı MS, Köstü B, Ercan Ö, Serin S, Avcı F, et al. Seroprevalance of *Toxoplasma gondii*, rubella and cytomegalovirus among pregnant women. Dicle Med J 2014; 41: 326-31.
16. 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. Turkiye Parazitol Derg 2015; 39: 200-4.
17. Akpınar O, Akpınar H, Keskin EŞ. Seroprevalence of *Toxoplasma gondii* among pregnant women in Isparta Province, Turkey. J DU Health Sci Inst 2017; 7: 133-6.
18. Çalgın MK, Çetinkol Y, Altunçekiç AY. Evaluation Of The *Toxoplasma gondii* Seroprevalence Among Pregnant Women In Ordu. The Journal of Gynecology - Obstetrics and Neonatology 2017; 14: 22-4.
19. Kılınç Ç, Güçkan R, Aydın O, İdil Ö, Özkan B, Arslan M, et al. Amasya bölgesindeki gebelerde toksoplazma ve sitomegalovirüs seroprevelansı. Eur J Health Sci 2015; 1: 72-5.
20. Çınar Tanrıverdi E, Goktuğ Kadıoğlu B, Alay H, Ozkurt Z. Retrospective evaluation of anti-*Toxoplasma gondii* antibody among first trimester pregnant women admitted to Nenehatun Maternity Hospital Between 2013 and 2017 in Erzurum. Turkiye Parazitol Derg 2018; 42: 101-5.
21. Altunal LN, Esen AB, Karagöz G, Kart Yaşar K. Seroprevalence of *Toxoplasma gondii*, rubella, and cytomegalovirus among pregnant refugees and Turkish women: A retrospective comparative study. South Clin Ist Euras 2018; 29: 235-9.
22. Kasap B, Öner G, Küçük M, Öztürk Turhan N, Akın MN, Arıkan S, et al. Evaluation of toxoplasmosis, rubella, cytomegalovirus and hepatitis prevalence of pregnant women in Muğla. Tepecik Eğit ve Araşt Hast Dergisi 2017; 27: 31-6.
23. Bozok T. Adana bölgesindeki gebelerde 2014-2016 yıllarında *Toxoplasma gondii* seroprevalansı. FLORA 2017; 22: 67-72.
24. Aydemir Ö, Karakeçe E, Köroğlu M, Altındiş M. Kadın doğum polikliniklerine başvuran kadınlarda *Toxoplasma gondii* seroprevalansının değerlendirilmesi. Türk Mikrobiyol Cem Derg 2018; 48: 125-9.
25. Esenkaya Taşbent F, Beder D, Özdemir M, Doğan M, Feyzioğlu B. Hastanemizdeki farklı hasta gruplarında *Toxoplasma gondii* seroprevalansı. Turkiye Parazitol Derg 2022; 46: 1-6.
26. Obut M, Doğan Y, Bademkıran MH, Akgöl S, Kahveci B, Peker N, et al. Diyarbakır ilindeki gebe kadınlarda toksoplazma, rubella ve sitomegalovirus seroprevalansı. Dicle Med J 2019; 46: 189-94.
27. Şay Coşkun US, Yılmaz Doğru H. *Toxoplasma gondii* and Rubella seroprevalence in pregnancies: Two-years evaluation. F.Ü.Sağ.Bil.Tıp.Derg 2018; 32: 119-22.
28. Kahraman H, Savcı Ü. Rubella, cytomegalovirus and toxoplasmosis seroprevalence in pregnants in Çorum province. Anatolian Curr Med J 2022; 4: 202-5.

29. Madendag Y, Erarslan Şahin M, Çöl Madendağ İ, Şahin E, Açmaz G, Müderris İİ. Investigation of toxoplasma, cytomegalovirus and rubella seroprevalence in pregnant women admitted to our hospital. Perinatal Journal 2018; 26: 7-10.

30. Alver O, Payaslıoğlu AM, Sağlık İ. Son iki yılda (2017-2018) Awareness, knowledge and risk factors of *Toxoplasma gondii* infection among pregnant women in the Western Black Sea region of Turkey. Turkiye Parazitol Derg 2021; 45: 257-61.

31. Eroglu S, Asgin N. Awareness, knowledge and risk factors of *Toxoplasma gondii* infection among pregnant women in the Western Black Sea region of Turkey. J Obstet Gynaecol 2021; 41: 714-20.

32. Çubuk F, Hasbek M, Kafa AHT, Çelik C. Evulation of serological indicators for Toxoplasma, Rubellas virus and Cytomegalovirus infections in pregnant women applied to our hospital. Turk Mikrobiyol Cem Derg 2020; 50: 211-7.

33. Demirci F, Mor N. *Toxoplasma gondii* in pregnant women in Kars province: Seroprevalance and possible risk factors. Turk Hij Den Biyol Derg 2021; 78: 175-86.

34. Ceylan AN, Benli A. Muş ilindeki gebelerde *Toxoplasma gondii* seroprevalansının belirlenmesi. ANKEM Derg 2022; 36: 30-3.

35. Gonca S, Serin MS, Halepliler S, Erden Ertürk S. Seroprevalence of *Toxoplasma gondii* in pregnant women admitted to a state hospital in Mersin, 2019. Turkiye Parazitol Derg 2021; 45: 176-80.

36. Takmaz T, Kütük MS, İşlek Taha HS, Öncü HN. Seroprevalence of *Toxoplasma gondii* infection in pregnant population revisited; changing trends and call for action. Erciyes Med J 2021; 43: 278-81.

37. Dindar Demiray EK, Alkan S, Barutcu A, Tahmaz A. Investigating the toxoplasmosis seroprevalence in pregnant women from Turkey by pool analyses method. Pediatr Pract Res 2022; 10: 16-21.