Research Article / Araştırma Makalesi

J Ankara Univ Fac Med 2025;78(3):207-215
DOI: 10.65092/autfm.1747748

# Evaluation of Toxoplasmosis Serology Results and Test Request Dynamics in Ankara University Medical Faculty Hospitals*

## Ankara Üniversitesi Tıp Fakültesi Hastanelerinde Toksoplazmoz Seroloji Sonuçlarının ve Test İsteme Dinamiklerinin Değerlendirilmesi

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## ABSTRACT

**Background:** Toxoplasmosis, caused by *Toxoplasma gondii*, is one of the most common parasitic diseases in the world and in our country. Serological methods are mainly used for diagnosis; however, there are some difficulties in the diagnosis of acute infection.

**Aim:** The aim of this study was to evaluate the anti-*Toxoplasma* IgM and anti-*Toxoplasma* IgG results of serum samples sent to Ankara University İbni Sina Research and Training Hospital from various clinics, as well as the sociodemographic characteristics of the patients.

**Materials and Methods:** Blood sample results from January 1, 2021, to September 1, 2024, were assessed. Anti-*Toxoplasma* antibodies were examined using the Elecsys kit in the Cobas device with the electrochemiluminescence immunoassay technique.

**Results:** Anti-*Toxoplasma* IgG and IgM positivity rates were found to be 23.95% and 1.30%, respectively, between the specified dates. IgG results were positive in 21.54% of women and 30.48% of men. There was a statistically significant difference between the two genders (p<0.001). It was discovered that 1.19% of males and 1.34% of women had reactive anti-*Toxoplasma* IgM results; however, the difference was not statistically significant between the two genders (p=0.667). Most patients who tested positive for anti-*Toxoplasma* IgM and IgG were 80 years of age or above. Anti-*Toxoplasma* IgG positivity was highest in immunocompromised adult and pediatric clinics (44.06% and 42.21%, respectively); however, the adult infection service had the highest percentage (1.59%) for IgM positivity.

**Conclusion:** Studies conducted in Türkiye revealed that the range of anti-*Toxoplasma* IgG positivity varied between 20.3% and 69.6%. Our study's anti-*Toxoplasma* IgG positivity rate was between this range near the lower limit and consistent with prior studies conducted in Ankara. Studies in Türkiye have shown that IgM seropositivity varied from 0% to 9.7%. The anti-*Toxoplasma* IgM positivity ratio of our study was in this range and close to the lower limit similar to the anti-*Toxoplasma* IgG.

**Keywords:** Anti-*Toxoplasma* IgM, anti-*Toxoplasma* IgG, positivity rate, immunocompromised, pregnant

## ÖZET

**Giriş:** *Toxoplasma gondii*'nin neden olduğu toksoplazmoz dünyada ve ülkemizde yaygın olarak görülen paraziter hastalıklardan biridir. Tanısında başlıca serolojik yöntemlerden faydalanılmasına rağmen akut enfeksiyon tanısında birtakım güçlükler yaşanmaktadır.

**Amaç:** Bu çalışmanın amacı Ankara Üniversitesi İbni Sina Uygulama ve Araştırma Hastanesi'ne çeşitli kliniklerden gönderilen serum örneklerinin anti-*Toxoplasma* IgM ve anti-*Toxoplasma* IgG sonuçlarını ve hastaların sosyodemografik özelliklerini değerlendirmektir.

**Gereç ve yöntem:** Çalışma kapsamında 1 Ocak 2021 ile 1 Eylül 2024 tarihleri arasında alınan kan örneklerinin sonuçları değerlendirildi. Anti-*Toxoplasma* antikorları Elecsys kiti ile Cobas cihazında elektrokemilüminesan immünoassay tekniği kullanılarak incelendi.

**Bulgular:** Anti-*Toxoplasma* IgG ve IgM pozitiflik oranları sırasıyla %23,95 ve %1,30 olarak bulundu. Anti-*Toxoplasma* IgG kadınların %21,54'ünde ve erkeklerin %30,48'inde pozitifti. İki cinsiyet arasında istatistiksel olarak anlamlı bir fark vardı (p<0,001). Erkeklerin %1,19'unun ve kadınların %1,34'ünün anti-*Toxoplasma* IgM sonuçları reaktif olarak saptandı, ancak fark istatistiksel olarak anlamlı değildi (p=0,667). Anti-*Toxoplasma* IgM ve IgG sonuçları pozitif olan hastaların çoğu 80 yaş ve üzeriydi. Anti-*Toxoplasma* IgG pozitiflik yüzdesi en yüksek, immün sistemi baskılanmış yetişkin ve çocuk kliniklerinde (sırasıyla %44,06 ve %42,21) saptanırken; yetişkin enfeksiyon servisi anti-*Toxoplasma* IgM pozitifliği bakımından en yüksek yüzdeye sahipti (%1,59).

**Sonuç:** Türkiye'de yapılan çalışmalar anti-*Toxoplasma* IgG pozitifliğinin %20,3 ile %69,6 arasında değiştiğini göstermektedir. Çalışmamızın anti-*Toxoplasma* IgG pozitiflik oranı bu aralığın içinde alt sınıra yakın olup, Ankara'da yapılan önceki çalışmalarla uyumlu bulunmuştur. Türkiye'deki çalışmalarda IgM seropozitifliğinin %0 ile %9,7 arasında değiştiği gösterilmiştir. Çalışmamızın anti-*Toxoplasma* IgM pozitiflik oranı anti-*Toxoplasma* IgG ile benzer olarak bu aralığın içinde alt sınıra yakın olarak saptanmıştır.

**Anahtar kelimeler:** Anti-*Toxoplasma* IgG, anti-*Toxoplasma* IgG, pozitiflik oranı, bağışıklığı baskılanmış, gebe

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**Received:** 21.07.2025 **Accepted:** 22.08.2025 **Publication Date:** 30.09.2025
**Cite this article as:** Ulusan Bağcı, Ö., Önder, R., Aral Akarsu, G. Evaluation of toxoplasmosis serology results and test request dynamics in Ankara University Medical Faculty hospitals. *J Ankara Univ Fac Med*. 2025;78(3):207-215

* The study has not been presented previously as an abstract in any congress or symposium

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## Introduction

One of the most prevalent protozoa in the world and in Türkiye is *Toxoplasma gondii* [1, 2]. Whereas felines are the agent's definitive host, mammals, including humans, are intermediate hosts. The protozoa is primarily spread via eating undercooked meat harboring tissue cysts, consuming food contaminated with oocysts excreted in cat feces, organ and blood transplantation, and transplacental transmission from mother to fetus. In an individual with a competent immune system, the disease proceeds asymptomatically or with mild symptoms resembling those of infectious mononucleosis, but it can be fatal in a patient with a compromised immune system. Moreover, congenital abnormalities, stillbirth, and miscarriage may also occur as a result of transmission of the protozoan from mother to fetus during pregnancy. Therefore, toxoplasmosis is an urgent threat for immunocompromised patients and pregnant women, and the approach to diagnostic testing and treatment must be carefully considered [2-4].

The majority of toxoplasmosis diagnoses are made by serological testing. Anti-*Toxoplasma* IgM turns positive in the first week of infection, peaks in the 1st-3rd months, begins to decline thereafter, and usually turns negative six months later, or within a year [5]. Positive results, however, may sometimes last for years [6]. Anti-***Toxoplasm***a IgG turns positive in the second week, peaks in the 3rd-6th months, then starts to decline and stabilizes after a while. It usually remains positive for the rest of the life [7]. It can be challenging to differentiate between acute and past infections since anti-***Toxoplasma*** IgM positivity may last for a long time [5]. The time of infection could be ascertained using the avidity test. High avidity definitely rules out the diagnosis of acute infection and suggests that the infection occurred at least 16 weeks earlier. Low avidity, on the other hand, could indicate either an acute infection or a past infection with inadequate avidity maturation. In this case, the dynamics of the anti-***Toxoplasma*** IgG test must be assessed in conjunction with the avidity index. The procedure of assessing the findings of serological tests used to diagnose toxoplasmosis is intricate [7, 8]. For the tests to be used effectively, it would be advantageous for the centers to ascertain their own test request and interpretation dynamics.

The aim of this study was to evaluate the results of serum samples sent to Ankara University İbni Sina Research and Training Hospital for anti-*Toxoplasma* IgM and anti-*Toxoplasma* IgG requests from various clinics, together with the sociodemographic characteristics of the patients.

## Materials and Methods

In the course of the study, the results of blood samples sent for anti-*Toxoplasma* IgM and anti-*Toxoplasma* IgG testing to İbni Sina Research and Training Hospital at Ankara University Faculty of Medicine between January 1, 2021, and September 1, 2024, were assessed retrospectively. The patient's age and gender, clinics and outpatient clinics where the sample was sent, anti-*Toxoplasma* IgM, anti-*Toxoplasma* IgG, and avidity test results were recorded. The patients were evaluated in nine age-based groups: 0–9, 10–19, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79, and 80 and above. When a patient gave multiple samples over the course of specified years, only the initial result—if any, the first positive result—was included.

The Elecsys Anti-***Toxoplasma*** kit (Roche Diagnostics, Rotkreuz, Switzerland), which detects anti-***Toxoplasma*** antibodies using the electrochemiluminescence immunoassay (ECLIA) method, was used on a Cobas system (Mannheim, Baden-Württemberg: Roche Diagnostics GmbH, Germany). Test results for IgM with a score of less than 0.8 were evaluated as negative, 0.8–1 as borderline, and 1 and higher as positive. Test results for IgG, which were less than 1 IU/ml, were reported as negative; those that were 1-30 were reported as intermediate, and those that were 30 and higher as positive. The avidity index had three categories, such as low avidity (less than 70), grey zone (70–79), and high avidity (80 and above). The study was approved by the Human Research Ethics Committee of Ankara University (date: 07.10.2024, desicion number: İ08-650-24).

### Statistical analysis

The statistical analysis was conducted with IBM Statistical Package for the Social Sciences for Windows

**Table 1. Distribution of anti-*Toxoplasma* IgG positivity rate according to age groups and gender**

| Age groups | Gender | Anti-*Toxoplasma IgG* *Negative* | | Intermediate | | Positive | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | n | % | n | % | n | % | n | % |
| 0-9 | **Women** | 422 | 80.38 | 6 | 1.14 | 97 | 18.48 | 525 | 100 |
| | **Men** | 530 | 81.54 | 8 | 1.23 | 112 | 17.23 | 650 | 100 |
| | **Total** | 952 | 81.02 | 14 | 1.19 | 209 | 17.79 | 1175 | 100 |
| 10-19 | **Women** | 298 | 86.38 | 5 | 1.45 | 42 | 12.17 | 345 | 100 |
| | **Men** | 268 | 83.23 | 7 | 2.17 | 47 | 14.60 | 322 | 100 |
| | **Total** | 566 | 84.86 | 12 | 1.80 | 89 | 13.34 | 667 | 100 |
| 20-29 | **Women** | 2356 | 88.70 | 3 | 0.11 | 297 | 11.18 | 2656 | 100 |
| | **Men** | 270 | 82.32 | 6 | 1.83 | 52 | 15.85 | 328 | 100 |
| | **Total** | 2626 | 88.00 | 9 | 0.30 | 349 | 11.70 | 2984 | 100 |
| 30-39 | **Women** | 2022 | 81.53 | 2 | 0.08 | 456 | 18.39 | 2480 | 100 |
| | **Men** | 273 | 75.62 | 3 | 0.83 | 85 | 23.55 | 361 | 100 |
| | **Total** | 2295 | 80.78 | 5 | 0.18 | 541 | 19.04 | 2841 | 100 |
| 40-49 | **Women** | 412 | 65.09 | 1 | 0.16 | 220 | 34.76 | 633 | 100 |
| | **Men** | 200 | 58.31 | 4 | 1.17 | 139 | 40.52 | 343 | 100 |
| | **Total** | 612 | 62.70 | 5 | 0.51 | 359 | 36.78 | 976 | 100 |
| 50-59 | **Women** | 199 | 47.84 | 4 | 0.96 | 213 | 51.20 | 416 | 100 |
| | **Men** | 164 | 51.41 | 4 | 1.25 | 151 | 47.34 | 319 | 100 |
| | **Total** | 363 | 49.39 | 8 | 1.09 | 364 | 49.52 | 735 | 100 |
| 60-69 | **Women** | 115 | 36.62 | 1 | 0.32 | 198 | 63.06 | 314 | 100 |
| | **Men** | 121 | 42.46 | 5 | 1.75 | 159 | 55.79 | 285 | 100 |
| | **Total** | 236 | 39.40 | 6 | 1.00 | 357 | 59.60 | 599 | 100 |
| 70-79 | **Women** | 47 | 39.83 | 0 | 0.00 | 71 | 60.17 | 118 | 100 |
| | **Men** | 47 | 37.30 | 0 | 0.00 | 79 | 62.70 | 126 | 100 |
| | **Total** | 94 | 38.52 | 0 | 0.00 | 150 | 61.48 | 244 | 100 |
| 80 and above | **Women** | 7 | 20.59 | 1 | 2.94 | 26 | 76.47 | 34 | 100 |
| | **Men** | 13 | 37.14 | 2 | 5.71 | 20 | 57.14 | 35 | 100 |
| | **Total** | 20 | 28.99 | 3 | 4.35 | 46 | 66.67 | 69 | 100 |
| All ages | **Women** | 5878 | 78.15 | 23 | 0.31 | 1620 | 21.54 | 7521 | 100 |
| | **Men** | 1886 | 68.11 | 39 | 1.41 | 844 | 30.48 | 2769 | 100 |
| | **Total** | 7764 | 75.45 | 62 | 0.6 | 2464 | 23.95 | 10290 | 100 |

(version 23.0; Armonk, NY: IBM Corp., USA). The chi-square test and Fisher's exact test were used to compare qualitative variables. A p-value of less than 0.05 was considered statistically significant.

## Results

A total of 10,290 patient samples were examined for anti-*Toxoplasma* IgG and 10,685 samples for anti-*Toxoplasma* IgM between January 1, 2021, and September 1, 2024. Anti-*Toxoplasma* IgG and IgM

positivity rates were detected as 23.95% and 1.30%, respectively. There were 2769 men and 7521 women whose anti-*Toxoplasma* IgG was tested. Among these patients, 30.48% of men had IgG-positive results and 1.41% had intermediate values, whereas 21.54% of women were IgG positive and 0.31% were within the intermediate values. There was a statistically significant difference between anti-*Toxoplasma* IgG seropositivity of men and women (p<0.001). Anti-*Toxoplasma* IgM was investigated in 2952 men and 7733 women. Anti-*Toxoplasma* IgM was found to be positive in 1.34% of women and borderline in 0.65% of them, while 1.19% of men tested positive and 0.54% of them were borderline. There was no statistically significant difference between the anti-*Toxoplasma* IgM positivity rate of men and women (p=0.667).

When the anti-*Toxoplasma* IgG positivity rates were evaluated according to the age groups of the patients, it was seen that the positivity rate, which was 17.79% in the 0-9 age group, decreased until the 20-29 age group (11.7%) and increased from the 30-39 age group onwards, reaching its highest point in patients aged 80 and above (66.67%) (Table 1). The differences between the anti-*Toxoplasma* IgG positivity rates of the age groups were found to be statistically significant (p<0.001). Analysis of the anti-*Toxoplasma* IgM positivity rates by age groups revealed that, resembling the IgG test results, the highest positivity rate was 5.33% in patients 80 years of age and above, and followed by the 40–49 (2.14%), 50–59 (1.73%), and 10–19 (1.54%) age groups (Table 2). The differences were also found to be statistically significant between the anti-*Toxoplasma* IgM seropositivity rates of age groups (p<0.001).

Immunocompromised adult and pediatric clinics showed the greatest percentages of anti-*Toxoplasma* IgG positivity (44.06% and 42.21%, respectively), while pediatric infection clinics had the lowest rate (7.55%). For ophthalmology services, the seropositivity rate was 28.02%, and for newborn units, it was 26.25%; however, for obstetrics and gynecology clinics, it was 14.83%. The differences between the positivity rates of departments were found to be statistically significant (p<0.001). For anti-*Toxoplasma* IgM positivity, adult infection clinics led with 1.99%, followed by adult immunocompromised with 1.69% and ophthalmology clinics with 1.59%; however, the differences between clinics were not found to be statistically significant (p=0.158). The distribution of anti-*Toxoplasma* IgG and IgM positivity rates according to clinics was given in Table 3.

Sixty-five patients, 18 of whom were men and 47 of whom were women, had anti-*Toxoplasma* IgG avidity test results during the study period. Six men had low avidity, three had grey zone avidity, and nine had high avidity, while 15 women had low avidity, 10 had grey zone avidity, and 22 had high avidity (Table 4). There was no statistically significant difference between the avidity indexes of men and women (p=0.917). Of the 23 patients who visited the obstetrics and gynecology services, six had low avidity, five had grey zone, and 12 had high avidity. Of the patients in whom avidity testing was performed, 64 were anti-*Toxoplasma* IgM positive, while one was negative. The sample with negative anti-*Toxoplasma* IgM came from the neonatal intensive care unit, and the avidity testing was reported as a grey zone.

## Discussion

Toxoplasmosis is a neglected parasitic disease caused by the obligate intracellular protozoan *Toxoplasma gondii*. The disease is common all over the world and significant, especially in pregnant women and immunocompromised patients. The average of various studies undertaken globally indicates that approximately one-third of the population has had toxoplasmosis at a time in their lives [9]. The studies conducted in various regions of Türkiye reveal a prevalence ranging from 20.3% to 69.6%, as shown in Table 5 [10-32]. Anti-*Toxoplasma* IgG positivity in our study was found to be 23.95%, which is around the lower limit of the range of the studies conducted in our country. In Ankara, three studies investigating *Toxoplasma* seroprevalence in pregnant women reported similar ratios of 21.85%, 22.3%, and 25.5% [19, 20, 23]. Contrary to the studies conducted in Ankara, the ratios reported from Şanlıurfa city and the southeastern region were found to be the highest among the local studies in Türkiye. The high positivity ratio in this region was asso-

**Table 2. Distribution of anti-*Toxoplasma* IgM positivity rate according to age groups and gender**

| Age groups | Gender | Anti-*Toxoplasma* IgM | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Negative | | Borderline | | Positive | | Total | |
| | | n | % | n | % | n | % | n | % |
| 0-9 | **Women** | 595 | 99.50 | 3 | 0.50 | 0 | 0.00 | 598 | 100 |
| | **Men** | 719 | 99.58 | 2 | 0.28 | 1 | 0.14 | 722 | 100 |
| | **Total** | 1314 | 99.55 | 5 | 0.38 | 1 | 0.08 | 1320 | 100 |
| 10-19 | **Women** | 354 | 97.52 | 2 | 0.55 | 7 | 1.93 | 363 | 100 |
| | **Men** | 343 | 97.72 | 4 | 1.14 | 4 | 1.14 | 351 | 100 |
| | **Total** | 697 | 97.62 | 6 | 0.84 | 11 | 1.54 | 714 | 100 |
| 20-29 | **Women** | 2606 | 98.27 | 12 | 0.45 | 34 | 1.28 | 2652 | 100 |
| | **Men** | 325 | 98.48 | 1 | 0.30 | 4 | 1.21 | 330 | 100 |
| | **Total** | 2931 | 98.29 | 13 | 0.44 | 38 | 1.27 | 2982 | 100 |
| 30-39 | **Women** | 2418 | 97.66 | 24 | 0.97 | 34 | 1.37 | 2476 | 100 |
| | **Men** | 349 | 97.21 | 5 | 1.39 | 5 | 1.39 | 359 | 100 |
| | **Total** | 2767 | 97.60 | 29 | 1.02 | 39 | 1.38 | 2835 | 100 |
| 40-49 | **Women** | 640 | 96.82 | 5 | 0.76 | 16 | 2.42 | 661 | 100 |
| | **Men** | 359 | 98.09 | 1 | 0.27 | 6 | 1.64 | 366 | 100 |
| | **Total** | 999 | 97.27 | 6 | 0.58 | 22 | 2.14 | 1027 | 100 |
| 50-59 | **Women** | 457 | 98.07 | 1 | 0.21 | 8 | 1.72 | 466 | 100 |
| | **Men** | 338 | 97.97 | 1 | 0.29 | 6 | 1.74 | 345 | 100 |
| | **Total** | 795 | 98.03 | 2 | 0.25 | 14 | 1.73 | 811 | 100 |
| 60-69 | **Women** | 345 | 98.57 | 2 | 0.57 | 3 | 0.86 | 350 | 100 |
| | **Men** | 294 | 98.33 | 2 | 0.67 | 3 | 1.00 | 299 | 100 |
| | **Total** | 639 | 98.46 | 4 | 0.62 | 6 | 0.92 | 649 | 100 |
| 70-79 | **Women** | 129 | 99.23 | 0 | 0.00 | 1 | 0.77 | 130 | 100 |
| | **Men** | 139 | 97.89 | 0 | 0.00 | 3 | 2.11 | 142 | 100 |
| | **Total** | 268 | 98.53 | 0 | 0.00 | 4 | 1.47 | 272 | 100 |
| 80 and above | **Women** | 35 | 94.59 | 1 | 2.70 | 1 | 2.70 | 37 | 100 |
| | **Men** | 35 | 92.11 | 0 | 0.00 | 3 | 7.89 | 38 | 100 |
| | **Total** | 70 | 93.33 | 1 | 1.33 | 4 | 5.33 | 75 | 100 |
| All ages | **Women** | 7579 | 98.01 | 50 | 0.65 | 104 | 1.34 | 7733 | 100 |
| | **Men** | 2901 | 98.27 | 16 | 0.54 | 35 | 1.19 | 2952 | 100 |
| | **Total** | 10480 | 98.08 | 66 | 0.62 | 139 | 1.30 | 10685 | 100 |

ciated with conditions such as warm and humid climate, unhygienic eating habits, eating raw meatballs, and drinking contaminated water [12, 16, 26].

In the current study, there was a statistically significant difference in the IgG positivity ratio of men and women ($p<0.001$). This may be due to a couple of reasons. Firstly, far more tests were requested from women than men, and especially from gynecology clinics accounted for around half of all women's test requests as preconceptional and pregnancy screening tests. One possible explanation for the low positivity rate among women may be the large quan-

**Table 3. Distribution of anti-*Toxoplasma* IgG and anti-*Toxoplasma* IgM positivity rates according to departments**

| Departments | | Anti-*Toxoplasma* IgG | | | | Anti-*Toxoplasma* IgM | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Negative** | **Intermediate** | **Positive** | **Total** | **Negative** | **Borderline** | **Positive** | **Total** |
| Obstetrics and Gynecology | n | 3714 | 3 | 647 | 4364 | 4266 | 34 | 56 | 4356 |
| | % | 85.11 | 0.07 | 14.83 | 100 | 97.93 | 0.78 | 1.29 | 100 |
| Adult immunocompromised* | n | 595 | 17 | 482 | 1094 | 1157 | 4 | 20 | 1181 |
| | % | 54.39 | 1.55 | 44.06 | 100 | 97.97 | 0.34 | 1.69 | 100 |
| Pediatric immunocompromised** | n | 133 | 8 | 103 | 244 | 251 | 1 | 2 | 254 |
| | % | 54.51 | 3.28 | 42.21 | 100 | 98.82 | 0.39 | 0.79 | 100 |
| Adult infection | n | 359 | 0 | 143 | 502 | 488 | 5 | 10 | 503 |
| | % | 71.51 | 0.00 | 28.49 | 100 | 97.02 | 0.99 | 1.99 | 100 |
| Pediatric infection | n | 195 | 1 | 16 | 212 | 215 | 0 | 1 | 216 |
| | % | 91.98 | 0.47 | 7.55 | 100 | 99.54 | 0.00 | 0.46 | 100 |
| Adult other | n | 1553 | 18 | 817 | 2388 | 2433 | 13 | 38 | 2484 |
| | % | 65.03 | 0.75 | 34.21 | 100 | 97.95 | 0.52 | 1.53 | 100 |
| Pediatrics (other) | n | 971 | 15 | 163 | 1149 | 1303 | 9 | 8 | 1320 |
| | % | 84.51 | 1.31 | 14.19 | 100 | 98.71 | 0.68 | 0.61 | 100 |
| Ophtalmology | n | 185 | 0 | 72 | 257 | 247 | 0 | 4 | 251 |
| | % | 71.98 | 0.00 | 28.02 | 100 | 98.41 | 0.00 | 1.59 | 100 |
| Newborn | n | 59 | 0 | 21 | 80 | 120 | 0 | 0 | 120 |
| | % | 73.75 | 0.00 | 26.25 | 100 | 100.00 | 0.00 | 0.00 | 100 |
| Total | n | 7764 | 62 | 2464 | 10290 | 10480 | 66 | 139 | 10685 |
| | % | 75.45 | 0.60 | 23.95 | 100 | 98.08 | 0.62 | 1.30 | 100 |

*Adult immunocompromised=hematology, medical oncology, transplantation unit

**Pediatric immunocompromised=pediatric hematology, pediatric oncology, pediatric immunology, pediatric bone marrow transplantation

tity of screening tests that were ordered. Secondly, the positivity rate of men may be significantly higher because anti-*Toxoplasma* antibody tests are mostly requested from men suspected to have toxoplasmosis. In most of the studies, the anti-*Toxoplasma* IgG positivity rate was found to be higher in women than in men [10, 17, 21, 25, 27]. However, a single study reported higher seropositivity among men, which was similar to our study [28]. This finding may also change based on patients' demographic properties and test-request patterns of the hospital. Anti-*Toxoplasma* IgM positivity was found to be 1.30% in our study. According to studies conducted in Türkiye, IgM seropositivity ranged from 0% to 9.7% (Table 5). The finding of our investigation falls within this range and is around the lower limit, similar to that of anti-*Toxoplasma* IgG. Anti-*Toxoplasma* IgM positivity was 1.34% among women, and it was 1.19% among men. However, the difference between two genders was not deemed statistically significant (p=0.667).

The majority of patients with anti-*Toxoplasma* IgM and IgG positivity were 80 years of age and above. Similarly, the study by Alver et al. in 2019 indicated that patients aged 60 and above had the greatest prevalence of both anti-*Toxoplasma* IgG and *anti-Toxoplasma* IgM positivity [21]. Anti-*Toxoplasma* IgM and anti-*Toxoplasma* IgG positivity were shown to be highest in the 20–39 age range in two further investigations published in the literature [22, 28]. Comparing our study with these two studies, we found lower positivity rates of anti-*Toxoplasma* IgG and IgM among women in the childbearing age group of 20–39 years.

**Table 4. Distribution of the avidity index results of 65 patients according to gender**

| | | Avidity | | | |
|---|---|---|---|---|---|
| Gender | | Low | Grey-zone | High | Total |
| Women | n | 15 | 10 | 22 | 47 |
| | % | 31.91 | 21.28 | 46.81 | 100 |
| Men | n | 6 | 3 | 9 | 18 |
| | % | 33.33 | 16.67 | 50 | 100 |
| Total | n | 21 | 13 | 31 | 65 |
| | % | 32.31 | 20 | 47.69 | 100 |

Both adult and pediatric immunocompromised individuals had the highest anti-*Toxoplasma* IgG positivity rates (Table 3). In a study by Taşbent et al. that evaluated *Toxoplasma* serology in different patient groups, in contrast to our results, immunocompromised patients exhibited lower anti-*Toxoplasma* IgG and IgM positivity rates by 14.7% and 0.5%, respectively [27]. The IgG positivity rate among patients referred from obstetrics and gynecology services was found to be 14.83% in our study. This rate seems to be lower than the positivity rates reported in other published studies in the literature [11-15, 18-20, 23, 24, 23, 24, 23, 24, 23,24,28-32]. In our study, the adult infection service led in IgM positivity rate with 1.99%. The patients whose samples were detected positive for anti-*Toxoplasma* IgM in the adult infection units may be the patients who were tested positive in other healthcare facilities and were referred to our hospital for further investigation. When *Toxoplasma* seropositivity distribution according to the clinics was examined, 26.25% of the newborns' samples tested positive for anti-*Toxoplasma* IgG, while none tested positive for anti-*Toxoplasma* IgM. This indicates that around one in four newborns was detected as IgG positive. *Toxoplasma* serology is typically requested from newborns who exhibit symptoms suggestive of congenital toxoplasmosis or whose mothers have been diagnosed or suspected of having acute toxoplasmosis, which may be the cause of the high seropositivity rate. During pregnancy, IgG can passively diffuse from mother to fetus. In this case, the diagnostic exclusion of congenital toxoplasmosis could be made by either using an immunoblot test to compare the IgG patterns of the mother's and the newborn's sera or by monitoring the decline in IgG levels at specific intervals [33].

Low avidity was detected in six of the samples sent from the obstetrics and gynecology service. These results may indicate acute toxoplasmosis in these pregnant women, but not enough for a definite diagnosis. Due to the retrospective nature of the study and the restriction in patient data within the hospital information management system, information about the subsequent processes of the pregnant women could not be obtained.

### Study limitations

The study's limitations include its retrospective design, the fact that it only included data from one center, and the fact that patient data was restricted to information found in the hospital information management system. Prospectively planned studies are required in which the results of the avidity, anti-*Toxoplasma* IgM, and anti-*Toxoplasma* IgG tests are assessed together within clinical and serological follow-up to find out how the avidity test contributes to the diagnosis of acute toxoplasmosis, which is not within the scope of our study.

## Conclusion

Our study is expected to contribute to the literature by highlighting the results of patients whose *Toxoplasma* serology was requested according to age groups, gender, and the clinics they applied to during the 44-month period. The anti-*Toxoplasma* IgG positivity rate was determined to be 23.95%, and the results of the study are similar to the results of other studies conducted in our province.

**Table 5. Summary of studies conducted in Türkiye investigating *Toxoplasma* serology**

| Study population | The number of serum samples (n) | The positivity rate of anti-*Toxoplasma* IgG (%) | The positivity rate of anti-*Toxoplasma* IgM (%) | The test method | City | Time Interval | References |
|---|---|---|---|---|---|---|---|
| All patients | 4908 | 31.01 | 0.77 | ELISA | Elazığ | 1999-2003 | 10 |
| Pregnant women | 4651 | 39.9 | 2.5 | ELISA | İzmir | 2003-2008 | 11 |
| Pregnant women | 1652 | 52.1 | 0.54 | ELISA | Hatay | 2004-2006 | 12 |
| Women (childbearing age) | 17751 | 24.61 | 1.34 | ELFA | İstanbul, Bursa, Adana, Kayseri, Kocaeli | 2004-2010 | 13 |
| Pregnant women | 389 | 30.1 | 0 | ELISA, IFA, DA | Aydın | - | 14 |
| Pregnant women | 1972 | 48.3 | 0.4 | ELISA | Kocaeli | 2005-2007 | 15 |
| Women | 2586 | 69.6 | 3 | CLIA | Şanlıurfa | 2006 | 16 |
| All patients | 8095 | 31.5 | 1.6 | ELISA, IFA | Aydın | 2007-2017 | 17 |
| Pregnant women | 1102 | 37 | 1.4 | - | Denizli | 2008-2009 | 18 |
| Pregnant women | 30863 | 25.5 | 0.3 | CLIA | Ankara | 2008-2010 | 19 |
| Pregnant women | 84587 | 22.3 | 0.64 | CLIA | Ankara | 2008-2017 | 20 |
| All patients | 25251 | 30.7 | 9.7 | ELFA | Bursa | 2009-2016 | 21 |
| All patients | 2778 | 47.1 | 1.19 | ELISA | Reference laboratory | 2009-2019 | 22 |
| Syrian pregnant women<br>Turkish pregnant women | 752<br>76835 | 47<br>21.85 | 0.4<br>0.56 | CLIA | Ankara | 2010-2018 | 23 |
| Pregnant women | 9809 | 37.6 | 1.1 | ELISA | Van | 2012-2013 | 24 |
| All patients | 3899 | 32.4 | 2.7 | ELISA | İzmir | 2012-2013 | 25 |
| Farmworker women | 684 | 58.3 | 1 | EIA | Southeastern region | 2013 | 26 |
| All patients | 20875 | 24.1 | 2.4 | ELFA | Konya | 2015-2019 | 27 |
| All patients<br>Turkish pregnant women<br>Syrian pregnant women | 12694<br>3798<br>264 | 29.58<br>25.88<br>47.10 | 0.94<br>0.49<br>1.83 | CMIA | İzmir | 2017-2021 | 28 |
| Pregnant women | 3141 | 23 | 0.6 | CLIA | İstanbul | 2018-2019 | 29 |
| Pregnant women | 1294 | 20.3 | 1.1 | CLIA | Kastamonu | 2018-2022 | 30 |
| Pregnant women | 1844 | 28.7 | 0.7 | ELFA | Mersin | 2019 | 31 |
| Pregnant women | 256612 | 36.76 | 2.91 | - | Türkiye | Last 30 years | 32 |

ELISA: Enzyme-Linked Immunosorbent Assay
ELFA: Enzyme-Linked Fluorescent Assay
IFA: Immunofluorescent Antibody DA: Direct Agglutination
CLIA: Chemiluminescent Immunoassay
EIA: Enzyme Immonoassay
CMIA: Chemiluminescent Microparticle Immunoassay
DA: Direct Agglutination

**Author Contributions:** Concept: Ö.U.B., R.Ö., G.A.A., Design: Ö.U.B., R.Ö., Data Collection or Processing: Ö.U.B., R.Ö., Analysis or Interpretation: Ö.U.B., G.A.A., Literature Search: Ö.U.B., Writing: Ö.U.B., G.A.A.
**Conflict of Interest:** No conflict of interest was declared by the authors.
**Financial Disclosure:** The authors declared that this study received no financial support.
**Informed Consent:** Written informed consent was obtained from all participants.

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