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List of abbreviations:
Congenital toxoplasmosis (CT), Prenatal care (PC), Group 1 (G1), Group 2 (G2), Group 3 (G3), Group 4 (G4), *Odds ratio* (OR), Confidence interval (CI), Gestational toxoplasmosis (GT).

Serological Monitoring of Gestational Toxoplasmosis: Retrospective Analysis of Pregnant Women in Petrópolis, RJ, Brazil

Monitoramento sorológico da toxoplasmose gestacional: análise retrospectiva de gestantes em Petrópolis, RJ, Brasil

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ABSTRACT

Introduction: Congenital toxoplasmosis is one of the most serious forms of *Toxoplasma gondii* infection, acquired by the fetus when pregnant women are infected, at the beginning of pregnancy or close to conception. Therefore, diagnosis, monitoring, and guidance during prenatal care are essential factors to help reduce the number of cases of this disease and its consequences. **Objectives:** To evaluate the serological monitoring of gestational toxoplasmosis during prenatal care based on data collected from medical records of postpartum women treated at a public hospital in Petrópolis city, Rio de Janeiro state, Brazil, between 2020 and 2022. **Methods:** Pregnant women were divided into four groups, according to the number of serological tests they were subjected to during prenatal care. Variables related to mother, pregnancy, and prenatal care were analyzed and compared between groups. **Results:** In total, 240 (39.9%) of the 602 analyzed medical records presented IgG antibodies, whereas eight (1.3%) of them showed IgM antibodies; 16 (2.7%) of patients were subjected to four serological tests during pregnancy; 115 (19.1%) of them were subjected to three tests; 214 (35.5%), to two tests; and 257 (42.7%) of patients only underwent one test. Group 4 was the only group in which all susceptible pregnant women underwent all three serological tests following the initial test. Consequently, the number of toxoplasmosis tests conducted decreased as pregnancy progressed. **Conclusions:** Based on the analyzed data, approximately 60% of pregnant women were susceptible to infection caused by *Toxoplasma gondii*, and many were not monitored as recommended by the Ministry of Health.

Keywords: Prenatal Care; Congenital Toxoplasmosis; Serology; Toxoplasma.

RESUMO

Introdução: A toxoplasmose congênita é uma das formas mais graves de infecção pelo *Toxoplasma gondii*, adquirida pelo feto quando as mulheres grávidas são infectadas, no início da gravidez ou próximo à concepção. Assim, o diagnóstico, acompanhamento e orientação durante o pré-natal são fatores essenciais para auxiliar na redução do número de casos desta doença e atenuar suas sequelas. **Objetivos:** Avaliar o acompanhamento sorológico da toxoplasmose gestacional durante o pré-natal com base em dados coletados de prontuários de puérperas atendidas um hospital público de Petrópolis, Estado do Rio de Janeiro, entre 2020 e 2022. **Métodos:** As gestantes foram divididas em quatro grupos, de acordo com o número de exames sorológicos a que foram submetidas durante o pré-natal. Variáveis relacionadas à mãe, gestação e pré-natal foram analisadas e comparadas entre os grupos. **Resultados:** No total, 240 (39,9%) dos 602 prontuários analisados apresentavam anticorpos IgG, enquanto oito (1,3%) apresentavam anticorpos IgM; 16 (2,7%) das pacientes realizaram quatro testes sorológicos durante a gravidez; 115 (19,1%) realizaram três testes; 214 (35,5%) dois testes; e 257 (42,7%) das pacientes realizaram apenas um exame. O Grupo 4 foi o único no qual todas as gestantes suscetíveis realizaram os três testes sorológicos, após o primeiro teste; portanto, o número de testes realizados para toxoplasmose diminuiu à medida que a gravidez avançava. **Conclusões:** Com base nos dados analisados, aproximadamente, 60% das gestantes estavam suscetíveis à infecção causada pelo *Toxoplasma gondii* e muitas delas não foram acompanhadas, conforme preconiza o Ministério da Saúde.

Palavras-chave: Cuidado Pré-Natal; Toxoplasmose Congênita; Sorologia, Toxoplasma.

INTRODUCTION

Congenital toxoplasmosis (CT) is one of the most severe infections caused by *Toxoplasma gondii*[1]. It occurs when the parasite crosses the transplacental barrier and infects the fetus[2]. Transmission of toxoplasmosis can occur through the consumption of raw, poorly washed food or water contaminated with protozoan oocysts, as well as inadequate hand hygiene. Signs of fetal infection may be present at birth; however, clinical manifestations can emerge months or even years later[1-6]. Maternal infection is asymptomatic in 90% of cases, making clinical diagnosis particularly challenging."

Serological screening plays an essential role in preventing toxoplasmosis transmission during pregnancy[7]. Serological screening also helps to identify toxoplasmosis-susceptible women,

whose primary prevention process must be carefully conducted and focused on health education[8]. Although pregnant women presenting reactive IgG serological results are often immune to toxoplasmosis; they can undergo further serological tests[9]. All pregnant women presenting non-reactive serological results are susceptible to toxoplasmosis; thus, they must be tested again in the three gestational trimesters and advised on preventive actions. Women presenting anti-*T. gondii* IgM antibodies must be classified as recent–infection case; consequently, they are likely to transmit toxoplasmosis to their fetus. Therefore, they must be referred to both treatment and fetal infection diagnosis. Since 2016, CT during pregnancy has been in the category of mandatory notification diseases; a fact that helped to improve its tracking process in Brazil[10].

Toxoplasmosis seroprevalence among Brazilian pregnant women can range from 42% to 91%[3]. In a review study conducted by Dubey and colleagues, in 2021, an update on congenital toxoplasmosis in humans was provided. Although Dubey's article did not specifically focus on evaluating screening programs in Brazil, it highlights the absence of a unified national screening program for pregnant women and children in the country. The data presented on the Brazilian situation has originated from studies carried out in different research centers spread across the national territory. Furthermore, other studies have demonstrated that both the rate of congenital infection and the severity of the disease in infected children are higher in Brazil than in Europe.

This indicates that in Brazil, the risk of developing severe sequelae is five times higher compared to European children[11]. It is believed that the higher number of cases in Brazil is associated with the genetic composition of *T. gondii* strains, which are predominantly atypical in most studies, as well as other factors such as host genetics, environmental conditions, and cultural and economic factors[12].

This study aimed to evaluate the serological monitoring of gestational toxoplasmosis during prenatal care (PC) based on data from medical records of postpartum women treated at a public hospital in Petrópolis, Rio de Janeiro, between 2020 and 2022. The goal was to better understand the epidemiology of toxoplasmosis in the studied region.

METHODOLOGY

The study was carried out based on medical records of pregnant women who attended medical appointments at a public health hospital in Petrópolis city, state of Rio de Janeiro. This hospital is considered a reference for the region, being the only one in the public network for monitoring high-risk pregnancies. Therefore, many women choose to undergo prenatal care or give birth at this hospital, even if they live in other nearby cities. In total, 602 of the 680 medical records found at the reference hospital, between January 2020 and December 2022, were included in the study; 78 of them were excluded because PC was not carried out or because they did not have a record of any toxoplasmosis serological test.

The documentary research conducted using patients' medical records followed these steps: verification and organization of documents, critical analysis of medical records, characterization and description of groups based on the number of toxoplasmosis tests performed during PC, and commentary. The collected data were entered into an Excel spreadsheet and analyzed quantitatively. No information was available regarding the specific tests used for serological analysis or their titers; results were limited to "positive" or "negative" for toxoplasmosis.

Follow-up records provided information on the pregnant women under investigation, including personal data, obstetric history, comorbidities, and various laboratory results from up to four serological toxoplasmosis tests conducted during PC, as well as childbirth data. The pregnant women were categorized into four groups based on the number of serological toxoplasmosis tests performed during pregnancy: Group 1 (G1) – one test; Group 2 (G2) – two tests; Group 3 (G3) – three tests; and Group 4 (G4) – four tests. The medical records followed a standardized format, allowing for the documentation of a maximum of four test results.

The variables selected after documentary analysis included maternal age, number of pregnancies and miscarriages, pregnancy complications, timing of PC initiation, number of consultations, serological test results for toxoplasmosis, and gestational age. Graphs were generated using GraphPad Prism software, version 8, while statistical analyses were conducted using R software, version 4.3.2.

Univariate and multivariate analyses were performed, considering the following covariates: maternal age, municipality, number of pregnancies, number of miscarriages, number of consultations, and the result of the first serological test. The p-value for each model and the *odds ratio* (OR) were calculated. Estimated coefficients were derived based on the final p-value of the adjusted model. All analyses were conducted with a 95% confidence interval (CI) and a 5% significance level.

Research approval was granted by the Human Research Ethics Committees of all involved institutions, under the following approval numbers and dates: FMPFASE: 5.521.413, July 11, 2022; IOC: 5.466.481, June 13, 2022.

RESULTS

Among the 602 analyzed medical records, at least one recorded serological test result for anti-*T. gondii* IgG during PC was available. Of these, 39.9% (240) (CI: 35.95%–43.24%) tested positive for anti-*T. gondii* IgG antibodies, while 1.3% (8) (CI: 0.414%–2.244%) tested positive for IgM antibodies, indicating acute infection and a potential risk of fetal transmission. Additionally, 0.6% (4) of patients had indeterminate results for IgG, and 0.2% (1) had indeterminate results for IgM anti-*T. gondii* antibodies.

According to the number of ran tests; 42.7% (257) of patients were G1, 35.5% (214) in G2, 19.1% (115) in G3 and 2.7% (16) in G4. (Figure 1).

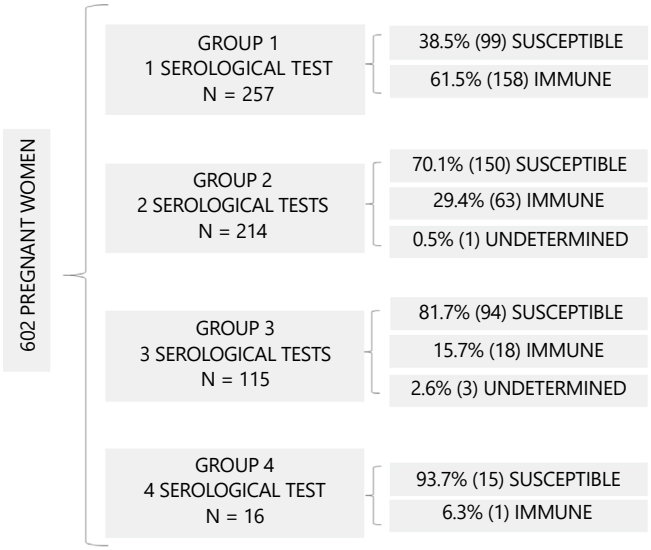

Figure 1. Flow chart showing laboratory results recorded for toxoplasmosis, based on the number of serology tests carried out throughout prenatal care.

The youngest mother was 14 years old, and the oldest one was 46; the patients' mean age was 26-27 years. More than half (318) of pregnant women were in the age group 20-29 years; 40.9% of them were in their first pregnancy and 78.6% (473) had no history of miscarriages. Furthermore, 65% (391) of these women had complications during pregnancy, and 57% (343) of babies were born at term (between 37 and 42 weeks). More than half of pregnant women attended at least eight appointments. The majority of them were tested for toxoplasmosis at the first exam; most of them lived in Petrópolis.

Regarding PC, 62.5% (376) of pregnant women began monitoring in the first trimester; however, 36.7% (138) underwent only one exam, while 2.4% (9) completed four exams. A total of 28.4% (171) of these women started monitoring in the second trimester; 49.1% (84) underwent one exam, and 2.9% (5) underwent four exams. In the third trimester, 4.2% (25) of pregnant women started PC, with 72% (18) undergoing one exam and 4% (1) completing four exams. In total, 93% of women who underwent four exams were found to be susceptible to toxoplasmosis.

The comparative analysis between the timing of PC initiation and serological results revealed that 65.8% (158) of IgG-reactive women underwent only one serological test, while 34.2% (82) were subjected to additional tests. In total, 30.4% (109) of susceptible women underwent three or four serological tests, while 27.6% (99) were only tested once during pregnancy, despite being seronegative (Figure 2).

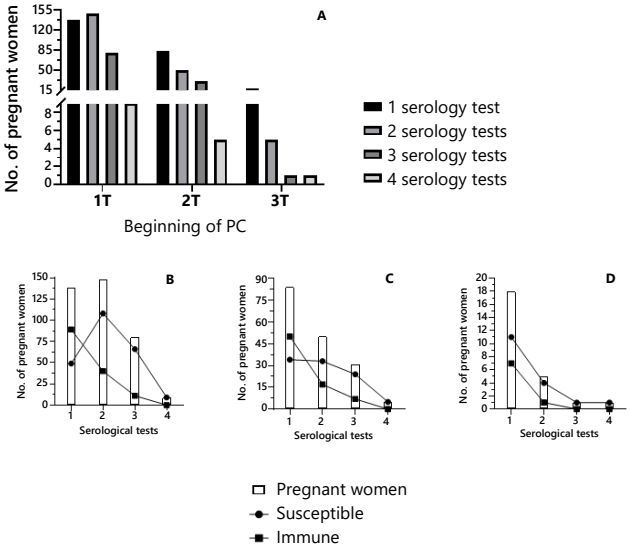

Figure 2. Serological toxoplasmosis monitoring in prenatal care: A – Beginning of prenatal care; B – First gestational trimester; C – Second gestational trimester; D – Third gestational trimester.

Data about PC serological monitoring applied to pregnant women susceptible to toxoplasmosis after their first exam are shown in Figure 3. G1 held 257 women who only underwent one serology test during the entire PC period, and 53.3% of them (137) were IgG-positive, therefore they did not need to be subjected to further serology tests. However, 31.1% of patients (80) were susceptible to toxoplasmosis and none of them was subjected to further toxoplasmosis tests. Yet, 15.5% of women (40) did not undergo the requested first serological test for toxoplasmosis, and 2.7% of them (7) were only screened for the third test.

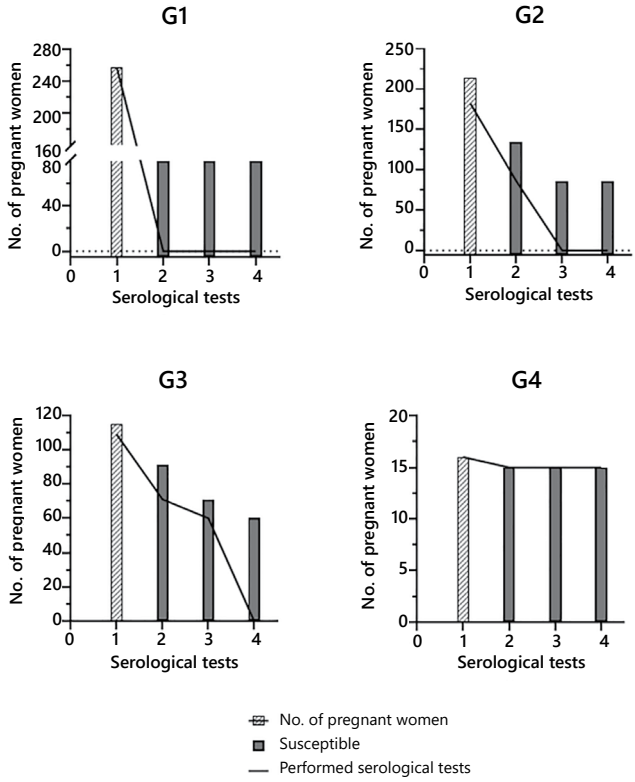

Figure 3. Serological monitoring during prenatal care provided to pregnant women susceptible to toxoplasmosis after first–test results.

A total of 135 women in G2 (74.2%) tested negative on the first test, indicating susceptibility to toxoplasmosis. Of these, 86 women (63.7%) underwent a second test, but none proceeded to the third or fourth tests. However, 25.8% (47) of women tested positive for antibodies, and 57.4% (27) of them were unnecessarily subjected to an additional serological test.

Additionally, 83.5% (91) of G3 patients were susceptible to toxoplasmosis based on the first test. Of these, 78% (71) underwent a second test, and 84.5% (60) proceeded to a third test; however, none underwent the fourth test. A total of 16 women (14.7%) were immune and were subjected to two additional unnecessary serological tests.

Sixteen (16) women in G4 were tested for IgG anti-*T. gondii* in the first exam and 93.8% (15) of them were susceptible to it. Therefore, they would need further serological tests throughout their pregnancy - 100% of susceptible women in this group attended follow-up after the four requested tests.

Three pregnant women who were IgG negative in the first test had seroconversion and were IgG positive in subsequent tests, besides recording two inconclusive IgG. Likewise, three women were initially negative IgM seroconverted. It is important to notice that two women showed IgG and IgM seroconversion.

Eight women (100%) with positive serology for IgM antibodies underwent the first and second serological tests, although only 37.5% (3) of them underwent the third and fourth. In total, 62.5% (5) of these patients had a positive result; 25% (2) had a negative result and 12.5% (1) had an inconclusive result in the first serological test. There was no record of avidity test evaluation in their medical records.

However, one of the pregnant women who tested negative in the first test, and the one who presented inconclusive results, tested

positive in the second test. One of the pregnant women with two negative serological-test results tested positive in the 3rd test.

Exploratory data analysis based on the probability of positive IgG has shown that only covariates age, number of pregnancies, and number of consultations were significant in both univariate and multivariate analyses (Table 1).

The results recorded for positive IgG odds ratio have shown that each additional year in pregnant women's age is expected to increase their likelihood of being IgG positive by approximately 7.1%. Similarly, each additional pregnancy is expected to increase the likelihood of positive IgG by 15.6%, but each additional attended appointment is expected to reduce the likelihood of positive IgG by 8.4%. (Table 1).

Table 1. Exploratory data analysis applied to the investigated covariates.

Covariate	p-value	Coefficient	OR
Age	2.62×10^{-6}	0.06912	1.071565
City	-	-	-
Pregnancies	0.0302	0.1453	1.156386
Miscarriages	-	-	-
Consultations	0.007	-0.0878	0.915944

If pregnant women who were not immune in the first exam were considered; the mean number of tests undergone by each pregnant woman was 1.055 (CI = 0.9695 – 1.1414). The rate of pregnant women who underwent another test reached 71.43% (CI= 66.79% - 76.07%), but 28.6% (n) of them did not undergo any toxoplasmosis test again. The age of non-immune pregnant women and a higher number of consultations can favor the likelihood of women undergoing future tests.

Immune pregnant women underwent a mean number of tests equal to 0.3941 (CI = 0.3141-0.4740). The rate of those who underwent a new test reached 32.2% (CI= 26.2% - 38.2%). Therefore, approximately 1/3 of these women underwent toxoplasmosis tests again. According to the municipality of residence OR, immune pregnant women living in Petrópolis have approximately twice the chance of being tested again for toxoplasmosis compared to immune pregnant women living outside it (Table 2).

Table 2. Logistics model related to pregnant women immune and non-immune to toxoplasmosis.

Covariate	Non-immune pregnant women			Immune Pregnant Women		
	p-value	Coefficient	OR	p-value	Coefficient	OR
Age	0.000557	0.03474	1.0353	0.3253	-	-
City	-	-	-	0.0262	0.6928	1.9993
Pregnancies	-	-	-	0.7368	-	-
Miscarriages	-	-	-	0.6249	-	-
Consultations	5.87×10^{-13}	0.2184	1.2441	0.3349	-	-

DISCUSSION

In total, 39.9% of the 602 pregnant women included in the current study had anti-toxoplasmosis antibodies; therefore, they were considered immune to this infection, whereas 59.5% of them were susceptible to it. A recent meta-analysis study observed toxoplasmosis prevalence in 45.2% of pregnant women in the Americas, and in 53.8% of this population, in Brazil[13]. Based on another review and meta-analysis study, global annual CT incidence rates were estimated at 190,100 cases (179,300–206,300) and CT prevalence in pregnant women reached 1.0% (95% CI: 0.7– 1.4%) in Latin America[2].

The number of women excluded from the study also underscores an important point: 78 out of 680 medical records were from pregnant women who either did not have serological data for toxoplasmosis available or did not undergo any PC. This indicates a significant number of women who were at risk of infection.

Several studies performed in Brazil recorded anti-*T. gondii* IgM antibodies' prevalence ranging from 0.41% to 4.2%, depending on aspects, such as climate, assessed-population socioeconomic conditions, investments in health and education, as well as habits and customs of each investigated region[14-15]. In total, 1.3% of pregnant women in the current study presented positive IgM antibodies and this number is according to previous findings reported in Brazil, including a meta-analysis study showing acute infection prevalence ranging from 0.01% to 2.5%[2]. Each region must collect epidemiological information about its population to help develop strategies to be applied to its localities.

The herein observed sociodemographic profile comprised pregnant women in the age group 14-46 years - most of them were in the age group 20-29 years. In this study, coefficients estimated each have evidenced that age is positively related to IgG. Therefore, the older the pregnant woman the greater her chance of being IgG positive. Studies have shown that younger mothers are more often affected by toxoplasmosis, mainly due to risky habits[2].

Nevertheless, several studies conducted in Brazil have indicated an increased risk of *T. gondii* infection as pregnant women age, while also emphasizing education as a protective factor. Higher levels of schooling provide greater access to information, making education a crucial strategy for promoting health and preventing congenital toxoplasmosis (CT)16. In the present study, the highest number of IgG-reactive pregnant women was observed in the 40–46-year age group, confirming that *T. gondii* seroprevalence increases with maternal age. Similar findings were reported in a literature review by Rostami et al.[2], which analyzed 217 studies from 74 countries.

Most patients were primiparous. The rate of pregnant women with chronic infection increased according to the number of pregnancies. In total, 32.1% of women were primiparous and 57.8% had two, or more, children. In this study, the estimated coefficient evidenced that the number of pregnancies is positively related to IgG. Therefore, the more pregnancies she has had, the greater her chance of being IgG-positive.

Studies have pointed out that women with more than one child, or with more than one pregnancy, have fewer risky habits. It is so, because they have had previous access to information about disease prevention, a fact that has a positive influence on the process of acquiring knowledge about toxoplasmosis[16]. However, the chronic infection/multiparity association can be explained by individuals' increased exposure to infection sources over time[17]. Likewise, assumingly, women with a history of previous miscarriages are more interested in understanding the risk factors leading to new miscarriages, such as toxoplasmosis[16]. It is important to emphasize the significant number of women who had one, or more, miscarriages (more than 20%), since this outcome may also points towards likely gestational toxoplasmosis (GT), which, in its turn, is associated with infection. However, the GT hypothesis could not be confirmed, since these cases were not investigated and, consequently, they may have happened due to other factors. However, 43.6% of women who had one, or more, miscarriages recorded positive IgG anti-*T. gondii* serological test results.

Given the importance of PC monitoring, this service is expected to be as thorough as possible[18]. Studies have suggested that the earlier PC begins, the lower the likelihood of gestational complications and disease transmission to the fetus[3,19]. Moreover, implementing primary

prevention measures, such as educating pregnant women—especially those who are seronegative—on strategies to prevent congenital toxoplasmosis (CT), remains the most effective approach to reducing its occurrence[20].

The Brazilian Ministry of Health[21] recommends performing six PC consultations. The first consultation is expected to take place in the first gestational trimester. In total, 68.5% of the investigated pregnant women had seven, or more, consultations - this number was within the expectations and recommendations. In this study, statistical analysis demonstrated that the number of appointments a pregnant woman attends is negatively correlated with IgG. This finding indicates that pregnant women who manage to attend more appointments are less likely to be IgG positive. According to some scholars, reducing the number of consultations does not lead to worse mother and baby outcomes[22]. However, a smaller number of consultations may result in less adequate tests, vaccinations and guidance. Therefore, a larger number of consultations can provide more opportunities for pregnant women to receive preventive and health promotion guidance. However, the most relevant discussion lies in the quality of these consultations and the effectiveness of monitoring procedures aimed at preventing and diagnosing infections.

According to the literature, CT is associated with a considerable increase in the number of premature births. This rate reaches 34.8% in comparison to the 11.7% observed for premature babies without congenital infection[23]. In total, 57% of babies in the current study were born at term, i.e., at the appropriate time.

The decreased number of tests conducted as pregnancy progressed was a relevant factor observed in the analysis of serological screenings performed during PC. Only 16 women underwent all four serological tests for toxoplasmosis requested by their doctors, and 15 of them were susceptible to it.

The analysis at the beginning of PC in correlation to serological results showed that 65.8% of immune women only underwent one serology test, and this number is in compliance with recommendations by the Ministry of Health[9,21]. However, 34.2% of them underwent more serology tests, although they were not recommended, since it could generate unnecessary expenses. Tests shall not be repeated unless there is some justification for repeating them.

An aliquot of 30.4% of susceptible women was subjected to three or four serological tests, and this procedure is according to recommendations by the Ministry of Health[21,24]. On the other hand, 27.6% of this population only underwent one test during pregnancy, although they were seronegative. In this case, these women were at risk of both infection and toxoplasmosis transmission. However, it is important to highlight that PC beginning can influence the number of tests and follow-ups. Women who have started PC late in pregnancy have fewer tests than those who started in the first gestational trimester. However, against the odds, pregnant women who started PC in the first or second gestational trimesters only underwent one test, although they were seronegative, i.e., they were susceptible to infection

According to these data, only a small number of women were subjected to proper toxoplasmosis investigation during PC. Likewise, the number of women tested in groups 1, 2 and 3 has decreased over time, i.e., few women underwent proper serological toxoplasmosis monitoring during pregnancy This is a concerning finding since many pregnant women were no longer screened in other consultations; consequently, they would not undergo early treatment in case of seroconversion. Therefore, only group 4 was subjected to all four serological tests recommended by the Ministry of Health[25]. On the other hand, 80% of pregnant women in groups 1, 2 and 3 were subjected to serological tests when they started PC, but less than 36% of them kept on being tested at the end of PC, with emphasis on groups 1 and 2, which accounted for less than 8% of these serological tests.

These findings become even more concerning when analyzing the proportion of seronegative pregnant women after the first serological test—those susceptible to infection—who should undergo additional serological testing during PC, as recommended by the Rio de Janeiro State protocol for usual-risk pregnancies[9]. Despite their susceptibility, a significant number of pregnant women had only one toxoplasmosis test throughout pregnancy, highlighting gaps in adherence to recommended monitoring practices.

According to Rostami et al.[2], many *T. gondii*-seronegative pregnant women are not aware of their pregnancy in the first gestational weeks. This factor can be associated with participation in activities that expose these women to this parasite. These factors reinforce the importance of both implementing PC screening programs and providing health education in all PC consultations. Therefore, based on the analyzed data, there is evidence of a lack of importance given to serological toxoplasmosis test application during pregnancy and indicative of PC failure. Several studies have proven that efficient monitoring during pregnancy reduces the risks of both primary infection and sequelae in babies[18,25].

However, data analysis in the present study has pointed out that medical records, despite being useful for identifying pregnant women's PC monitoring, are not effective instruments to portray real health conditions due to process flaws. Data in medical records may be biased, mainly when it comes to their completion. Some variables in the present study must be taken into account, such as whether, or not, the toxoplasmosis test was performed; whether carrying out the test in another unit and/or municipality; the long time to get the serological test results; likely wrong medical record completion, among others. It is worth highlighting that the present study was carried out during the COVID-19 pandemic period. Therefore, PC may have been affected, mainly because pregnant women were in the risk group, and it could cause them to avoid going to hospitals since they were overloaded due to care, hospitalizations, and tests provided to COVID-19 patients.

Serological results indicative of acute infection were similar in terms of some serologically tested individuals, although this number decreased, overtime. It is worth emphasizing that 62.5% of patients tested positive for toxoplasmosis in the first serological test and that 87.5% of them tested positive in the second test. This finding points out increased infection incidence. In other words, two women who had initially tested negative for IgM antibodies, and one woman who presented inconclusive results, recorded different results in other tests. This reinforces the relevance of subjecting this population to serological monitoring. These three cases encompassed pregnant women who had initially tested negative for toxoplasmosis, but who tested positive for it, later on.

It is important to pay attention to the PC provided to pregnant women due to the high risk of vertical toxoplasmosis transmission and, consequently, of compromising the fetus. It is so, because this transmission type poses risks to the baby's health and development, even in its adult life. According to the current study, it is imperative to pay more attention to the large number of women susceptible to this disease, despite the large number of pregnant women with anti-toxoplasmosis antibodies. This factor makes efficient PC and

primary prevention care even more relevant to help reduce the risks of infection during pregnancy[26].

Exploratory data analysis allows observing that both age and number of pregnancies are positively related to IgG. It points out that the older the pregnant woman, or the more pregnancies she has had; the greater her chances of being IgG positive[2]. This outcome is expected, since the older the pregnant women; the larger the number of times they may have been exposed to the toxoplasmosis agent. On the other hand, the number of appointments attended by pregnant women was negatively correlated to IgG. This finding has evidenced that pregnant women who manage to attend more appointments have lower chances of being IgG-positive – this outcome has also been highlighted in other studies[18]. Therefore, it is possible to assume that pregnant women who can attend more appointments likely have more resources and better socioeconomic conditions.

Consequently, these women tend to live in environments with a lower risk of exposure to the infectious agent. A study conducted in Espírito Santo found that a higher level of education in women, particularly among household heads, increased the likelihood of accessing prenatal care. In general, research has shown that social and economic factors—such as low income, limited education, and younger maternal age—are associated with inadequate prenatal care in Brazil[27-28].

The housing-associated coefficient was positive, and it indicated increased likelihood of immune pregnant women to undergo future tests if they live in Petrópolis compared to those who live in other municipalities. This finding might be the consequence of higher shortage of resources in other municipalities, which must be more careful at the time to spend money on tests for unnecessary cases.

CONCLUSIONS

These findings point out a high number of pregnant women susceptible to T. gondii infection. Although most initiated prenatal care early, approximately 30% underwent only one toxoplasmosis test throughout pregnancy, which is considered inadequate given the significant number of women at risk of infection. Both maternal age and the number of pregnancies were directly associated with IgG antibody positivity, while the number of prenatal consultations was identified as a protective factor. Furthermore, data analysis revealed that, despite their usefulness, medical records are not entirely effective in accurately reflecting health conditions due to process-related deficiencies.

Therefore, close attention must be given to both testing and early diagnosis of *T. gondii* infection to enable the timely implementation of necessary interventions, including primary prevention, through educational initiatives that inform pregnant women about the disease transmission and preventive measures.; secondary prevention, which facilitates the identification of probable congenital infections and ensures appropriate treatment and tertiary prevention, involving the monitoring and treatment of affected newborns to prevent complications and long-term sequelae.

Given the Brazilian Ministry of Health's efforts to identify the most vulnerable regions and strengthen measures to prevent primary infections; it is crucial to implement a more rigorous PC approach. Greater emphasis should be placed on serological screening for pregnant women, ensuring that all susceptible patients are tested throughout all trimesters of pregnancy and receive proper guidance on infection prevention.

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