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Research Article

Toxoplasmosis in Patients with Psychosis: A Cross-Sectional Study

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Received: October 11, 2024; **Published:** November 06, 2024

Abstract

Background and Objectives: Toxoplasmosis is among the most frequent zoonotic illnesses worldwide. Its connection emerges substantially among psychotic patients. There have been few studies on the associations between these ailments. Hence, we mapped this study to determine the incidence of toxoplasmosis in female and male patients with acute and transient psychotic disorders (ATPD).

Methods: In this cross-sectional study, we recruited 115 patients with ATPD. Their psychotic symptoms were gauged with the Brief Psychiatric Rating Scale (BPRS) scores. The BPRS scores above 52 imply severe psychotic disorder. We also assessed the toxoplasma immunoglobulin G (IgG) levels. Similarly, IgG levels above 12 IU/ml are rendered positive for toxoplasmosis. We contrasted the age, BPRS, and IgG values of female and male participants. The Shapiro-Wilk test was employed to determine the normality of the data distribution. We also correlated the BPRS and IgG values of the study population. R software (version 4.4.1) was leveraged for the data analysis.

Results: Out of 137 patients we screened, 115 (83.9%) were eligible. Of them, 64 (55.7%) were females. The median age of the study population was 40.5 (35.5-47.0) years [female: 41.5 (35.0-47.0) years; male: 41.0 (38.0-47.0) years; p = 0.48]. Only 13 (11.3%) participants were diagnosed with toxoplasmosis. The median BPRS score of the study population was 41.5 (37.0-47.5) [female: 42.0 (37.5-48.0); male: 40.0 (37.0-46.0); p = 0.48]. The median IgG value of the study population was 2.0 (1.0-4.0) IU/ml [female: 1.8 (1.0-4.5) IU/ml; male: 2.3 (1.0-3.8) IU/ml; p = 0.62]. We found a positive association (r = 0.24, p = 0.68) between BPRS and IgG values [female: (r = 0.27, p = 0.62); male: (r = 0.22, p = 0.71)].

Conclusion: Our study revealed that middle-aged persons were affected with toxoplasmosis. We demonstrated a positive correlation between the BPRS and IgG values. However, the association was not statistically significant.

Keywords: *Toxoplasma gondii; Psychosis; Immunoglobulin; Correlation; Chronic Infection; Raincloud Plot*

Abbreviations

ATPD: Acute and Transient Psychotic Disorders; BPRS: Brief Psychiatric Rating Scale; ELISA: Enzyme-Linked Immunosorbent Assay; IQR: Interquartile Range; *T. gondii*: *Toxoplasma gondii*

Introduction

Toxoplasma gondii (*T. gondii*) is an obligate intracellular protozoan that infects all warm-blooded mammals [1]. It frequently causes flu-like symptoms in immunocompetent people for a brief length of time before remaining in the body as a latent stage in the host's nucleated cells [2]. *T. gondii*'s definitive hosts are felines, with humans, birds, and reptiles serving as intermediate hosts [1,2]. In human beings, this disease occurs by feco-oral or vertical (mother-to-child) transmission [1,3].

T. gondii infection affects around 30% of the world's population [4,5].

Toxoplasmosis has the potential to disrupt its host's behavior through a variety of mechanisms [6,7]. Throughout the latent stage, the parasitic organism can impact neurotransmitter levels in intermediate hosts' brains [6]. *T. gondii* infection promotes dopamine release in neurons, most likely by self-expression of genes encoding the rate-limiting enzyme for dopamine synthesis [8,9]. The parasite also disrupts glutamate signaling in the brain by interfering with the kynurenine pathway [10].

Another putative mechanism is that pro-inflammatory cytokines produced by *T. gondii* infection can activate apoptosis via microglial activation, facilitating progressive neurodegeneration [11]. These proposed pathways for how *T. gondii* infection affects its host may have a role in the expression of psychotic symptoms, as neurotransmitters and immunological abnormalities have also been linked to the pathophysiology of psychosis and schizophrenia [6].

As per a recent study, *T. gondii* seroprevalence was 50.9% in individuals with schizophrenia and 52.6% in patients with bipolar disorders [12]. Nonetheless, there exists a handful of studies on ATPD patients infected with *T. gondii*. Thus, we undertook this study to investigate the incidence of toxoplasmosis in ATPD patients. We additionally explored the relationship between *T. gondii* IgG levels and BPRS scores among study participants.

Materials and Methods

This cross-sectional study was conducted from September 2022 to April 2024 at Kalinga Institute of Medical Sciences, India. Before commencing the study, we obtained the ethics approval from the concerned authority (KIIT/KIMS/IEC/1033/2022 dated 25/08/2022). All participants or their close relatives provided consents before the enrolment.

Our study included both adult patients of either gender, diagnosed with ATPD. We excluded people who had mental illnesses caused by alcohol or drug intoxication or abstinence, neurodevelopmental problems, traumatic, or stress-related disorders. This study also excluded nursing mothers or pregnant women.

Following enrollment, the psychiatrist ordered a test for anti-*Toxoplasma* antibodies. Then, under aseptic conditions, 5 mL of blood was drawn using a venipuncture. Blood samples from patients were centrifuged at 3000 rotations per minute for 5 minutes. Serum was extracted and stored at -20°C until serological analysis. The extracted serum samples from the participants were analyzed for anti-*Toxoplasma* IgG antibodies using the enzyme-linked immunosorbent assay (ELISA). The IgG values above 12 IU/ml were considered as positive. The values below 9 IU/ml and 10-11 IU/ml were taken as negative and equivocal, respectively. A positive test for anti-*Toxoplasma* IgG antibodies implied that the individual had current or past infections with *T. gondii*.

The Brief Psychiatric Rating Scale (BPRS) is a widely-accepted scale for assessment of the psychotic disorder [13]. It entails 18 questions regarding the psychological condition of the individual. The responses to each question are accompanied with scores of 0-7. Higher scores indicate severity of the symptoms. The total score above 52 is suggestive of severe psychotic illness. The scores of 31-40 and 41-51 indicate mild and moderate degree of the illness, respectively. We recorded the IgG values and BPRS scores for each participant.

For this cross-sectional study, we adopted convenience sampling as we did not know the prevalence of toxoplasmosis in our institution. We used the Shapiro-Wilk test to ensure that the collected data were normally distributed. For categorical variables, frequency and proportion were used as summary statistics. The continuous data was presented using the median and interquartile range (IQR). We used Pearson's chi-square test to compare sociodemographic characteristics. The Wilcoxon test was calibrated to get the median IgG and BPRS scores. For data analysis, we used R software (version 4.4.1) [14]. The statistical tests were two-tailed. The p-values less than 0.05 were interpreted as statistically significant.

Results

We screened a total of 137 patients with the study criteria. Fourteen patients were chronic alcoholics. Five had stress-related disorder and three were diagnosed with neurodevelopmental diseases. Hence, we excluded these 22 people. The remaining 115 (83.9%) subjects met the eligibility criteria. Of them, 64 (55.7%) were females. The sociodemographic traits have been elucidated in table 1. The median age of the study population was 40.5 (35.5-47.0) years [female: 41.5 (35.0-47.0) years; male: 41.0 (38.0-47.0) years; p = 0.48]. Only two participants (one female and one male) were aged above 60 years. A total of 13 (11.3%) participants were diagnosed with toxoplasmosis. The age distribution of the study participants is shown in figure 1.

The continuous and categorical variables are expressed as median (IQR) and frequency (proportion), respectively.

Parameter	Total (n = 115)	Female (n = 64)	Male (n = 51)	p-value
Age (years)	40.5 (35.5-47.0)	41.5 (35.0-47.0)	41.0 (38.0-47.0)	0.48
Age > 60 years	2 (1.7%)	1 (1.6%)	1 (1.9%)	1
Socioeconomic status				
Lower	28 (24.3%)	11 (17.2%)	17 (33.3%)	0.07
Lower-middle	74 (64.4%)	45 (70.3%)	29 (56.9%)	
Upper-middle	13 (11.3%)	8 (12.5%)	5 (9.8%)	
Toxoplasmosis diagnosed	13 (11.3%)	10 (15.6%)	3 (5.9%)	0.02
IgG value (IU/ml)	2.0 (1.0-4.0)	1.8 (1.0-4.5)	2.3 (1.0-3.8)	0.62
BPRS score	41.5 (37.0-47.5)	42.0 (37.5-48.0)	40.0 (37.0-46.0)	0.48

Table 1: *The sociodemographic traits of the study population.*

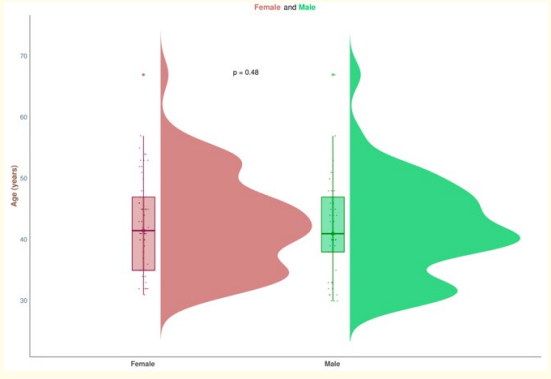

Figure 1: *Age distribution of the participants.*

The raincloud plots demonstrate the age of the female and male participants. The width of the cloud (half-eye) plot corresponds to the number of participants with their age on the y-axis. The box-whisker and jitter plots illustrate the age values. The Wilcoxon test was used to calculate the p-value.

The median IgG value of the study population was 2.0 (1.0-4.0) IU/ml [female: 1.8 (1.0-4.5) IU/ml; male: 2.3 (1.0-3.8) IU/ml; p = 0.62]. The median BPRS score of the study population was 41.5 (37.0-47.5) [female: 42.0 (37.5-48.0); male: 40.0 (37.0-46.0); p = 0.48]. Figure 2 and 3 portray the IgG values and BPRS scores of the study participants, respectively.

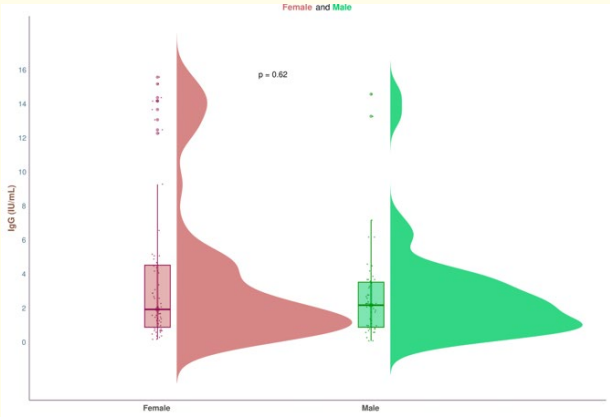

Figure 2: *IgG values of the participants.*

The raincloud plots demonstrate the IgG values of the female and male participants. The width of the cloud (half-eye) plot corresponds to the number of participants with their IgG values on the y-axis. The box-whisker and jitter plots illustrate the IgG values. The Wilcoxon test was used to calculate the p-value.

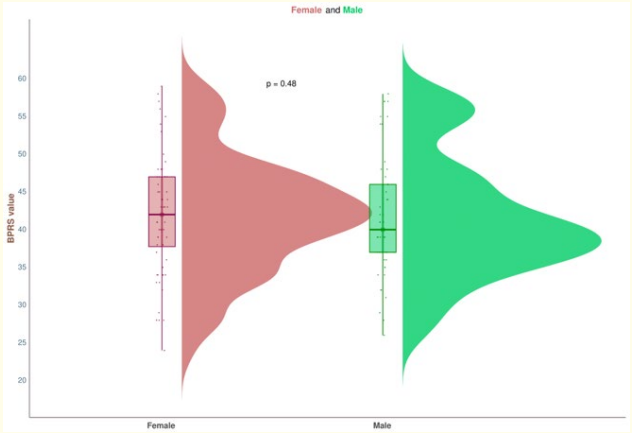

Figure 3: *BPRS scores of the participants.*

The raincloud plots demonstrate the BPRS scores of the female and male participants. The width of the cloud (half-eye) plot corresponds to the number of participants with their BPRS scores on the y-axis. The box-whisker and jitter plots illustrate the BPRS scores. The Wilcoxon test was used to calculate the p-value.

The IgG values and BPRS scores of the female and male participants were used to make a scatter plot. Two regression lines (one for female and another for male participants) were drawn to check the relationship between these values. We found a positive association (r = 0.24, p = 0.68) between BPRS and IgG values [female: (r = 0.27, p = 0.62); male: (r = 0.22, p = 0.71)] The correlation between these parameters is shown in figure 4.

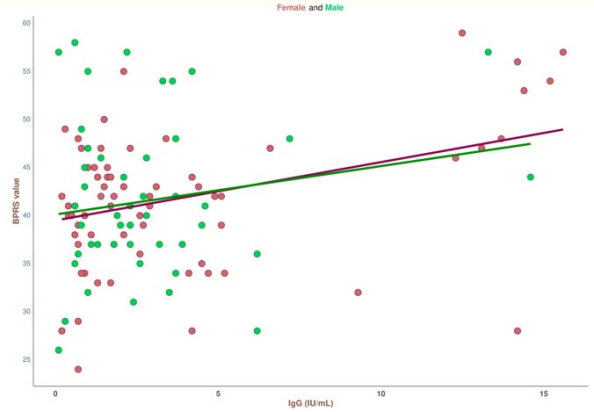

Figure 4: *Correlation between IgG value and BPRS scores.*

The scatter plot portrays the IgG and BPRS values of the female and male participants on the X and Y axes, respectively. We used the Pearson's correlation in our study.

Discussion

In this cross-sectional study, we evaluated and compared the anti-*Toxoplasma* IgG antibodies and BPRS scores of the female and participants. Additionally, we analyzed the correlation between these parameters.

We found that mostly middle-aged persons were diagnosed with both ATPD and toxoplasmosis. Females were more affected than male participants. Only one-tenth of our study population had toxoplasmosis. It suggested a lower prevalence rate of *T. gondii* infection in our institution as compared to the global picture [4,5]. Lately, Bisetegn., *et al*. [15] revealed in their meta-analysis that the pooled prevalence of chronic *T. gondii* infection among patients with neuropsychiatric ailments is around 40%.

Another meta-analysis advocated that chronic *T. gondii* infection increases the likelihood of serious neuropsychiatric illnesses like schizophrenia, psychosis [16]. Recently, Flegr., *et al*. [17] demonstrated the negative impact of latent toxoplasmosis on the mental health. The ill-effect of *T. gondii* infection on cognition, memory, judgement, and higher mental functions are debatable [15-17]. Though we found a positive correlation between the *T. gondii* infection and severity of ATPD, it did not yield any statistical significance.

To the best of our knowledge, this is the first study to elucidate the relationship between toxoplasmosis and psychotic disorder. Our study has a few limitations as well. First, the sample size was relatively small. Second, we did not perform any subgroup analysis based on

the duration of psychotic disorder, the medication history, and comorbidities. Third, we did not evaluate the parameters of the participants at their subsequent visits. Fourth, our study findings lack generalizability as our study population was not heterogeneous.

Conclusion

Toxoplasmosis afflicted middle-aged people, according to our findings. We discovered a positive association between BPRS scores and IgG levels. However, the correlation was not of statistical significance. Hence, studies with larger sample sizes and longer study durations are warranted to generalize the study results.

Acknowledgements

We would like to acknowledge our participants and their family members for their invaluable cooperation and support.

Conflict of Interest

The authors declare that there is no conflict of interest.

Funding Source

The authors declare that there was no external source of funding.

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Volume 7 Issue 12 December 2024