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Toxoplasma gondii Infection and Mental Health: A Neglected One Health Priority

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Abstract. Toxoplasmosis, caused by the parasite Toxoplasma gondii, has traditionally been associated with congenital infection and immunocompromised patients. Recent evidence suggests that latent infection may also contribute to the development of several mental disorders. This paper reviews the epidemiological literature on the association between T. gondii seropositivity and mental health outcomes, with a focus on schizophrenia, bipolar disorder, and suicidal behaviour. The analysis draws on published meta-analyses and systematic reviews. The findings indicate that the association is consistent across multiple studies and that the attributable disease burden is substantial. The paper concludes that T. gondii infection represents a neglected but potentially preventable risk factor for mental illness, and that a One Health approach integrating human, animal, and environmental health offers a practical framework for addressing this issue.

Keywords: Toxoplasma gondii, mental health, One Health, disease burden, prevention policy

1. Introduction

Toxoplasmosis has long been framed as a disease of three specific populations: unborn children, immunocompromised patients, and those who eat undercooked meat. This framing is clinically accurate, but may have inadvertently limited our understanding of the public health significance of T. gondii infection. The parasite establishes lifelong latency in the brain, and in most healthy individuals this chronic infection produces no obvious symptoms [1]. However, a growing body of epidemiological evidence suggests that this 'silent' infection may not be so silent after all, at least not with respect to mental health.

In the past decade, several meta-analyses have shown strong correlations between T. gondii seropositivity and some mental disorders, such as schizophrenia, bipolar disorder and suicidal behaviour [2, 3]. These associations are not statistical anomalies. Recent estimates suggest that the number of cases of mental disease attributable to toxoplasmosis is substantial, and this burden falls disproportionately on low- and middle-income countries, where both infection rates and gaps in mental health treatment are greatest [4].

However, the mental health implications of latent toxoplasmosis are systematically ignored in the dominant global mental health policy frameworks, and no prevention programmes exist for the general public [5]. Against this backdrop, T. gondii infection emerges as a neglected, preventable

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contributor to the global burden of mental illness. This paper reviews the epidemiological evidence, evaluates the disease burden, and makes the case for integrating toxoplasmosis control into mental health prevention strategies through a One Health framework that connects human, animal, and environmental health.

2. Epidemiological evidence and biological context

The association between T. gondii infection and mental disorders is supported by a plausible biological foundation. The parasite can alter dopaminergic signalling, trigger neuroinflammation, and dysregulate the stress-response system, all of which have been independently implicated in psychiatric disorders [3, 6]. Taken together, this mechanistic context provides a rationale for examining population-level evidence.

The epidemiological case for a T. gondii-mental health link rests on 30 years of observational studies culminating in several large-scale meta-analyses. As summarised in Table 1, a 2015 meta-analysis by Sutterland et al. covered 50 independent studies and found that T. gondii seropositivity was associated with almost two-fold increased odds of schizophrenia (OR = 1.81, $p < 0.00001$). Similar effect sizes were found for bipolar disorder (OR = 1.52, $p = 0.02$). Correlations appeared stronger for obsessive-compulsive conditions and substance use disorders, with respective odds ratios of 3.4 ($p < 0.001$) and 1.91 ($p < 0.00001$). However, major depression was not found to be significantly associated (OR = 1.21, $p = 0.28$), which might suggest that parasite-related effects are not evenly distributed across all psychiatric diagnoses [2].

Table 1. Association between T. gondii seropositivity and mental disorders

Disorder	Odds Ratio (OR)	Statistical Significance
Schizophrenia	1.81	$p < 0.00001$
Bipolar disorder	1.52	$p = 0.02$
Obsessive-compulsive disorder	3.4	$p < 0.001$
Addictive disorders	1.91	$p < 0.00001$
Major depression	1.21	$p = 0.28$ (not significant)

A 2024 systematic review has further corroborated these findings, reporting a seroprevalence of 38 % among neuropsychiatric patients versus 25 % in control groups. Individual-study odds ratios for schizophrenia spanned 2.5 to 3.39, showing that some single-study effect sizes exceed the pooled estimate from the 2015 meta-analysis [5]. Patients with bipolar disorder also showed elevated seropositivity (88 % vs 53 %, $p = 0.005$) [5].

In addition to diagnosed psychiatric disorders, the association extends to suicidal behaviour. Another meta-analysis covering 20 studies found a statistically significant association between T. gondii infection and suicide attempts (OR = 1.39, $p = 0.006$). The population attributable fraction was estimated at 10%. This figure implies that roughly one out of ten recorded suicide attempts could be avoided if this parasitic exposure were fully eliminated, though this is a theoretical calculation [7]. For global public health, this is a striking burden stemming from a largely preventable exposure.

Overall, cumulative data from different study populations, research frameworks and diagnostic groups point to strong statistical associations between T. gondii exposure and mental illness. Nevertheless, some methodological limitations are worth mentioning. Most available datasets are

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based on cross-sectional sampling, which poses challenges for determining the direction of causality between infection and psychiatric symptoms.

3. Global disease burden

The cross-sectional nature of most studies leaves a critical question unanswered: if the association is real, how many cases might plausibly be attributable to the infection? This section moves from relative risk to absolute burden.

To grasp the full public health significance, three dimensions matter beyond the statistical association itself: the scale of cases, how this burden is distributed across regions, and what this distribution means for the countries least equipped to respond. These dimensions are interlinked and mutually reinforcing.

3.1. Attributable disease burden

A study by Nessim and colleagues provided the first global estimates. Using prevalence data and pooled odds ratios from existing meta-analyses, they estimated the number of mental disease cases globally that could be attributed to T. gondii infection in 2019 [4].

Table 2. Global mental disease cases attributable to T. gondii infection (2019)

Disease	Attributable fraction (PAF)	Estimated global cases
Schizophrenia	20.4%	4.8 - 5.6 million
Bipolar disorder	27.3%	6.3 - 7.5 million
Self-harm	0.29%	24,000 - 28,000

According to Table 2, schizophrenia and bipolar disorder account for the vast majority of the attributable burden, with approximately one in five schizophrenia cases and more than one in four bipolar disorder cases theoretically linked to the infection [4]. The total across these three outcomes amounts to roughly 11 to 13 million cases. The estimate for schizophrenia is particularly striking. Theoretically, eliminating T. gondii infection could prevent about one in five cases worldwide, a contribution comparable to that of many established risk factors for non-communicable diseases [4].

3.2. Regional variation

The burden is not evenly distributed globally. Nessim et al. mapped the risk of schizophrenia associated with latent toxoplasmosis by country, using a composite measure that combined seroprevalence with estimated effect sizes [4]. As visualised in Figure 1, risk estimates are grouped into four tiers. Red-shaded areas indicate ultra-high-risk countries, with composite scores ranging from 0.439 to 1.338. Orange regions represent high-risk settings (0.230-0.425), yellow corresponds to moderate-risk territories (0.077-0.226), and green shading marks low-risk nations, with scores between 0 and 0.063. The highest-risk countries (with a risk score above 0.439) are concentrated in Latin America, parts of sub-Saharan Africa, and Eastern Europe. By contrast, most of Western Europe, North America, and East Asia fall into the low- or middle-risk categories [4].

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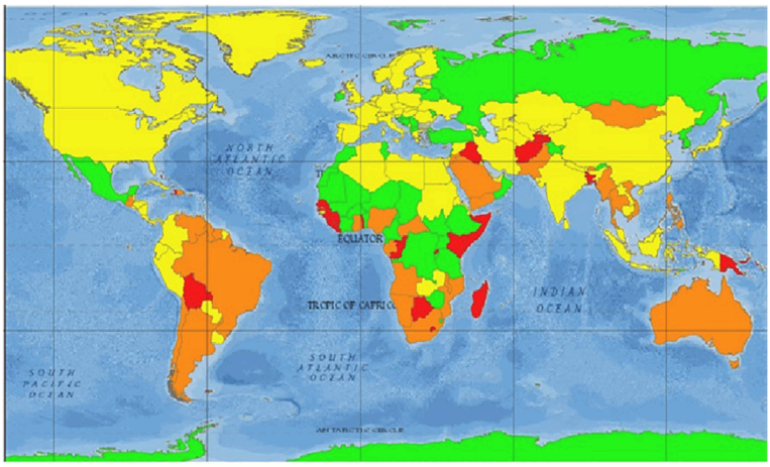

Figure 1. Risk level by country for schizophrenia in seropositive people measured through anti-Toxoplasma IgG antibodies

This pattern matters because the disease burden is not randomly distributed but follows the same ecological gradients as the parasite itself—warmer climates, poorer sanitation, and closer human-animal contact all increase transmission. Moreover, the countries with the highest estimated psychiatric burden from toxoplasmosis are often those least equipped to address it [4]. The fundamental inequity is that those most at risk possess the fewest resources to respond. But it is this inequity that makes action a matter of global health justice and not only of epidemiological interest.

3.3. The triple burden in low- and middle-income countries (LMICs)

These regional disparities matter most for LMICs, which face a triple burden. First, infection rates are higher in tropical and subtropical regions, driven by environmental conditions that favour parasite survival and transmission. Second, mental health treatment gaps are largest precisely where infection burden is highest: in low-income countries, over 90% of people with schizophrenia receive no treatment at all. Third, poverty and infection reinforce each other. Poor sanitation increases exposure to T. gondii; infection may increase the risk of mental illness; and mental illness, in turn, deepens poverty through lost productivity and caregiving costs [8].

The consequences are not hypothetical. In Brazil, where congenital toxoplasmosis is a notifiable condition, the incidence is 14.1 cases per 10,000 live births, resulting in an estimated 53 infant deaths annually [8]. These figures are strongly correlated with social vulnerability indices, indicating that the poorest communities bear the heaviest burden. While congenital toxoplasmosis is a different outcome from the mental health associations discussed here, it serves as a sentinel indicator of what happens when infection prevalence is high and public health infrastructure is weak. The populations with the highest rates of congenital infection are also those with the highest rates of latent infection and the associated potential mental health consequences. These estimates are necessarily imprecise as they depend on assumptions about causality that cross-sectional studies cannot confirm. But even conservative interpretations suggest a burden large enough to merit serious policy attention.

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4. One health framework and prevention

4.1. Limitations of current prevention

Despite the scale of the burden described above, current prevention efforts remain remarkably narrow. Measures such as cooking meat thoroughly, washing vegetables, and wearing gloves when gardening are recommended primarily to pregnant women and immunocompromised individuals [5]. The general public receives limited systematic education about T. gondii exposure risks, with no prevention programmes targeting this population [5]. Furthermore, integrated surveillance linking human, animal, and foodborne data is scarce and fragmented. Veterinary and human health systems operate separately, and environmental monitoring is rarely connected to either [8]. This means that outbreaks or rising infection rates in livestock are not used to warn human health systems. The tools to prevent infection exist, but they are used in isolation and thus miss the opportunity for a coordinated response.

This fragmented approach is not only inefficient; it is also a missed opportunity for mental health. As a 2024 systematic review noted, T. gondii infection is "not considered in the management of psychiatric patients" [5]. The same infection that is monitored in animals, screened for in pregnancy, and tracked in food safety systems is not considered by mental health services. This is the gap that a One Health approach is designed to address.

4.2. Why one health

One Health offers a solution to this fragmentation. Its core premise is straightforward: human health cannot be separated from animal health or environmental conditions. T. gondii is a classic example of this approach. The basic transmission cycle is well understood—felids shed oocysts, the environment becomes contaminated, and humans ingest them through food or water [8]. But the value of a One Health framework extends beyond describing this well-documented cycle. It targets the sectoral silos that hinder coordinated public-health action.

A One Health approach would connect antenatal screening, food safety monitoring, veterinary surveillance, and psychiatric care into a single coherent system. It would mean that a rise in livestock infections triggers an alert not only for food safety authorities but also for clinicians who treat populations at risk. It would integrate psychiatry into a discourse from which it has been largely absent [5]. Rather than introducing entirely new interventions, the framework builds connections among existing public-health measures.

4.3. Prevention opportunities and policy implications

This is not a distant vision. Many of the tools are already available and low-cost, needing only to be scaled beyond their current narrow focus on pregnant women and immunocompromised individuals. In Europe, where meat consumption is a major transmission route, food safety messaging and cooking standards are a logical entry point. In parts of Africa, where water contamination is a more significant factor, improving water quality and sanitation is the priority [4]. Control measures targeting cat faeces, such as regular cleaning of litter boxes and the reduction of free-roaming cat populations, are relevant everywhere.

Beyond community-focused public-health actions, One Health integration also opens new opportunities within clinical psychiatric practice. There is a strong argument for considering toxoplasmosis screening in the care of patients with severe mental illness, especially those with

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treatment-resistant symptoms [9]. If a subset of psychiatric symptoms is exacerbated by a chronic infection, treatment of the infection may improve clinical outcomes for patients who do not respond to standard therapies. Supporting this hypothesis, several studies have reported that antipsychotic medications may have anti-parasitic effects, suggesting that some response to treatment may be partly mediated by the drugs' suppression of brain-resident latent T. gondii [9]. While screening is not yet routine practice, the evidence base is sufficient to justify pilot programmes in psychiatric settings where infection prevalence is high. These clinical interventions complement population-wide food, water, and animal control measures that form a full-spectrum One Health prevention system encompassing both community and hospital settings.

Alongside emerging clinical opportunities, embedding a One Health approach further requires rethinking research priorities and public health governance structures. A starting point is to recognise T. gondii as a research priority in global mental health. At present, funding for psychiatric research is focused on genetics, neurobiology, and psychosocial interventions [10]. Infectious aetiologies are relatively little considered, despite the above epidemiological data. Shifting priorities would not mean abandoning work that has been done; rather, it would add a dimension that has been neglected. Food safety and veterinary surveillance systems should also be better integrated with human health data. As discussed in the previous section, infection trends in animals can act as early warnings for human exposure risks, but only if the data are shared across sectors [8]. This is a relatively inexpensive investment that could have long-term public health gains. Another entry point is screening for antenatal toxoplasmosis. There are guidelines in many countries, but the quality and coverage vary greatly. Improving this established intervention would reduce congenital disease and also the overall reservoir of infection in the population. Public health messaging should also be broadened beyond just pregnant women. Basic information on routes of transmission and prevention can routinely be included in psychiatric outpatient and community mental health services [5]. It does not require expensive campaigns; rather, it requires doctors and health workers to be aware of the risk.

However, there are clear boundaries. Population-wide screening for T. gondii cannot be justified, as the high seroprevalence in most settings would lead to many false positives leading to unnecessary anxiety and overtreatment [11]. Nor should mental illness be framed simplistically as "caused" by infection. Such a narrative would stigmatise patients and obscure the complex interaction of genetic, social, and environmental factors that shape psychiatric outcomes. But these limitations do not weaken the core public health rationale for integrated prevention. They instead help set the scope for safe, appropriate public health action. One Health perspectives leverage existing, but disconnected public health resources, enabling established infection-control measures to also mitigate downstream psychiatric risks.

5. Conclusion

This paper has reviewed the evidence suggesting an association between Toxoplasma gondii infection and a range of mental disorders. Toxoplasmosis represents a substantial modifiable risk factor for mental ill-health, but this pathogen remains largely overlooked within mainstream mental health policy. Existing prevention activities are heavily restricted to pregnant women and immunocompromised populations, which creates protection gaps for the general population and for psychiatric patients in particular. These gaps are most acute in LMICs, where high seroprevalence overlaps with under-resourced mental-health systems. One Health frameworks provide a coherent conceptual model to address such inequities through coordinated human, animal and environmental

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surveillance, combined with a shift in focus from fragmented, population-specific interventions to integrated, cross-sector strategies.

Looking ahead, several areas deserve further investigation. First, integrated cross-sector surveillance drawing on human serology, veterinary records and environmental monitoring can provide early risk alerts for targeted interventions [12]. Secondly, research on the gut-brain axis provides preliminary preclinical evidence: animal models show butyrate-producing bacteria can mitigate T. gondii-triggered neuroinflammation and behavioural disturbances, which could open new adjunctive treatment options for infected people with mental illness [13]. Third, vaccines that reduce oocyst shedding in cats are under investigation, but still in preclinical stage [14]. These findings are preliminary, but they point to the potential for One Health interventions in environmental governance and clinical treatment. Collectively, they point towards a broader reconceptualisation of how infectious disease control, environmental health, and psychiatric care can be brought together. Ultimately, T. gondii is not merely a parasite. It reflects how seriously we take prevention, how broadly we define mental health, and how willing we are to cross the sectoral boundaries that have long constrained public health.

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