Seroprevalence of Toxoplasma gondii infection in HIV-positive and HIV-negative subjects in Gauteng, South Africa

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Introduction

Toxoplasmosis is an infection of warm-blooded vertebrates caused by one of the most common parasites of humans, Toxoplasma gondii. T. gondii is an obligate intracellular protozoan parasite with a worldwide distribution and a varying prevalence between different continents and countries, and even within the same country. There is little known about T. gondii prevalence in Africa. In South Africa, there is limited information about the disease and detailed recent demographic data of groups at risk are missing. The seroprevalences of T. gondii antibodies in samples of selected populations, namely HIV-positive male and female subjects, and HIV-negative pregnant women in the Gauteng province, were therefore investigated and found to be 9.8% (95% confidence interval: 7.1%-13.4%) and 12.8% (CI: 8.9%-15.8%), respectively. A more general population sample (but biased towards pregnant women) showed a 6.4% (CI: 4.5%-9%) seroprevalence. These results show that T. gondii infection is present in South Africa, but its prevalence is much lower than previously reported in this region. While the burden of disease has been reduced in recent times, a low prevalence means that more previously unexposed people are at risk of acquiring an acute infection, which may cause congenital disease in pregnant women, or which, in reactivation form, may ultimately be life-threatening in HIV/AIDS patients.

Materials and methods

Prospective serosurvey in HIV-positive subjects

Patients enrolled in the antiretroviral (ARV) treatment programme at the Chris Hani Baragwanath Hospital in Soweto, Johannesburg, were invited to participate in the study. This work was done under ethics clearance from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand and informed consent was obtained from all participants.

Two tubes of blood (EDTA-anticoagulated and clotted) were drawn from each of 376 patients. Using the Pastorex Toxo latex particle agglutination test (Bio-Rad, France), serum samples were tested in duplicate according to the manufacturer's protocol. All discrepant, positive and indeterminate results were then retested and titrated using the BioMérieux Toxo-Screen DA test (BioMérieux SA, France), which was the
reference test for this part of the study as it corresponds to the Sabin-Feldman test, the traditional gold standard.

All BioMérieux test-negative results were further tested for IgM using indirect immunofluorescence (IF), because the BioMérieux test only detects IgG, whereas the Pastorex test detects both IgG and IgM.

**Retrospective serosurvey of rubella study subjects**

The retrospective serosurvey involved the use of 497 serum samples, mainly but not exclusively encompassing children and pregnant women, randomly selected from a residual serum bank previously collected for a rubella prevalence study. The age spectrum of selected subjects was wide, but most were young adults. HIV status was not determined. These subjects represent a more geographically diverse general population. Samples were tested using the Axsym Toxo IgG (Abbott Laboratories, Illinois, USA) automated enzyme immunoassay (EIA) to measure IgG antibodies to *Toxoplasma* antigens.

**Results**

Thirty-seven of 376 HIV-positive patients had antibodies to *T. gondii*, and the overall prevalence in this sample was 9.8% (95% confidence interval: 7.1%-13.4%). Forty-eight of the 376 HIV-negative samples were seropositive. An overall prevalence of 12.8% (95% CI: 8.9%-15.8%) in this sample was calculated. Thirty-two of 497 samples tested by EIA were positive for antibodies to *T. gondii*, and the overall prevalence was 6.4% (95% CI: 4.5%-9%). IF showed no IgM positive samples. Figure 2 shows the percentage seropositivity of each of the three sample groups. Rates of anti-*T. gondii*-antibody presence in HIV-positive and HIV-negative samples were significantly different (p value <0.05, chi-square test).

Figure 2: Toxoplasmosis seropositivity of HIV-positive, HIV-negative, and general population samples, South Africa

**Discussion**

This study has shown the prevalence of anti-*T. gondii* antibodies in an HIV-positive population in Soweto, Johannesburg, to be 9.8%. A comparable HIV-negative population showed a prevalence of 12.8%. The rubella study sample had the lowest prevalence at 6.4%, suggesting a lower risk of toxoplasmosis in the wider South African population. These prevalences are lower than those reported in a previous study by Jacobs and Mason in 1978, who examined the seroprevalence of *T. gondii* in four regions of southern Africa (KwaZulu-Natal, Western Cape, Eastern Cape and the combined Namibia and Botswana region) among five different ethnic groups (blacks, whites, coloureds, Indians and San). An overall prevalence of 20% was found among these different regions and population groups. The highest prevalence of 30% was found in KwaZulu-Natal, and the lowest in Namibia and Botswana (11%). By ethnicity, Indians and blacks had the highest prevalences, followed by the coloured, white and San populations, respectively.

In 1974, Mason et al showed an overall prevalence of 37% in the then Transvaal province of South Africa. The highest prevalence in this area was among the Indian population (58%), followed by coloured (43%), white (33%) and black (29%) populations.

Schneider et al investigated the *T. gondii* prevalence in women of different ethnic groups in Durban, KwaZulu-Natal province, in 1992. An overall prevalence of 31.3% was found and the highest prevalence here was among the black population (46.2%), followed by the Indian (36.9%), coloured (28.3%) and white (12.5%) populations.

A study on toxoplasmosis and HIV infection in South Africa by Sonnenberg et al was carried out at the Gold Fields West Mine Hospital. Patients originated from several different home regions, such as the Eastern Cape and KwaZulu-Natal provinces, Lesotho and Mozambique, and an overall prevalence of 24.6% was found.
Hari et al investigated *T. gondii* seroprevalence in 307 consecutive HIV-infected medical inpatients in 2007 at the Helen Joseph Hospital in Johannesburg. All patients were black and ARV naïve and did not receive toxoplasmosis prophylaxis. An overall prevalence of 8% was found, with only two patients showing clinical manifestations. In these two studies, symptomatic HIV-positive hospitalised patients were tested; one reason for the substantial difference in prevalence might be socio-economic, namely a bias towards rural and expatriate subjects among the miners.

The retrospective serosurvey reported here, targeting a geographically diverse population sample with a high proportion of pregnant women and children, showed a 6.4% prevalence of anti-*T. gondii* antibodies. This prevalence is lower than that reported by Schneider et al, but the populations sampled were not directly comparable.

These prevalences are also lower than those reported for other parts of Africa, as well as other continents. A study by Woldemichael et al in Ethiopia on HIV-positive and HIV-negative adults showed an 80% prevalence. Simpore et al showed a 25.3% prevalence in pregnant women in Burkina Faso, and Lindström et al showed a 54% prevalence in HIV-positive adults in Uganda.

There are several possible explanations for the low prevalences found in this study, as well as the reported historical differences in prevalences between regions. In some HIV/AIDS patients, the failing immune system may be unable to produce or maintain detectable levels of antibodies. As a result, antibody tests may be less sensitive as an indicator of infection in this group, and this may account for the lower prevalence in the HIV-positive sample. However, evidence against this being an important factor is that a sufficient proportion of HIV-positive patients have detectable levels of antibodies to make such testing of clinical value.

A less pathogenic clonal lineage of the parasite may be present in South Africa compared to the rest of Africa and other continents. Very little is known genetically about *T. gondii* in Africa. However, a study by Lindström et al found that the genotype distribution in Uganda appears to be similar to that found in Europe among immunocompromised individuals. The type II allele of the SAG2-locus was the most common disease-causing strain found. Nothing is known about *T. gondii* strains affecting humans in South Africa, further studies will be required in this regard.

Previous studies on *T. gondii* in South Africa date back to 1974, which was during the apartheid era and prior to the emergence of the HIV epidemic. Prevalences reported in these earlier studies were higher than those found in this study and other more recent ones. This may be due to current differences in socio-economic and cultural factors.

The development of better farming practices and the widespread use of freezers and frozen meat, as well as pasteurised milk, means that some of the risk factors for acquiring *T. gondii* infection have been reduced.

Climatic conditions may account in some part for the global variation in *T. gondii* prevalence. The climate across much of Africa is generally uniform, with considerably less climatic variation between seasons when compared to Europe and North America. *T. gondii* prevalence on this continent is generally lower than that of Europe and North America; climatic and topographical factors may account for these lower prevalences.

In South Africa, the climate may also contribute to the differences in prevalence between different provinces. In KwaZulu-Natal, a study by Bhigjee et al showed that toxoplasmosis was the most frequent cause of intracranial mass lesions (comprising 52%) in HIV-positive patients. Modi et al, however, found that tuberculosis, not toxoplasmosis, was the most frequent cause of focal brain lesions in a Gauteng population. KwaZulu-Natal and Gauteng provinces fall in different climatic regions. KwaZulu-Natal is generally hot with high humidity and rainfall, while Gauteng generally has low humidity and moderate rainfall. These differences in climate may contribute to the differences in prevalences. Prevalences might be expected to be higher in hotter, wetter areas, as these conditions are more favourable for the sporulation of oocysts. This trend is also evident in the seroprevalence of *T. gondii* in sheep in South Africa, which is higher in the humid coastal regions (KwaZulu-Natal: 6.3%, Eastern Cape: 7.75%) and lowest in the arid regions (Gauteng: 6%, Free State: 2.7%).

Differences between reported prevalences may also be due to different sampling procedures and assay methods. Various tests have different sensitivities, specificities, false-positive rates and false-negative rates. These factors need to be considered when comparing studies. Generally, more sensitive and specific assays are now available and this could account for the variability in prevalences reported in more recent studies.

This study helped to answer questions relating to the current seroprevalence and diagnosis of *T. gondii* in South Africa. Many questions still remain to be answered, however, to fully understand the impact of this parasite in our country and to help implement solutions aimed at reducing risk for this curable but potentially fatal disease. Lower prevalences mean more people at risk for acute and reactivation disease and a greater need for public health interventions, such as improved education about risk reduction. The growing AIDS epidemic and the emergence of drug-resistant HIV strains are a disturbing reminder that opportunistic infections such as toxoplasmosis, even at low prevalences, remain a major potential threat to human health.

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References