Serosurvey of anti-Toxoplasma gondii and anti-HIV antibodies in homeless persons of southeastern Brazil

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Abstract

Background: Homeless persons have been described as one of the most vulnerable populations worldwide, with higher morbidity and mortality of diseases associated with HIV occurrence. Seroprevalence of *Toxoplasma gondii* and HIV has been extensively studied in other vulnerable populations, however, no study to date have focused on their concomitant seroprevalence in homeless persons. Accordingly, the present study aimed to assess the concomitant seroprevalence of anti-*T. gondii* and anti-HIV antibodies and associated risk factors in homeless persons in a daytime homeless shelter of São Paulo, southeastern Brazil.

Methods: Anti-*T. gondii* antibodies were detected by indirect fluorescent antibody test and anti-HIV levels by chemiluminescence enzyme immunoassay, with positive samples confirmed by rapid immunoblot assay.

Results: Overall, IgG anti-*T. gondii* seropositivity was found in 43/120 (35.8%) homeless persons, with endpoint titers varying from 16 to 1,024. The only two pregnant women tested were negative for IgM by chemiluminescence enzyme immunoassay, with normal parturition and clinically healthy newborns in both cases. There were no statistical differences in the risk factors for anti-*T. gondii* serology ($p>0.05$). Anti- HIV seropositivity was found in 2/120 (1.7%) homeless persons, confirmed as HIV-1. One HIV seropositive individual was also sero-reactive to IgG anti-*T. gondii,* and both were negative to IgM anti-*T. gondii.* One HIV positive person was also diagnosed with syphilis, tuberculosis and body lice presence, while the other never returned for assistance. No evaluation of anti- HIV risk factors has been made due to the low seropositive rate.

Conclusions: The anti-*T. gondii* prevalence herein was lower than other Brazilian populations, likely related to predominant intake of processed food such as ready-to-eat and fast-food meals, and thus, low ingestion of fresh salad and raw meat. On the other hand, the anti- HIV seropositivity was higher than the average of the general Brazilian population, with 0.4%. Despite the low prevalence of anti-*T. gondii* in homeless persons, clinical manifestations may be aggravated in HIV positive individuals. To the author's knowledge, this is the first study of anti-*T. gondii* serosurvey in homeless persons concomitantly assessed with anti-HIV seropositivity.

Background

Homeless persons have been described as one of the three most vulnerable populations, along with refugees and incarcerated persons [1]. Morbidity and mortality of diseases have been reportedly higher in homeless than general population, probably due to social inequality associated with lack of settled home, job opportunity, and a series of family problems including drug addiction, mental health disorders, and social justice issues, mostly exacerbated by absence of health assistance [2]. A population of 1.6 billion people without adequate housing has been estimated worldwide, of which 100 million are homeless [3, 4]. In Brazil, the nationwide homeless population has been estimated in 101,854 individuals, with about 40.1% living in cities with over than 900,000 inhabitants and about 16,000 living on streets of São Paulo city [5, 6].

Toxoplasma gondii is a coccidian parasite relying on cats and other Felidae as definitive hosts, which may shed fecal oocysts infecting a variety of homeothermic intermediate hosts [7]. Human infection has been typically subclinical or asymptomatic, with the time of infection and transmission route not known in most cases [8, 9]. Although human T. gondii seroprevalence has been extensively reported, ranging from 0.8–77.5% worldwide [10], few reports are available for vulnerable populations including 123/597 (20.6%) aboriginal individuals of Thailand, 236/628 (37.6%) prisoners of Turkey, mostly (92.8%) males, and 63/199 (31.7%) pregnant refugee and borderline migrant women of Asia [11–13].

Human immunodeficiency virus (HIV) has been considered one of the leading causes of morbidity and deaths worldwide, with around 75 million infected people to date [14, 15]. A recent estimative has indicated 37.9 million HIV people living worldwide, with 1.7 million new infections and 770,000 related deaths [16]. Homeless persons has been considered one of the most susceptible populations to HIV infection, mainly related to social vulnerability and limited access to prevention measures such as high-risk groups including former convicts, crack and cocaine users, sex workers, minority groups, and people with mental health disorders [17–20].

In large USA cities, HIV has ranged from 1.8 to 20% among homeless persons, about 6-fold higher than the 0.3% seroprevalence found in the general American population [21–23]. In Brazil, out of 247,795 reported HIV cases between 2007 and 2018, 117,415

(47.4%) persons were from the southeastern region, where Sao Paulo is located [24]. Studies in Brazilian general homeless population have shown HIV positivity in 6/330 (1.8%) and 69/1,405 (4.9%) individuals of Sao Paulo city, and 6/481 (1.2%) in another city of central-western Brazil [20, 25, 26]. In two studies of homeless populations co-infected with HIV and tuberculosis, prevalence varied from 4.4% in Minas Gerais to 17.3% in São Paulo, both southeastern Brazilian states [20, 27, 28].

Homeless overlapping risk groups have also shown high HIV prevalence rates, such as 3.4% in persons deprived of liberty and 19.1% in trans women in a worldwide metanalysis study, 460/1,637 (28.1%) in sex workers of sub-Saharan Africa, and 17-fold higher chance to have HIV in refugee mothers of Canada when compared to Canadian-born mothers [29–31]. In Brazil, 15/2,237 (0.7%) people with mental disorders, and 25/333 (7.5%) migrants from Venezuela were positive for HIV [32, 33]. In addition, immunological impairment caused by HIV may aggravate co-infections, with a tendency of severe clinical manifestations in HIV-toxoplasmosis combination [14, 34]. HIV patients have also been associated with increased susceptibility of T. gondii invasion into the central nervous system and toxoplasmic encephalitis, mostly caused by bradyzoite conversion to active forms and rapidly replicating tachyzoites [35–38].

HIV-T. gondii co-infection prevalence varies widely in general populations, from 35.8% worldwide and up to 88.4% in Ethiopian individuals, according to meta-analysis studies [39, 40]. Other vulnerable populations also presented HIV-T. gondii co-infection, such as in 31/42 (73.8%) drug users in Iran and 84/342 (24.6%) drug users in China [41, 42]. Opportunistic infection with T. gondii in HIV-infected homeless persons may represent a serious public health threat, particularly due to the absence or discontinuity of antiretroviral therapy [43–45].

Although T. gondii and HIV seroprevalence has been reported in a variety of vulnerable populations, no study has focused on concomitant seroprevalence in homeless populations. Accordingly, the present study aimed to assess the seroprevalence of anti-T. gondii and anti-HIV antibodies, concomitant infection and the associated risk factors for exposure in homeless persons from São Paulo city, southeastern Brazil.

Material And Methods

Local of Study

The present study represents a descriptive cross-sectional seroepidemiological approach of the homeless population from the western São Paulo city (23°33'1"S, 46°38'2"W) shelter (Social Center “Our Lady of Good Delivery”), responsible for daytime attendance of all the city region. The shelter is a Non-Governmental Organization (NGO), sponsored by a city partnership daily attending around 800 to 1,200 homeless persons, providing meals, medical assistance, job opportunities, and recreational activities.

São Paulo city, capital of São Paulo State, southeastern Brazil, has been ranked as the most populated city with 11,253,500 inhabitants and the largest Gross Domestic Product (GDP) of Brazil, and the most populated city and the tenth-largest GDP of Latin America, with a very high Human Development Index (HDI) (0.805). The city is located under a humid subtropical climate with average temperatures ranging from 19 °C (winter) to 25 ºC (summer) [46].

The present study was conducted along with the city multi-task professionals team at the São Paulo City Secretary of Health, called “street outreach office”, which includes physicians, nurses, dentists, social assistants, and psychologists, based on the strategy of the Brazilian Unified Health System [47]. This city official team offers permanent assistance and save clinical records of the homeless population, promoting health actions on a continuing care bond.

Epidemiological data collection

Epidemiological analyses were performed based on a questionnaire associated with homeless persons exposure to T. gondii and HIV, which included: 1) Demographic profile: sex, marital status, racial self-declaration, age, educational background, income, and city of origin; 2) Social profile: travel to other cities, communication with family, causes for becoming homeless, homelessness time, resting place, have children, have own children, pregnant woman, live alone, pet owner, use of licit and illicit drugs, alcohol consumption, tobacco use, marijuana use, cocaine use, crack use, assistance by the Psychosocial Care Centers (CAPS) as part of

the free national Unified Health System; 3) Hygiene profile: bath frequency, change of clothes frequency, wash clothes, body lice (Pediculus humanus humanus) bites, and body lice presence (S1 Dataset). Refusal to fully or partially answer any question or incomplete answers were accepted and registered.

Sample Collection

A minimal sampling of 71 individuals was calculated using commercially available software (Epi Info 7.7.7.6) based on an estimative of 16,000 homeless persons in São Paulo City and homeless HIV infection prevalence of 4.9% [20]. Blood samples of homeless persons were conveniently collected in São Paulo city from June to August 2018. Homeless persons were voluntarily invited to participate, and blood collection was performed by cephalic puncture. Samples were placed in tubes without anticoagulant and kept at 25 °C until visible clot retraction. Serum was separated by centrifugation at 3,000 revolutions per minute for 10 minutes and stored at -20ºC until processing.

In addition, the packed cell volume (PCV) by capillary tube centrifugation and total plasma protein (TPP) by refractometry were performed on the day of sampling and immediately given to the shelter administration. Due to the shelter demand, homeless persons were also examined for body lice (Pediculus humanus humanus) bites and presence, as previously described at the same shelter [48]. The University made a clothing donation drive during the study and researchers offered clean clothes to all lice-infested homeless persons.

Serological diagnosis

Detection of T. gondii antibodies was performed by indirect immunofluorescent antibody test (IFAT) [49], with serial serum dilutions of 1:16 to 1:4,096 performed in pH 7.2 phosphate-buffered saline solution (PBS) with the cut-off titer of ≥ 16 IU. Immunofluorescence slides were previously sensitized with 0.1% formaldehyde to inactivated tachyzoites of T. gondii (RH strain) obtained from an intraperitoneal lavage in Swiss mice after three days of inoculation. A commercial anti-human IgG antibody, conjugated with fluorescein isothiocyanate (Bethyl Laboratories, Montgomery, TX, USA) was used as secondary antibody. For positive samples, the highest titer was considered with at least 50% of fluorescence on the border of tachyzoites.

Detection of HIV was performed by chemiluminescent microparticle immunoassay (CMIA) (Alinity´s HIV Ag/Ab Combo Reagent Kit, Abbott Laboratories, Chicago, IL, USA) used for the simultaneous qualitative detection of HIV p24 antigen and antibodies to HIV type 1 (HIV-1 group M and group O) and/or type 2 (HIV-2) in human serum. HIV-1/HIV-2 antigen and HIV-1 p24 antibody (mouse IgG, monoclonal) coated paramagnetic microparticles, assay diluent, HIV-1/HIV-2 synthetic peptides and HIV-1 p24 antibody acridinium-labeled conjugate were added to create a reaction. The resulting chemiluminescent reaction was measured as relative light units (RLU).

The presence or absence of HIV-1 p24 antigen and/or HIV-1/HIV-2 antibodies in the sample was determined by comparing the chemiluminescent RLU in the reaction to the cut-off RLU determined from an active calibration. Cases of reactive serology were confirmed by a commercially available rapid immunoblot assay (DPP HIV1/2®, Fiocruz, Rio de Janeiro, Brazil).

Samples of the pregnant woman and the HIV-positive individuals were tested for T. gondii IgM presence by CMIA (Anility´s Toxo IgM Reagent Kit, Abbott Laboratories, Chicago, IL, USA). The immunoassay was performed in two steps for the qualitative detection of IgM antibodies to T. gondii in human serum. Paramagnetic microparticles coated with anti-human IgM monoclonal antibody were combined with serum samples and when present, the anti-T. gondii specific IgM was bound. The conjugate complex consisted of an acridinium-labeled anti-T. gondii p30 F (ab ') 2 monoclonal fragment and added a native T. gondii lysate containing the p30 antigen, ligated by anti-T. gondii specific IgM and forming an antibody-antibody conjugate complex, with the resulting chemiluminescent reaction measured as RLU. As for anti- HIV antibodies, the presence or absence of anti-T. gondii IgM in the sample was determined by comparing the chemiluminescent signal in the reaction with the cutoff signal determined from an active calibration curve.

Statistical analysis

Statistical analysis was performed using SPSS 20.0 [50]. Frequencies of T. gondii and HIV seropositivity (absolute and relative) were determined by the stratification of the observations according to demographic, social, and hygiene profiles. The Chi-Square

test was used to determine the bivariate association between studied variables, and odds ratios (OR) were used for the association of T. gondii prevalence and potential risk factors.

Results

Overall, anti-T. gondii antibodies were detected in 43/120 (35.8%, CI 95%) homeless persons, with endpoint titers varying from 16 to 1,024. No statistical differences were found regarding risk factors for anti-T. gondii exposure ($p > 0.05$) in homeless persons (Table 1).

Table 1

Statistical results of univariate and multiple logistic regression models of associated risk factors for seropositivity of IgG anti-T. gondii antibodies in homeless persons.

T. gondii									
Risk Factor		Total		Positive		Negative		p-value	OR
		N	% of total	N	% of line	N	% of line		
1) Demographic profile									
Sex	Male	107	89.2	41	38.3	66	61.7	0.282	0.48(0.12–1.85)
	Female	13	10.8	3	23.1	10	76.9		
Marital Status	Unmarried	108	90.0	41	38.0	67	62.0	0.377	0.54(0.13–2.12)
	Accompanied	12	10.0	3	25.0	9	75.0		
Racial self-declaration	White	28	23.3	8	28.6	20	71.4	0.310	1.60(0.64–4.03)
	Non-white	92	76.7	36	39.1	56	60.9		
Educational background	None to 8th grade	91	75.8	34	37.4	57	62.6	0.438	0.72 (0.32–1.64)
	High School and University	29	24.2	9	31.0	20	69.0		
Income	No income	99	84.6	37	37.0	63	63.0	0.879	1.08(0.38–3.03)
	With income	18	15.4	7	38.9	11	61.1		
City of origin	São Paulo city	38	32.2	12	31.6	26	68.4	0.404	1.41(0.62–3.02)
	Other cities	80	67.8	32	39.5	49	60.5		
Travel to other cities	Yes	23	20.2	33	36.3	58	63.7	0.799	1.13(0.44–2.89)
	No	91	79.8	9	39.1	14	60.9		
2) Social profile									
Contact with family	Yes	66	55.9	23	34.8	43	65.2	0.582	1.22(0.58–2.59)
	No	52	44.1	21	39.6	32	60.4		
Causes for becoming homeless	Alcohol and drugs	28	23.3	9	32.1	19	67.9	0.736	1.16(0.47–2.89)
	Family conflicts	48	40.0	19	39.6	29	60.4	0.360	0.69(0.32–1.51)
	Housing loss	13	10.8	3	23.1	10	76.9	0.347	1.89(0.49–7.33)
	Other	18	15.0	9	50.0	9	50.0	0.140	0.47(0.17–1.30)
	Unemployment	34	28.3	10	29.4	24	70.6	0.433	1.41(0.59–3.35)
Resting place	Hostel	68	45.3	26	38.2	42	61.8	0.683	0.85(0.40–1.81)
	Street	52	34.7	18	34.6	34	65.4	0.905	1.05(0.43–2.54)

* The percentages can go higher than 100% because individuals could answer more than one option.

T. gondii									
	Occupancy	30	20	10	33.3	20	66.7	0.662	1.21(0.50–2.90)
Pregnant woman	Yes	2	1.7	0	0.0	2	100.0	0.278	*
	No	118	98.3	44	37.3	74	62.7		
Have children	Yes	81	67.5	33	40.7	48	59.3	0.182	0.57(0.25–1.30)
	No	39	32.5	11	28.2	28	71.8		
Have own children	Live together	4	5.1	0	0.0	4	100.0	0.087	*
	Other people	74	94.9	32	43.2	42	56.8		
Live alone	Yes	52	46.0	19	36.5%	33	63.5%	0.815	0.91(0.42–1.97)
	No	61	54.0	21	34.4%	40	65.6%		
Pet owner	Yes	26	22.4	12	46.2	14	53.8	0.231	0.58(0.24–1.41)
	No	90	77.6	30	33.3	60	66.7		
Dog owner	Yes	21	18.1	11	52.4	10	47.6	0.088	0.44(0.16–1.14)
	No	95	81.9	31	32.6	64	67.4		
Cat owner	Yes	6	5.2	2	33.3	4	66.7	0.880	1.14(0.20–6.52)
	No	110	94.8	40	36.4	70	63.6		
Use of licit and/or illicit drugs	Yes	91	75.8	35	38.5	56	61.5	0.470	0.72(0.29–1.75)
	No	29	24.2	9	31.0	20	69.0		
Alcohol consumption	Yes	52	43.3	18	34.6	34	65.4	0.471	0.76(0.36–1.60)
Tobacco use	Yes	32	26.7	16	50.0	16	50.0	0.068	0.46(0.20–1.06)
Marijuana use	Yes	31	25.8	12	38.7	19	61.3	0.784	0.88(0.38–2.06)
Cocaine use	Yes	34	28.3	12	35.3	22	64.7	0.844	1.08(0.47–2.48)
Crack use	Yes	16	13.3	7	43.8	9	56.2	0.528	0.71(0.24–2.06)
Other drugs	Yes	5	4.2	3	60.0	2	40.0	0.269	0.36(0 05–2.30)
Assistance by Psychosocial Care Centers (CAPS)	Yes	31	25.8	10	32.3	21	67.7	0.554	1.29(0.54–3.08)
	No	89	74.2	34	38.2	55	61.8		
3) Hygiene profile									
Bath frequency	Daily	99	82.5	34	34.3	65	65.7	0.252	1.73(0.67–4.50)
	Sporadic	21	17.5	10	47.6	11	52.4		

* The percentages can go higher than 100% because individuals could answer more than one option.

T. gondii									
Wash clothes	Yes	82	69.5	30	36.6	52	63.4	0.978	1.01(0.45–2.24)
	No	36	30.5	14	36.8	24	63.2		
Change clothes frequency	Daily	50	42.7	17	34.0	33	66.0	0.838	1.08(0.50–2.33)
	Sporadic	67	57.3	24	35.8	43	64.2		
Body lice bite	Yes	63	59.4	23	36.5	40	63.5	0.752	1.13(0.51–2.52)
	No	43	40.6	17	39.5	26	60.5		
Presence of body lice	Yes	17	14.2	4	23.5	13	76.5	0.225	2.06(0.62–6.77)
	No	103	85.8	40	38.8	63	61.2		
* The percentages can go higher than 100% because individuals could answer more than one option.									

Associated risk factors for the presence of anti-T. gondii were not statistically significant regarding educational background (p = 0.438), income (p = 0.805), resting place (hostels, street, occupancy) (p > 0.05), pregnancy (p = 0.567), pet owner (p = 0.399); cat owner (p = 0.916), bath frequency (p = 0.652), age (p = 0.223), and homelessness time (p = 0.827) (Table 2). The homeless persons sampled were mostly men counting 107/120 (89.2%) individuals, with 39/107 (36.8%) seropositive samples for T. gondii. On the other side, women accounted for 13/120 (10.8%) with 3/13 (23.1%) positive samples. Despite in lower number, eight women were within the reproductive age of 24 to 35 years old, and 7/8 (87.5%) presented negative serology for T. gondii, including the two pregnant homeless women exposed to infection. Fortunately, the two pregnant women tested negative for anti-T. gondii antibodies in both IgG by IFAT and IgM by CMIA, with normal parturition and clinically healthy newborns in both cases.

Table 2

Average, median and standard deviation (SD) of T. gondii positive and negative homeless persons according to age (years), homelessness time (months), number of children, number of dogs, number of cats, packed cell volume (PCV), total plasma protein (TTP).

T. gondii							
Risk Factor	Negative			Positive			p-value
	Average	Median	SD	Average	Median	SD	
Age (years)	43.55	44.50	14.03	41.18	42.50	11.96	0.412
Homelessness time (months)	67.68	36.00	78.43	85.10	36.00	103.60	0.557
Number of children	2.19	1.00	4.02	2.07	2.00	2.08	0.385
Number of dogs	0.34	0.00	1.27	0.62	0.00	1.40	0.081
Number of cats	0.05	0.00	0.23	0.17	0.00	0.82	0.928
PCV	42.46	42.00	4.00	42.84	44.00	4.40	0.629
TPP	7.65	7.60	0.63	7.64	7.60	0.52	0.918
SD, standard deviation; PCV, packed cell volume; TTP, total plasma protein.							

A total of 2/120 (1.7%, 95% CI) anti-HIV seropositive homeless persons were detected by CMIA and confirmed by rapid immunoblot assay tests. No evaluation of HIV risk factors was made due to low seropositive rate. One anti-HIV seropositive homeless individual was also seroreactive to anti-T. gondii, but both were negative to anti-T. gondii IgM. The combined anti- HIV and anti- T. gondii positive person was also diagnosed with syphilis, tuberculosis and body lice presence, while the other one was negative for these diseases and never returned for proper HIV assistance.

Discussion

To the authors' knowledge, this is the first study reporting the seroprevalence of anti-T. gondii in homeless persons, as well the first concomitant anti-T. gondii and anti-HIV seroprevalence associated with risk factors.

The seroprevalence of anti- T. gondii antibodies herein (35.8%) was higher than other vulnerable populations, such as aborigines (20.6%) and pregnant refugee and borderline migrant women (31.7%) but similar to incarcerated populations (37.6%) [11–13]. In Brazil, the anti-T. gondii seroprevalence herein was higher than the general population of the northeastern region, with 14/65 (21.5%) seropositive urban students, but lower than the central-western region, with 113/116 (97.4%) farmers from a single dairy cattle farm with domestic cats and potentially contaminated environment [51, 52]. Interestingly, the seroprevalence of anti-T. gondii antibodies in the present study was lower than other Brazilian neglected populations, such as 131/231 (56.7%) persons of riverside communities in the northern and 119/148 (80.4%) indigenous persons in the central-western region [53, 54]. In São Paulo, similar results were found, with 110/339 (32.4%) seropositive children from a low-socioeconomic community [55]. Not surprisingly, a previous study has shown an association between high seropositivity for T. gondii and socioeconomic vulnerability in southern Brazil, with 526/715 (73.57%) seropositive individuals, particularly in low-income families [56].

Although low education and socioeconomic status have been associated with increased risk of T. gondii infection in different Brazilian studies [57–59], no statistical association with T. gondii infection was previously found regarding educational background and income, probably due to the broadly variable classification of and the low population homogeneity [60, 61]. Similarly, no association was found in either education or income, likely associated to the impact of the vulnerable living style, with mostly drug addicts with poor eating habits.

Since the low socioeconomic status may be associated to malnutrition and might impair the host defense against protozoan infection, the relatively low seroprevalence of anti- T. gondii antibodies in homeless herein may be consequence of mainly consumption of ready-to-eat foods, as already indicated by previous studies on homelessness and food preparation facilities, which have reported dependence on charity meals such as pre-prepared foods, processed foods or popular snacks [62–65]. Not surprisingly, pre-processed ready-to-eat and meat-based foods have been shown to inactivate T. gondii cysts [66].

In addition, healthier and more expensive items such as meat, fish, vegetables, and fruits have been less often consumed by homeless [62, 65, 67, 68], which may be a contributing factor to the low T. gondii seroprevalence found in this study. Hence, it is reasonable to speculate that the beneficial shelters, hostels, and meal services may have offered protection to the homeless population [65, 69] but not as nutritional good food habits when compared to the general population. Although no homeless persons has been diagnosed with either anemia by packed cell volume (PCV) or hypoproteinemia by refractometry, such tests may not have enough sensitivity to detect chronic alimentary deficiencies, which should be further investigated.

A previous study with pregnant women has shown high seroprevalence of specific anti-T. gondii antibodies (68.4%; 333/487) and vertical transmission associated with social vulnerability in central Brazil [70]. In the present study, despite negative for both IgG and IgM anti- T. gondii antibodies, the two pregnant women sampled, fortunately, gave birth to clinically healthy babies. T. gondii infection during pregnancy has been a significant problem, especially during the first months, and may result in spontaneous abortion, fetal and/or neonatal death or several congenital disabilities such as hydrocephalus, central nervous system disorders, and chorioretinitis [71, 72]. In the second and third trimester, newborns have usually been asymptomatic, with symptoms appearing late in childhood or early in adulthood, and may sporadically cause visual impairment [71, 73, 74]. In addition, congenital toxoplasmosis may also be associated with reactivation of the chronical maternal infection, particularly in HIV-infected and immunosuppressed women [75]. As 7/8 (87.5%) women herein were within reproductive age and presented negative serology for T. gondii, the homeless may be highly unprotected to infection during pregnancy.

Although the present study has shown no association between T. gondii infection and pet ownership, including stray cat owners, corroborating with previous studies in rural and other vulnerable populations of southern Brazil [56, 60], only 6/120 (0.5%) homeless persons owned a total of 11 cats. Outdoor lifestyle of stray cats may include hunting of birds and rodents, leading to raw meat dietary habits and increased risk of T. gondii ingestion [76]. Nonetheless, human toxoplasmosis outbreaks may be attributed to exposure to infected cats, which may indicate an important role of cat oocyst excretion on infection spreading [77,

78], and homeless might be daily overexposed to environmental contamination. However, as mentioned above, homeless dietary habits of high intake of processed foods and low fresh meat, fish, vegetables and fruits may have led to lower T. gondii exposure.

Despite the HIV seroprevalence of 2/120 (1.7%) in homeless persons was above the estimated prevalence of 0.4% for the general Brazilian population and lower than a recent study with 69/1,402 (4.9%) seropositive homeless, was similar to other studies that showed 6/481 (1.2%) and 6/330 (1.8%) prevalence in homeless persons in Brazil, 181/10657 (1.7%) in Iran and 6/329 (1.8%) homeless women in the USA and within worldwide HIV prevalence in homeless persons ranging from 0.6% in Los Angeles to 23.5% in South Africa [24, 25, 79–81].

Although T. gondii and HIV co-infection has been widely studied due to the consequences that may occur in pregnant women and immunocompromised persons, no study to date has focused on the homeless population. Despite previous studies have shown a high prevalence of such coinfection, with 35.8% worldwide in a meta-analysis study and up to 88.4% of individuals coinfected in Ethiopia [39, 40], analysis of associated risk factor was not possible herein due to low HIV positive rate.

Despite frequent alcohol and drug use of homeless persons have been already observed in Brazil and worldwide [20, 26, 82, 83] and with higher infection risk to HIV and T. gondii in general population studies [41, 84, 85], there was no statistical association observed in the present study. Although one HIV-positive homeless person herein with multiple infections also declared himself as alcohol, marijuana, and skunk cannabis user, the other HIV-positive homeless persons denied alcohol and drug use.

Body lice (Pediculus humanus humanus) has been recently considered as a reemerging problem among homeless populations in France, Italy, USA, Colombia, and Brazil [48, 86–89]. Even though body lice presence suggests social vulnerability and 17/120 (14.2%) of the homeless herein were infested with lice, no statistically risk of T. gondii exposure was found.

As limitations of the present study, the most recent report of HIV homeless prevalence in São Paulo of 4.9% [20] was used for calculation of minimum sampling size since no T. gondii was available at the time. However, our HIV outcome prevalence of 1.7% was 2.9-fold lower than this study used as the basis for calculation but very similar to a previous 1.8% found in the homeless of São Paulo [25]. In addition, questionnaires to assess homeless information may be problematic, particularly regarding food intake and dietary habits, once such a population has often shown a chaotic lifestyle and a high prevalence of drug use and mental health disorders [65].

Conclusions

In conclusion, the prevalence of anti-T. gondii antibodies in homeless persons in this study was lower than the general population, probably due to homeless diet habit of eating mainly processed food intake, a situation that may be aggravated in HIV positive individuals. To the author's knowledge, the present study has been the first report of anti-T. gondii serosurvey in homeless persons concomitantly assessed with anti-HIV seropositivity.

Abbreviations

CAPS
Psychosocial Care Centers
CMIA
chemiluminescentmicroparticle immunoassay
GDP
Gross Domestic Product
HDI
Human Development Index
HIV
Human immunodeficiency virus
IFAT
immunofluorescent antibody test

NGO
Non-Governmental Organization
PBS
phosphate-buffered saline solution
PCV
packed cell volume
RLU
relative light units; OR:odds ratios
SD
standard deviation.
TPP
total plasma protein

Supplementary Information

Additional file 1: S1 Dataset. Data source, risk factors of demographic, social and hygiene profile and serological results for T. gondii the HIV in homeless persons.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee in Human Research at the Federal University of Paraná (CAAE: 80099017.3.0000.0102, protocol number: 2.512.196), by the Ethics in Human Health Committee at the São Paulo City Secretary of Health (CAAE: 80099017.3.3004.0086, protocol number: 3.366.684) and by Ethics Committee in Human Research of the Clinics Hospital at the Federal University of Paraná (CAAE: 80099017.3.3005.0096, protocol number: 3.623.845), all subordinate to the National Human Ethics Research Committee of the Brazilian Ministry of Health. The Informed Consent Form was applied to all homeless persons, according to the ethical guidelines and principles of Federal University of Paraná. All participants research provided written informed consent.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article [and its supplementary information files].

Competing interests

The authors declare no conflict of interest.

Funding

Not applicable.

Authors' contributions

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Formal analysis: LGF, CMM, ESV and AWB.

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Investigation: LGF, PITJ, LBK, ACC, LSU and AWB.

Methodology: LGF, CMM, LSU and AWB.

Project administration: LGF, LSU and AWB.

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