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SEROEPIDEMIOLOGY OF HUMAN TOXOPLASMOSIS IN CHILE

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SUMMARY

A series of already published and unpublished seroepidemiological surveys for toxoplasmosis, carried out in Chile in 1982-1994, is reviewed, expanded and analyzed. The surveys included 76,317 apparently healthy individuals of different ages (0.57% of the country's total population), from 309 urban and rural-periurban localities.

Urban groups were integrated by blood donors, delivering mothers and middle grade schoolchildren, while rural-periurban individuals corresponded to unselected family groups. Blood samples were collected in filter paper. The presence of antibodies to *Toxoplasma gondii* was determined by the indirect hemagglutination test (IHAT), titers ≥ 16 were considered positive.

The test resulted positive in 28,124 (36.9%) of the surveyed people. Two hundred and six (0.3%) individuals presented IHAT titers ≥ 1000, probably corresponding to acute or reactivated infections. A progressive increase of positive IHAT from northern to southern regions of the country was noted, phenomenom probably related to geographical conditions and to a higher production and consumption of different types of meat in the latter regions. It is postulated that ingestion of *T. gondii* cysts by humans is epidemiologically as important as ingestion of oocysts.

The results presented stress the epidemiological importance of toxoplasmosis in humans, and warn about eventual implications in immunocompromised patients and in transplacental transmission, organ transplants and transfusions.

KEYWORDS: Toxoplasmosis; Seroepidemiology; Chile.

INTRODUCTION

Chile, a long and narrow coastal and mountainous country, is located in the south-western extreme of South America. In its continental part it is 4,329 km long and 96-342 km wide. According to biogeographical characteristics, the country is divided, from north to south, into five different zones: deserts (arid), steppes (moderate climate), bushes (four differentiated seasons), forests (moderately cold, humid, agricultural, cattle raising) and austral (cold, humid, sheep raising). The country population of 13, 348, 401 (83.5% urban) is distributed into 13 political-administrative regions, numbered I to XII, including the Metropolitan Region located between V and VI regions[3,5].

Toxoplasma gondii, a protozoon widely found in nature with a cosmopolitan distribution, has been demonstrated in a great number of mammalians, including man, and several species of birds. Although *T. gondii* can cause severe pathology to human, in most of the cases it produces only asymptomatic infections[4,9,14,15]. Man can

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be infected either through ingestion of oocysts eliminated into the environment by cats or by consumption of raw or undercooked meat containing cysts. The infection may also be acquired transplacentally, or by organ transplants or by blood of blood components transfusions[4,12,32].

The observation that immunosupression activates and aggravates latent *T. gondii* infections, often leading to encephalitis with a fatal outcome, has prompted special clinical attention to immunocompromised patients in the last two decades[4,8].

In order to increase the knowledge of the epidemiology of human toxoplasmosis in Chile, since 1982 our group has carried out a series of laborious seroepidemiological surveys which included 71,797 apparently healthy people from urban and rural-periurban areas comprising the whole country[18,22-26,29]. For the same purpose another 4,520 apparently healthy people from different sections of Chile territory were added to the study, giving rise a total of 76,317 which is herein analized and discussed.

MATERIAL AND METHODS

The 76,317 individuals, between 15 days and 104 years old (43.2% males and 56.8% females), representing 0.57% of the country's total population from 45 urban and 264 rural-periurban localities of the country. According to recommendations of a WHO experts group on immunological surveys, only groups of no less than 300 persons were tested[17]. As it is well known, in many Latin American countries an important number of rural individuals and families has migrated to the outskirts of towns and cities, originating rings of defficient dwellings with poor environmental sanitation and giving rise to periurban populations.

The urban groups were formed by blood donors (age range 18-60 years, mean 30; 78.0% males), delivering mothers (age range 11-47 years, mean 29.2) and middle grades schoolchildren (age range 10-16 years, mean 13.1; 49.1% males), whereas the rural-periurban groups corresponded to unselected families (mean age 29.5 years, 40.0% males).

Blood samples were collected from each person in filter paper, a practical and well accepted procedure, particularly useful for seroepidemiological surveys[6,10,11]. The blood samples, when dried, were deposited in separated envelopes and transported to the laboratory. An indirect hemagglutination test (IHAT) for toxoplasmosis, a reliable and worldwide used test, was performed to each of the samples[4,10]. IHAT titers ≥ 16 were considered positive.

Statistics – Analysis were performed according to SNEDECOR & COCHRAN[27] by using two tests: 1) Frequency of positivity between urban and rural-periurban populations by z distribution. 2) Linear trends proportions from I to XII regions of the country.

TABLE 1

Human toxoplasmosis in Chile. Serological prevalence rates of infection, by region, place of residence and total, in 76,317 inhabitants from the 13 regions.

Regions	N examined			Positive		
	Urban	Rural-periurban	Total	Urban	Rural-periurban	Total
I-III	15,288	5,190	20,478	5,031 (32.9%)	1,597 (30.8%)	6,628* (32.4%)
IV-VI	18,076	7,030	25,106	6,819 (37.7%)	2,292 (32.6%)	9,111* (36.3%)
Metropolitan	9,893	3,744	13,637	3,340 (33.8%)	1,205 (33.2%)	4,545** (33.3%)
VII-IX	8,722	1,785	10,507	4,097 (47.0%)	682 (38.2%)	4,779* (45.5%)
X-XII	4,422	2,167	6,589	2,166 (49.0%)	895 (41.3%)	3,061* (46.5%)
Total	56,401	19,916	76,317	21,453 (38.0%)	6,671 (33.5%)	28,124* (36.9%)

* Significant ($p < 0.01$)

** No significant ($p > 0.05$)

RESULTS

The prevalence of human *T. gondii* infection, according to regions and place of residence of the examined persons is presented in Table 1.

Because of the great deal of information, the data from the 13 regions have been collected in the five groups shown in Table 1. As no significant differences between male and female rates of infection were observed, only general results are presented.

Age distribution and the corresponding rates of IHAT positivity are shown in Table 2.

TABLE 2
Human toxoplasmosis in Chile. Serological prevalence rates of infection, by age, in 76,317 inhabitants from the 13 regions.

Age groups (years)	n examined	Positive	
		n	%
0-9	3,462	620	17.9
10-19	24,478	7,548	30.8
20-29	25,698	10,217	39.8
30-39	12,676	5,274	42.7
40-49	5,461	2,362	43.3
50-59	2,478	1,150	46.4
≥ 60	2,064	953	46.1
Total	76,317	28,124	36.9

IHAT for toxoplasmosis positivity rates in three groups of urban residents are summarized in Table 3.

TABLE 3
Human toxoplasmosis in Chile. Serological prevalence rates of infection in 56,401 urban inhabitants from three different categories.

Categories	n examined	Positive	
		n	%
Blood donors	23,456	10,066	42.9
Delivering mothers	19,426	7,536	38.8
Schoolchildren	13,519	3,851	28.5
Total	56,401	21,453	38.0

Table 4 shows that 28,124 (36.9%) individuals presented antibodies to *T. gondii*: almost all to titers ≤ 512 (36.6%), and 206 (0.3%) with titers ≥ 1000. Global distribution of positive IHAT persons with titers ≥ 1000: 124 (60.2%) were urban residents and 122 (59.2%) corresponded to the 10-29 year-old groups.

TABLE 4
Human toxoplasmosis in Chile. Results of the IHAT in 76,317 human sera.

IHAT	n	%
Negative	48,193	63.1
≤ 512	27,918	36.6
≥ 1000	206	0.3
Total	76,317	100.0

DISCUSSION

The high prevalence of *T. gondii* infection in humans, reported from all major regions of the world has led to estimate that toxoplasmosis exists in chronic form in approximately half of the population in the United States[4] and perhaps in many other countries.

In spite of the existing and generally accepted knowledge on the epidemiology of human toxoplasmosis[2,4,9], most of the important concerning studies carried out in the last 25 years in different parts of the world are restricted to local situation[1,7,10,13,19], or focused in particular population groups[16,19,28,31], with few studies at national levels[21,30].

According to the life cycle of *T. gondii*, man and other susceptible vertebrates acquire the infection either through ingestion of oocysts shed into the environment by infected cats or ingestion of viable trophozoites in cysts contained in the flesh of infected mammals and/or birds. However, the principal mode of infection, indispensable to maintain the parasitosis in a country or community, is that resulting of ingestion of oocysts[4]. These oocysts find their way into intermediate hosts such as mice, rats and birds, that when eaten as prey carry the infection back to cats. In rural and suburban communities, a variable but generally high proportion of cats are infected at least once in their lives, each shedding millions of oocysts into the environment which can survive in moist and shaded soil for more than a year, becoming the soil an important source of infection[20]. Prevalence of *T. gondii* infection increases with age, a reflection of continued exposure to the risk of ingesting the infective forms of the parasite[4,19,28]. In the first decade of life, particularly in the toddler age, children eat, in proportion, reduced amount of meat, and may stay in or very close to

the ground and frequently play with soil, which serves – through oocysts – as source of *T. gondii* infection to them. Thus, it is possible to explain the 17.9% of infection found in our studies in the 0-9 years of age group. The successive increases of serological positivity in the remaining age groups may be attributed both to ingestion of oocysts and cysts, with a progressive diminishing of the first and increase of the last (Table 2). Except vegetarians, and some particular religious groups, most of people in the world eat flesh (meat and fowl) with different degrees of cooking, from conscious ingestion of raw dishes such as tartar steak and red or medium beefsteaks, to inconscious ingestion of improperly cooked pieces of apparently brown fried or roasted beefsteaks, chops or chicken, situations that favor the possibilities of *T. gondii* infection.

Similarly to observations performed in Germany[14], we have observed a higher proportion of IHAT positiveness in urban than in rural-periurban inhabitants. With the exception of the Metropolitan Region, this difference is statistically significant ($p < 0.01$) and may be attributed to a relative higher consumption of flesh from domestic mammals and birds among urban residents. The observed progressive increase of serologic positivity rates from north to south, also statistically significant, should be caused by two main factors: a) Different geographic and climate conditions, particularly increasing of rainfall[33], which favor a higher environmental humidity contributing to a longer viability and infectivity of *T. gondii* oocysts, and consequently the increasing of risk of infection for man and susceptible animals. b) A progressive higher meat consumption in southern regions – the cattle, sheep and swine raising zones – with the corresponding meat production.

In conformity with these considerations, it is possible to assume that ingestion of raw or insufficiently cooked *T. gondii* cysts infected meat, including chicken, is a significant mode of transmission of infection to man, and under an epidemiological perspective, is probably at least as important as ingestion of oocysts[1, 2, 8].

The apparent differences observed on the prevalences rates of infection among blood donors, delivering mothers, schoolchildren and the total population become unimportant when figures are compared in relation to the respective age groups in the total population examined (Tables 2 and 3).

According to the 36.9% prevalence rate of infection found in seroepidemiological studies for *T. gondii* infection of 76,317 apparently healthy persons, practically the wholeness may correspond to chronic asymptomatic infections, it can be assumed that about 4.9 million individuals have antibodies to *T. gondii* in Chile. The 0.3% of positive IHAT with titers ≥ 1000, apparently insignificant, may mean that about 14,700 persons are in an active phase of the infection in the country.

The overall results of the present study stress the epidemiological importance of toxoplasmosis in humans in Chile, with its eventual implications in immunocompromised patients and in transmission of the parasite through the placental route, organ transplants or transfusions[4, 12, 32].

RESUMEN

Seroepidemiología de la toxoplasmosis en Chile

En este trabajo se revisa, se amplía y se analiza en conjunto una serie de encuestas seroepidemiológicas sobre toxoplasmosis efectuadas en Chile entre 1982 y 1994, utilizando la reacción de hemaglutinación indirecta (RHAI). El estudio incluyó 76.317 personas aparentemente sanas de diferentes edades (0,57% de la población total del país), procedentes de 309 localidades urbanas y rural-periurbanas.

Los grupos urbanos estuvieron constituídos por donantes de sangre, parturientas y escolares del nivel medio de la enseñanza básica, mientras que los habitantes rural-periurbanos correspondieron a grupos familiares no seleccionados. Las muestras de sangre fueron recolectadas en papel filtro, y fueron consideradas positivas las RHAI con títulos ≥ 16.

La RHAI resultó positiva en un total de 28.124 (36,9%) de las personas encuestadas, encontrándose títulos ≥ 1000 en 206 (0,3%) individuos, los que probablemente correspondieron a infecciones agudas o reactivadas. Hubo un progresivo incremento de las RHAI positivas desde las regiones del extremo norte hacia las regiones del extremo sur del país, lo que podría relacionarse con una mayor humedad ambiental y con una mayor producción y consumo de diferentes tipos de carne en estas últimas.

Los resultados presentados destacan la importancia de la toxoplasmosis en el hombre y alertan sobre eventuales implicancias en pacientes inmunocomprometidos, en la transmisión transplacentaria, transplantes de órganos y transfusiones.

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