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RISK FACTORS FOR *TRYPANOSOMA CRUZI* INFECTION AMONG BLOOD DONORS IN CENTRAL BRAZIL

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Characteristics and possible risk factors associated with Trypanosoma cruzi *infection among blood donors were assessed within a routine screening programme in blood banks in an endemic area of Chagas disease. 6,172 voluntary blood donors were interviewed and tested for anti-*T. cruzi *antibodies by Haemagglutination and Complement Fixation tests in six blood banks in Goiânia-Central Brazil from October 1988 to April 1989. An overall prevalence of 2.3% for* T. cruzi *infection was obtained, being 3.3% for first-time blood donors and 1.9% for regular ones ($p < 0.01$). Considering this seropositivity among regular blood donors, selection of candidates relying only on the history of previous donation was found to be inadequate. The risk of infection increased inversely with the degrees of education and monthly income. There was a 9.2 risk of infection (95% CI 3.8-22.6) for those who had lived more than 21 years in an endemic area compared to subjects who had never lived in rural settings, after multivariate analysis. These informations may help to review the criteria of selection of donors in order to improve quality of blood products in endemic areas.*

Key words: *Trypanosoma cruzi* infection – risk factors – blood donors

The increasing urbanization of Latin America during the 70s and 80s, mostly due to rural-urban migration, has changed the picture of Chagas disease. Chagas disease can be no longer considered exclusively a rural problem, but it is now also urban, with transmission occurring from man to man by blood transfusion, representing a threat for endemic and nonendemic areas. Consequently, the interruption of *Trypanosoma cruzi* transfusional transmission is considered nowadays the most important goal in the Chagas disease Control Programme in urban areas (Schmunis, 1991).

Only five countries in Latin America (Argentina, Brazil, Honduras, Uruguay and Venezuela) have adopted laws that make screening of blood donors for *T. cruzi* compulsory. Despite of this legislation there are still blood transfusions being performed without previous serological screening, particularly in small communities. Several studies among blood donors have confirmed the potential risk of *T. cruzi* transfusional transmission and a large number of infection are likely to be occurring (Dias & Brener, 1984). In countries where candidates for donation are not screened for anti-*T. cruzi* antibodies, as in Bolivia, seronegative receptors who received *T. cruzi* infected blood showed an incidence of 47% of infection after 120 days follow-up (Zuna et al., 1985).

Various characteristics associated with *T. cruzi* infection seems to favour blood transmission. Infection is life long, assymptomatic in early stages and has a long chronic evolution. It has been shown that patients with both positive serology and positive xenodiagnosis have been found frequently among regular donors in endemic areas (Bronfen & Chiari, 1988).

The results of serological screening among blood donor has been a useful source of data of *T. cruzi* infection to determine prevalences among blood donors from different regions and to estimate temporal trends of prevalence but

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these data are poorly explored as a source of epidemiological information (Andrade et al., 1989; Zicker et al., 1990).

In a previous study we assessed the seroprevalence among blood donors and agreement between serological tests performed by blood banks and by a reference laboratory from a highly endemic area of Chagas disease in Central Brazil (Zicker et al., 1990; Andrade et al., 1992). In this paper we attempted to identify characteristics and possible risk factors associated with *T. cruzi* infection among blood donors.

METHODS

Study population – The study was carried out from October 1988 to April 1989, in Goiânia (population 1,042,500), the capital of the State of Goiás, mid-west Brazil. 6,172 voluntary blood donors were interviewed and tested for anti-*T. cruzi* antibodies by haemagglutination and complement fixation tests in six blood banks of the city, which are responsible for the supply of blood to approximately 90% of hospitals in the State. Those subjects included in the study corresponded to about 50% of all donors attending the blood banks in the study period and the sample size was enough to estimate prevalences of about 3% with a standard error of 2%.

Subjects were questioned regarding history of hepatitis, malaria, Chagas disease, and risk factors for sexually transmitted disease as part of the usual blood bank screening routine. All donors were also submitted to a serological screening for *Treponema pallidum,* AgHBs and HIV infections.

Subjects were not included in the study if they presented themselves as groups of a same corporation, specially the army or participants of blood donation campaigns because in such situation they could not be considered voluntary donors.

Data collection – Six trained interviewers, one in each blood bank, applied a standard questionnaire collecting information on age, sex, previous blood donation (regular or first-time donor), socio-economic level (monthly income in official minimum wages) and education level. For first-time donors a complete history of residence was also recorded and the sum of complete years lived in rural area were computed to assess the length of time of exposure to *T. cruzi* infection.

In a recent study we compared the results of the serological testing for *T. cruzi* conducted by these same banks with tests performed in a duplicate sample in a reference laboratory for Chagas disease serology. A high agreement was observed (Kappa index 0.75) (Andrade et al., 1992) and for this reason the present study was based on the results of tests for antibodies to *T. cruzi* provided by the blood banks.

Statistical analysis – Data were analyzed using the Statistical Package for Social Science (SPSS/PC, 1987). Seroprevalence rates based on the results of the blood banks were calculated for age group, sex and history of blood donation. For this study a subject was classified as "seropositive" when any of the serological tests done by the blood bank was positive. Chi-square and chi-square tests for trend were used to assess difference between proportions and t-tests for differences between means. Odds ratios, 95% confidence interval (CI) and statistical significance were estimated by logistic regression using the computer program EGRET (Epidemiological, Graphics, Estimation and Testing Package) to assess the association between exposure variables and *T. cruzi* infection.

RESULTS

Of the 6,172 subjects included in the study 1,504 (24.5%) were given blood for the first time (first-time donors) and 4,668 (75.5%) had donated before (regular donors). Males accounted for approximately 87% of first-time and 97% of regular donors. An overall prevalence of *T. cruzi* antibodies of 2.3% was calculated, the mean prevalences were 3.3% for first-time and 1.9% for regular donors ($p < 0.01$). Prevalence rates increased with age up to 45 years and thereafter decreased among first-time donors but remained constant among regular donors (Table I). The mean age for first-time donors was 27.5 ± 8.8 (sd) and for regular donors was 32.5 ± 9.2 (sd) ($p < 0.05$). Seroprevalence for male and female first-time donors did not differ significantly (3.5% vs 2.0%, respectively) but among regular donors females had a higher prevalence rate than males (5.3% vs 1.8%, respectively, $p < 0.01$) (Table II).

TABLE I

Prevalence[a] of *Trypanosoma cruzi* antibodies by age-group among first-time and regular blood donors in Goiânia, Brazil, 1988-1989

Age-group (years)	Blood donors: First-time no. pos/n (%)	Blood donors: Regular no. pos/n (%)
15-25	10/ 796 (1.3)[c]	5/1173 (0.4)[c]
26-35	23/ 449 (5.1)	37/1982 (1.9)
36-45	14/ 175 (8.0)	28/1020 (2.7)
46-54	2/ 61 (3.3)	16/ 391 (4.1)
55-68	1/ 21 (4.8)	4/ 98 (4.1)
Total	50/1502[b] (3.3)	90/4664[b] (1.9)

a: expressed as number of positive subjects/total number of subjects.
b: data are missing for 2 first-time and 4 regular blood donors.
c: test for trend, $p < 0.001$.

TABLE II

Prevalence[a] of *Trypanosoma cruzi* antibodies among first-time and regular blood donors by sex in Goiânia, Brazil, 1988-1989

	First-time donor no. pos/n (%)	Regular donor no. pos/n (%)
Males	46/1308 (3.5)	82/4518 (1.8)[b]
Females	4/ 196 (2.0)	8/ 150 (5.3)

a: expressed as number of positive subjects/total numbers of subjects.
b: male vs female regular donors, $p < 0.01$.

Estimates of odds ratios for exposure variables associated with *T. cruzi* infection are shown in Table III. The odds ratio of *T. cruzi* infection increased with age in both groups of donors (test for trend, $p < 0.01$) but was higher among first-time donors in all age groups. The prevalence of *T. cruzi* infection among first-time donors was estimated to increase by 1.6 times (95% CI 1.3-2.0), on average, for each decade of life. The corresponding figures for regular donors was 1.7 (95% CI 1.4-2.0).

First-time blood donors were at 2.5 (95% CI 1.7-3.6) fold the risk of *T. cruzi* infection than regular donors, after controlling for age, sex, income and education level.

Length of time living in an endemic area was associated with a increasing risk of infection. Those who have lived for 21 years or more in an endemic area an odds ratio of 9.2 (95% CI 3.8-22.6) compared to those who never lived, after controlling for age, sex and history of donation.

Subjects who reported monthly income lower than 1 minimum wage had an odds ratio for *T. cruzi* infection of 3.7 (95% CI 1.6-8.7) in comparison with those subjects earning 5 or more minimum wages monthly. The risk of infection increased inversely with the degrees of education. Subjects with no formal education had 4.1 (95% CI 1.6-15.5) times the risk of infection than those with an university degree.

DISCUSSION

Recently, a review of the serological studies of *Trypanosoma cruzi* infection from blood banks data and seroepidemiological surveys provided tends of seroprevalence for all Brazilian regions from 1948 to 1984. It was estimated a decreasing trend in prevalence for most of the regions, with an inference for no new cases of positive serology after 1991 (Feitosa & Krieger, 1991). However, these data must be analyzed with caution due to the methodological issues mainly the representativeness of the samples and different serological tests performed, limiting comparability of those data set.

In Goiânia-city, Central Brazil, prevalences of 11.0%, 10.4% and 3.3% of *T. cruzi* infection have been reported among blood donors in the 60', 70' and 80' respectively (Campos et al., 1975; Andrade et al., 1989). These results clearly indicate a decreasing trend in prevalence of this infection in blood banks, with an almost 4 fold drop in prevalence in the last three decades (Zicker et al., 1990).

In fact the overall prevalence of 2.3% found in our study, confirms this decreasing temporal trend of *T. cruzi* infection observed among blood donors. In contrast, a recent population based survey conducted among 5,425 unskilled workers in the same urban area has showed strikinly high prevalence of *T. cruzi* infection (12%) (Zicker et al., 1989). Considering that this population was mainly composed by rural migrates, this cohort represents a potential source of blood donors and a great threat to continue transfusion transmission since donors who had no formal education and lower socioeconomic conditions also had high risk of in-

TABLE III

Odds ratios (OR) for *Trypanosoma cruzi* antibodies associated with age, history of blood donation, rural residence, income and education level

Variables	no. (%)	OR[a] CI 95%	OR[b] CI 95%
Sex			
Males	5833 (2.5)	1	1
Females	347 (4.3)	1.6 (0.9-2.9)	1.3 (0.7-2.6)
Group age			
15-25	1169 (0.8)	1	1
26-36	2431 (2.5)	3.3 (1.8- 5.8)	4.5 (2.5- 8.2)
37-45	1195 (3.5)	4.7 (2.6- 8.6)	6.4 (3.4-12.2)
46-54	452 (4.0)	5.4 (2.7-10.8)	6.8 (3.2-14.2)
> = 55	119 (4.2)	5.7 (2.0-15.9)	6.5 (2.2-19.1)
Test for trend p < 0.01			
History of donation			
regular	4664 (1.9)	1	1
first-time	1503 (3.3)	1.7 (1.2-2.5)	2.5 (1.7-3.6)
Years living in rural area[c]			
0	997 (2.5)	1	1
1-10	224 (5.4)	4.5 (1.8-10.9)	4.1 (1.6-10.4)
11-20	170 (7.6)	6.7 (2.8-16.0)	5.1 (2.0-12.8)
> = 21	141 (15.6)	15.0 (6.8-32.9)	9.2 (3.8-22.6)
Monthly income			
> = 5 ms	1172 (0.9)	1	1
1-5 ms	4248 (2.8)	3.0 (1.5- 5.7)	2.3 (1.1-4.5)
< 1 ms	371 (4.9)	5.2 (2.4-11.7)	3.7 (1.6-8.7)
undefined	351 (2.8)	2.4 (0.9- 6.3)	1.9 (0.7-5.3)
Education			
university	497 (1.0)	1	1
high school	1614 (0.6)	0.9 (0.2- 3.4)	1.0 (0.3- 3.6)
elementary	3586 (3.5)	5.3 (1.7-16.6)	4.1 (1.2-13.5)
no formal education	293 (5.8)	7.6 (2.2-27.1)	4.1 (1.6-15.5)
Test for trend p < 0.01			

a: crude estimates.
b: adjusted for age, sex, income, education level and previous blood donation (as appropriate).
c: for first-time donors.

fection in the present study. In our study we detected a gradient of risk of infection with the length of years lived in rural area, with at least a 4 fold increased risk for those who lived until 20 years in rural areas. The importance of internal migration for the urbanization of Chagas disease is well demonstrated by these data.

The females represented approximately 6.0% of all candidates to blood donation. There was an enormous variability in frequency and intervals between donations, however males had more returns than females candidates. This fact, besides the small sample size of the female population may explain the difference in prevalence between the two groups. Although the highest prevalence were detected among females candidates, this group as a whole were not at higher risk of infection than males when controlling by confounders factors.

There was a 3:1 ratio between regular and first-time donors with predominance of young males among the blood donors in our sample. The seropositivity of anti-*T. cruzi* infection was 3.3% among first-time donors versus 1.9% of prevalence among the regular ones. Being a first-time donor implied higher risk of infection since the probability of infection was 2.5 times more in this group than for the regular donors after controlling for confounders.

Nevertheless, regular donors still had prevalences of 1.9% for the infection and considering that most of them are living in the city where there is no possibility of vector transmission, some hypothesis could be raised to explain this finding. The hemotherapy services may not inform blood donors of the serological results. Serological tests may provide false negative results, even when two techniques with different sensitivities were performed. False negative results have been reported in a study comparing the results of blood bank with a reference laboratory and it has been suggested the inclusion of a more sensitive technique (ELISA test) running in parallel to improve sensitivity (Andrade et al., 1992; Ferreira et al., 1991).

The gentian violet added to any blood and hemoderivates to be transfused was widely used before the improvement of the serological screening in blood banks specially in Goias and Minas Gerais States in Brazil (Rezende et al., 1965; Campos et al., 1975; Rassi & Rezende, 1975; Souza et al., 1985).

Considering that there is a concentration of blood banks in large towns and serological tests are not usually available in small communities, the reintroduction of gentian violet has been recommended to control *T. cruzi* transfusional transmission (Souza, 1989). Selection of blood donors relying only on the history of previous donation is clearly inadequate as we found 1.9% prevalence among regular blood donors.

Among the characteristics studied education level, income and years living in rural area were found associated to *T. cruzi* infection. These informations may help to review the criteria of selection of donors in order to improve quality of blood products in endemic areas.

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