REVIEW ARTICLE

Epidemiological aspects of strongyloidiasis in Brazil

F. M. PAULA[1] *and* J. M. COSTA-CRUZ[2]*

[1] *Laboratório de Investigação Médica – LIM/06, Instituto de Medicina Tropical de São Paulo, Universidade de São Paulo, São Paulo, Brazil*
[2] *Laboratório de Diagnóstico de Parasitoses, Instituto de Ciências Biomédicas, Universidade Federal de Uberlândia, Uberlândia, Minas Gerais, Brazil*

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SUMMARY

The objective of this review was to outline an epidemiological profile of *Strongyloides stercoralis* by parasitological and serological diagnosis in inhabitants, and to associate this profile with different immunosupression situations, in Brazil, over 20 years (1990–2009). The occurrence of *S. stercoralis* using parasitological methods was 5·5%, being 4·8% in rural and 5·0% in urban areas, characterizing the country as hyperendemic. There was a diversity of techniques used as a diagnostic tool and only 39·1% of the studies presented results based on at least 1 specific method. The occurrence increased with age, being 12·1%, for those over 60 that suggests an epidemiological condition of concern for the elderly population. Of the seroepidemiological studies in the general population the mean positivity in serum samples was 21·7% and 29·2%, using an immunofluorescence antibody test and enzyme-linked immunosorbent assay (ELISA), respectively. The occurrence of strongyloidiasis in immunosuppressed individuals was 11·8% by parasitological methods and 19·5% using immunological methods. Considering that Brazil is a tropical country and that the character of chronicity and autoinfection of the parasite that can result in severe forms of hyperinfection or dissemination makes strongyloidiasis an important medically and socially neglected problem.

Key words: strongyloidiasis, epidemiology, prevalence, Brazil.

INTRODUCTION

Strongyloides stercoralis (Bavay, 1876) is an intestinal nematode, which causes strongyloidiasis, helminthiasis usually responsible for chronic asymptomatic infections of the gastrointestinal tract in immunocompetent human hosts and may remain undetected for decades. In immunocompromised patients due to immunosuppressive therapy (particularly steroids) (Genta, 1992; Keiser and Nutman, 2004; Lam *et al*. 2006), infection with human immunodeficiency virus (HIV) (Ferreira, 2003; Keiser and Nutman, 2004; Silva *et al*. 2005), infection with human T-lymphotropic virus 1 (HTLV- 1) (Porto *et al*. 2002; Keiser and Nutman, 2004), solid organ transplantation (Keiser and Nutman, 2004; Concha *et al*. 2005), haematological malignancies (Graeff-Teixeira *et al*. 1997; Keiser and Nutman, 2004), solid-organ malignancies (Safdar *et al*. 2004), hypogammaglobulinaemia (Keiser and Nutman, 2004), chronic alcoholism (Oliveira *et al*. 2002; Silva *et al*. 2005; Marques *et al*. 2010) severe malnutrition (Keiser and Nutman, 2004) or diabetes mellitus (Mendonça *et al*. 2006), this infection may develop into a hyperinfection syndrome or disseminated disease (Keiser and Nutman, 2004; Marcos *et al*. 2008).

This parasite infects humans through skin penetration, and has a complex life cycle involving 2 stages of development: a phase of free-living that occurs in the environment, good conditions of temperature and humidity, and the other stage as a parasite, which occurs within the host. The parthenogenetic female of *S. stercoralis* lays few eggs per day, which are deposited in the intestinal epithelium, the rhabditiform mature larvae exit in the feces of the patients, and constitute in the diagnostic stage viewed in optical microscopy. By a process of autoinfection, there may be a rapid increase in the number of infective larvae; strongyloidiasis consequently persists for decades (Grove, 1996; Costa-Cruz, 2005). The fact that the free-living forms of the parasite in the soil depend on favourable environmental conditions such as humidity and high temperature, makes conditions in many regions of Brazil ideal for the development and maintenance of intestinal parasites (Carmo *et al*. 2005).

Definitive diagnosis of strongyloidiasis is performed mainly by the identification of larvae in fecal specimens, through concentration techniques or culture methods. Nevertheless, these larvae are excreted

* Corresponding author: Laboratório de Diagnóstico de Parasitoses, Instituto de Ciências Biomédicas, Universidade Federal de Uberlândia, Uberlândia, MG, Brasil. Av. Pará, 1720, 38400-902, Uberlândia, MG, Brazil. Tel: +55 34 3218 2187. Fax. +55 34 3218 2333. E-mail: costacruz@ufu.br

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in low numbers and not daily, making the parasitological methods unreliable in most cases, requiring the analysis of 7 stool samples to increase the positivity (Dreyer *et al*. 1996; Uparanukraw *et al*. 1999). Several techniques are described for the parasitological diagnosis of strongyloidiasis, including the modified Baermann method by Moraes (BM) (Baermann, 1917; Moraes, 1948), the method of Rugai (R) (Rugai *et al*. 1954), Harada-Mori (HM) (Harada and Mori, 1955) and culture method on agar plates (AP) (Arakaki *et al*. 1988). However, the increased number of stool samples and the inconvenience of fresh stool specimens, make these parasitological diagnostic methods unusable in routine laboratory practice. Larvae can also be found in other body fluids (sputum, broncho-alveolar lavage, among others), through endoscopy, colonoscopy, or intestinal biopsy (Costa-Cruz, 2005; Minematsu *et al*. 2011). The failure to diagnose this parasitosis is reflected in the frequent reports of fatal cases associated with hyperinfections, brought on by corticosteroid therapy. The similarity between corticosteroids and an ecdyses hormone of the parasite, which promotes maturation of infective larvae in the intestine of the patient, is a possible explanation for this association (Hernandez-Chavarria, 2001). Thus, the serological methods present a good alternative for early diagnosis and for evaluating the effectiveness of treatment (Sato *et al*. 1995; Paula *et al*. 2000; Siddiqui and Berk, 2003; Costa-Cruz, 2005; Page *et al*. 2006; Sudré *et al*. 2006; Varatharajalu *et al*. 2011).

Many epidemiological aspects of *Strongyloides* infection are not well known, such as prevalence rates that can be expected in different sectors of the population, environmental and zoonotic aspects, geographical variations, besides transmission and clinical presentation, host immunity and the risk factors for dissemination. The prevalence of *S. stercoralis* is underestimated, especially by the low sensitivity of parasitological diagnostic methods employed in routine procedures that do not include specific methods to search for larvae, and also the shortage of parasitological surveys. Thus, *S. stercoralis* infections in many areas remain without information (Hernandez-Chavarria, 2001; Olsen *et al*. 2009). Strongyloidiasis has a heterogeneous worldwide distribution, and prevalence has been divided into 3 categories: sporadic (<1%), endemic (1–5%) and hyperendemic (>5%) (Pires and Dreyer, 1993). It is estimated that strongyloidiasis affects 30–100 million individuals around the world. All hyperendemic areas are located in the tropics, the endemic areas in the subtropics, but the parasite is also present, sporadically, in the United States, Europe and Asia (Olsen *et al*. 2009).

The World Health Organization (2005) recommended that the *Strongyloides* infection could be included in the 'Parasite Control Program' in areas where the infection is endemic. However, now the infection is only a possible target and presumably, not effectively integrated in helminth control programmes. Recognizing that intestinal parasites are still prevailing in the country, the Brazilian government created the National Surveillance and Control of Enteroparasitoses in 2005 (Carmo *et al*. 2005) and in 2007, the Growth Acceleration Program (PAC) (Ministério da Fazenda, 2007) providing for actions in sanitation, targeting the reduction of infectious and parasitic diseases, including intestinal parasitosis.

Despite scientific knowledge and technological advances available for its treatment and prevention, strongyloidiasis is still a parasitic disease of great importance to public health in Brazil, but information on strongyloidiasis is based on studies that show local epidemiological data. The objective of this review is to outline an epidemiological profile of this intestinal helminth in Brazil by parasitological and serological diagnosis in inhabitants of rural and urban areas, and associate this profile with different immunosuppression situations.

METHODOLOGY

We conducted a review of the literature on epidemiological aspects of strongyloidiasis in Brazil, using the keywords '*Strongyloides stercoralis*', 'strongyloidiasis', 'intestinal parasites' and 'Brazil' in different combinations. We searched in the Scientific Eletronic Library Online (SciELO) and the U.S. National Library of Medicine (PubMed) over 20 years (1990–2009). There have been many studies regarding intestinal parasites from which the specific results for *S. stercoralis* were extracted. We used as inclusion criteria any study that gave values of the occurrence of *S. stercoralis* in Brazil in accordance with the region, location by state, rural and urban areas, considering the population by age, immunity, the method of diagnosis, or parasitological and serological association with other diseases (alcoholism, diabetes, cancer, infection with AIDS/HIV and HTLV-1, among others). As exclusion criteria: any study published before 1990 and after 2009, and papers that did not show the occurrence of *S. stercoralis*, when we used the keyword 'intestinal parasite'. To analyse the information the value of the mean (X) frequencies reported was chosen.

RESULTS AND DISCUSSION

Epidemiological profile of S. stercoralis *by parasitological methods*

In the period from 1990 to 2009 it was found that the occurrence of infection by *S. stercoralis* in Brazil, using parasitological methods of diagnosis was 5·5%, characterizing the country as a hyperendemic area for

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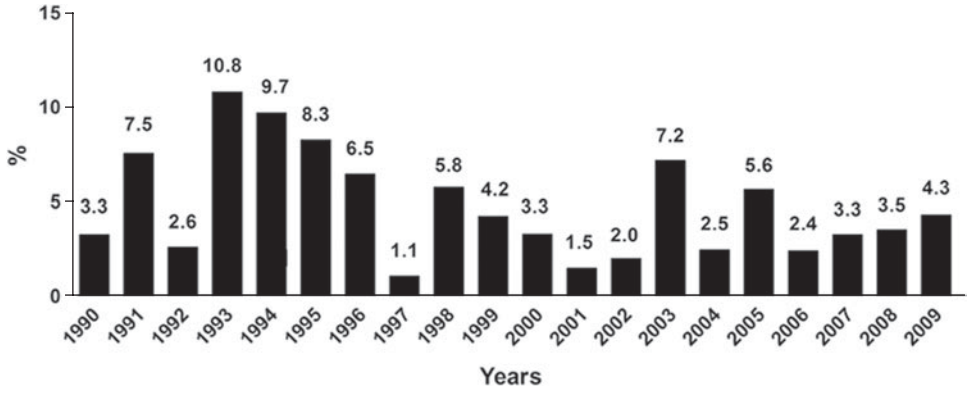


Fig. 1. Changes in the prevalence of *Strongyloides stercoralis* in Brazil in the period 1990–2009 as assessed by parasitological methods of diagnosis.

strongyloidiasis. There was a variation of 3·9% to 7·9% among the 5 regions of Brazil, but there was no variation between the rural (4·8%) and urban (5·0%) areas. It is known that the marked socio-economic inequalities observed in Brazil, combined with the disorderly urbanization process, cause portions of the population to live in precarious living conditions. The occupation of the peripheral areas of cities where sanitary conditions make the quality of life style not different from rural areas, and often in worse conditions that favour the transmission of intestinal parasites (De Carli *et al*. 1997).

Changes in the prevalence of *Strongyloides stercoralis* in Brazil in the period 1990–2009 as assessed by parasitological methods of diagnosis are shown in Fig. 1. The variation was from 1·1 to 10·8% during the period studied. The occurrence of *S. stercoralis* infection in humans, using parasitological methods, distributed by region, state of the federation and the population studied is shown in Table 1. The diversity of parasitological diagnostic methods used in parasitological survey, make epidemiological knowledge of this parasite irregular. Of the 64 studies analysed and shown in Table 1, the diversity of techniques used as a diagnostic tool can be observed, in which 39 of the studies (60·9%) used non-specific methods for the detection of *S. stercoralis* larvae. We included as non-specific parasitological methods the parasitological techniques used in the routine of clinical laboratories, for example: the Direct (Amato Neto and Correa, 1991), Faust (Faust *et al*. 1938), Lutz (Lutz, 1919), or Ritchie/Blagg/MIFC (Ritchie, 1948) methods that are not suitable or specific for the detection of nematode larvae. Only 25 (39·1%) of the studies present results based on at least 1 specific method (BM, R, HM or AP) for the detection of these helminth larvae.

The concept that children are a group largely involved in parasite infections (Moura *et al*. 1997; Carvalho *et al*. 2006; Silva *et al*. 2009) was not observed for this parasite in this period. When we analysed the articles that were available to characterize the age group studied, it was noted that the occurrence of *S. stercoralis* increased with age (Fig. 2). The mean occurrence of 12·1% for *S. stercoralis*, for age 60 and over (Hurtado-Guerrero *et al*. 2005; Aguiar *et al*. 2007; Miné and Rosa, 2008), suggests epidemiological conditions of concern for the elderly population in Brazil since, in this group, the immune system is weakened, particularly for those with poor health. In a parasitological study in the Amazon region, Hurtado-Guerrero *et al*. (2005) drew attention to the effect that intestinal parasites have on the nutritional status and health of the elderly population, and, moreover, mentioned an occurrence of 9·1% for *S. stercoralis* in this age group. The greater occurrence of *S. stercoralis* in the elderly was obtained from the study of Miné and Rosa (2008) in São Paulo state, which detected 20·4% infection in the elderly, considering both sexes, but 40% in elderly males of >80 years of age.

Epidemiological profile of S. stercoralis *by serological methods*

Owing to the limited sensitivity of parasitological methods for diagnosis of infection by *S. stercoralis*, serological methods have been resorted to, which have high sensitivity and specificity. Immunological tests such as enzyme-linked immunosorbent assay (ELISA), immunofluorescence antibody test (IFAT) and Western-blotting, have been described for the diagnosis of strongyloidiasis (Costa-Cruz *et al*. 1997; Sudré *et al*. 2007; Machado *et al*. 2008*c*; Feliciano *et al*. 2010). Among the various techniques used in immunodiagnosis of strongyloidiasis, the ELISA test has been shown to be superior with respect to practicality, safety and the availability of reagents (Liu and Weller, 1993), in addition to high sensitivity and specificity (Schaffel *et al*. 2001). The ELISA was the test of choice for most of the articles analysed as a single technique for serological diagnosis (Rossi *et al*. 1993; Costa-Cruz *et al*. 2003; Machado *et al*. 2003; Rodrigues *et al*. 2007), or in association with the IFAT and/or Western blot (Silva *et al*. 2003;

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Table 1. Occurrence of *Strongyloides stercoralis* infection in humans, considering the parasitological diagnosis, region, state and population in Brazil from 1990 to 2009

(% Positive parasitological methods, without discrimination of rural and urban general, All (studies without discrimination of age).)

Region	State	Population	%	Reference
North 5·3%	AC	All	2·6	Souza *et al*. (2007)
	AM	Child	0·8–8·8	Monteiro *et al*. (2009); Silva *et al*. (2009)
	AM	Elderly	9·1	Hurtado-Guerrero *et al*. (2005)
	AM	All	0·89–14·1	Willcox and Coura (1991); Coura *et al*. (1994); Boia *et al*. (1999); Tavares (2000); Araujo and Fernádez (2005); Rios *et al*. (2007)
	PA	All	5·6	Miranda *et al*. (1998)
Northeast 7·9%	AL	Child	14·0	Fontes *et al*. (2003)
	AL	All	12·38	Kobayashi *et al*. (1996)
	BA	All	4·6	Santos *et al*. (2007)
	PE	All	2·5–5·8	Gonçalves *et al*. (1990); Fontbornne *et al*. (2001)
Midwest 6·6%	DF	Child	0·98	Muniz-Junqueira *et al*. (2002)
	MS	All	3·8	Aguiar *et al*. (2007)
	MT	All	9·9–11·7	Lanelli *et al*. (1995); Santos *et al*. (1995)
Southeast 3·9%	ES	Child	0·47	Castro *et al*. (2004)
	MG	Child	0·3–13·0	Cury *et al*. (1994); Gennari-Cardoso *et al*. (1996); Ferreira and Marçal Jr (1997); Machado and Costa-Cruz (1998); Rocha *et al*. (2000); Ribeiro and Marçal Júnior (2003); Barbosa *et al*. (2005); Machado *et al*. (2008*a*)
	MG	Adult	2·0–6·5	Santos *et al*. (1998); Nunes *et al*. (2006); Machado *et al*. (2007)
	MG	Food handler	0·5–1·0	Costa-Cruz *et al*. (1995); Rezende *et al*. (1997)
	MG	All	1·3–6·4	Oliveira *et al*. (2003); Hurtado-Guerrero *et al*. (2005); Machado *et al*. (2008*b*); Mota-Ferreira *et al*. (2009)
	RJ	Child	2·0	Costa-Macedo *et al*. (1998)
	RJ	Adult	4·8	Macedo and Rey (1996)
	SP	Child	0·7–3·12	Pedrazzani *et al*. (1990); Moura *et al*. (1997); Malta *et al*. (2002); Faleiros *et al*. (2004); Carvalho *et al*. (2006)
	SP	Food handler	9·1	Capuano *et al*. (2008)
	SP	All	1·6–10·81	Guerra *et al*. (1991); Gioia (1992); Rossi *et al*. (1993); Kobayashi *et al*. (1995); Ludwig *et al*. (1999); Tavares-Dias and Grandini (1999); Martins *et al*. (2007); Miné-Rosa *et al*. (2008)
South 4·0%	PR	Child	0·47–2·85	Giraldi *et al*. (2001); Buschini *et al*. (2007)
	PR	All	0·9–3·3	Nascimento and Moitinho (2005); Falavigna *et al*. (2008); Toledo *et al*. (2009)
	RS	Child	0·6–4·5	De Carli *et al*. (1997); Morrone *et al*. (2004); Bencke *et al*. (2006); Basso *et al*. (2008)
	SC	Food hander	1·7	Nolla and Cantos (2005)
	SC	All	17·3	Tietz Marques *et al*. (2005)

Rodrigues *et al*. 2004; Mota-Ferreira *et al*. 2009). The difficulty in obtaining *S. stercoralis* larvae and thus obtaining a sufficient amount of antigenic material has been a limiting factor for the immunodiagnosis of strongyloidiasis (Rossi *et al*. 1993). This is why many researchers have been using heterologous antigens, *Strongyloides ratti* or *Strongyloides venezuelensis*, in the diagnosis of strongyloidiasis, since they are easy to obtain and are a safe source without risk to their handlers, besides having high sensitivity and specificity (Costa-Cruz *et al*. 1997; Machado *et al*. 2001, 2003; Silva *et al*. 2003; Rodrigues *et al*. 2004, 2007; Feliciano *et al*. 2010).

Of the 3 seroepidemiological studies conducted in the general population in Brazil, the mean positivity in serum samples of *S. stercoralis* infection was 21·7% and 29·2%, using serological testing by IFAT-IgG and ELISA-IgG, respectively, studies were concentrated in the Southeast region (Costa-Cruz *et al*. 1998; Machado *et al*. 2007; Mota-Ferreira *et al*. 2009).

Occurrence of S. stercoralis *infection associated with different types of immunosuppression*

The occurrence of *S. stercoralis* infection associated with different types of immunosuppression compared to parasitological diagnosis and/or serology, is shown in Table 2. The variety of techniques may be noted, but most studies have used techniques suitable for the detection of larval helminths since the suspicion of infection by *S. stercoralis* could be mentioned in the population studied. The average

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Table 2. Occurrence of *Strongyloides stercoralis* infection in humans using parasitological methods and/or serological diagnosis, distributed according to the type of immunosuppression (1990–2009)

Immunosuppression	%	State	Methods	Reference
Alcoholics	33·3	MG	BM, L	Oliveira *et al*. (2002)
Alcoholics	21·7	ES	L	Zago-Gomes *et al*. (2002)
Different immunosuppression (cancer, HIV+/AIDS, etc)	2·41 11·92*	MG	BM, L IFAT, ELISA	Paula *et al*. (2000)
Diabetes	3·8 23·0*	MG	BM, L IFAT, ELISA	Mendonça *et al*. (2006)
Haematological malignancies	13·0 18·9*	RJ	BM, D, L ELISA	Schaffel *et al*. (2001)
Haematological malignancies	8·3	SC	BM	Graeff-Teixeira *et al*. (1997)
Gastrointestinal cancer	9·1 24·2*	MG	L, BM IFAT, ELISA	Machado *et al*. (2008*d*)
HIV+	5·5	BA	L, F, BM, AR	Feitosa *et al*. (2001)
HIV+	10·0	SC	L, MIFC, HM, AP	Blatt and Cantos (2003)
HIV+	12·0	MG	BM, L, AS MIFC, CW	Silva *et al*. (2005)
AIDS	9·75	MG	L, R	Dias *et al*. (1992)
HIV/AIDS	3·8	MG	F	Costa-Cruz *et al*. (1996)
HIV/AIDS	2·5	SP	L, F, R	Cimerman *et al*. (1999)
HIV/AIDS	30·1	CE	D, L, BM, ZN	Bachur *et al*. (2008)
HTLV-1	12·1	SP	BM, L, HM	Chieffi *et al*. (2000)

* Positive by serological methods (ELISA – enzyme-linked immunosorbent assay; IFAT, indirect fluorescent antibody test); parasitological methods (BM, Baermann-Moraes; D, direct; F, Faust/flotation; HM, Harada-Mori; L, Lutz; MIFC, Ritchie/Blagg; AP, culture agar plate, R, Rugai) and staining (AR, acid fast; ZN, Ziehl-Neelsen; AS, Blue metilen Safranin; CW, Chromotropic Weber's).

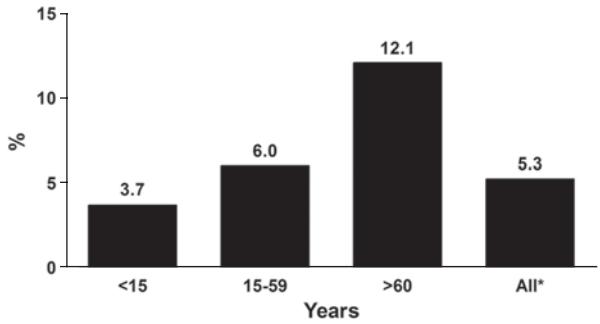


Fig. 2. Changes in the prevalence of *Strongyloides stercoralis*, by the age of the Brazilian population, in the period 1990–2009 as assessed by parasitological methods of diagnosis. * The population was not weighted by the age distribution of the sampled members.

occurrence was 11·8% using parasitological diagnostic methods. In 4 studies of immunosuppression using parasitological and immunological diagnosis it was found that the mean occurrence increased from 7·1% to 19·5% respectively (Paula *et al*. 2000; Schaffel *et al*. 2001; Mendonça *et al*. 2006; Machado *et al*. 2008*d*), emphasizing the usefulness of serological methods as a tool for diagnosis of strongyloidiasis, especially when the question involved is immunosuppression.

Although the association of strongyloidiasis and immunosuppression are important, case reports are scarce. In Brazil, the occurrence of strongyloidiasis in transplant patients (Dulley *et al*. 2009; Villela *et al*. 2009), the use of corticosteroids and/or with neoplasias (Godoy *et al*. 1998; Rodrigues *et al*. 2001; Lambertucci *et al*. 2003; Porto *et al*. 2005; Salluh *et al*. 2005; Giavina-Bianchi *et al*. 2006; Benincasa *et al*. 2007; Ben-Horin *et al*. 2008; Veloso *et al*. 2008), and haemolytic anaemia (Ferreira *et al*. 2008) have been emphasized. Many of these reports show that the late diagnosis of infection may be associated with the severity of infection, causing patient death (Rodrigues *et al*. 2001; Salluh *et al*. 2005; Benincasa *et al*. 2007; Ferreira *et al*. 2008; Veloso *et al*. 2008; Villela *et al*. 2009). In a study of prevalence of symptomatic parasitosis in adult renal transplant recipients, in Porto Alegre, Brazil, from 2001 to 2005, Valar *et al*. (2007) showed that out of 657 transplants, 11 (1·67%) had symptoms and confirmed *S. stercoralis* diagnosis by the finding of larvae in feces (8 cases), by broncho-alveolar lavage fluid (in 2 cases), duodenal biopsy and sputum (in 1 case), and from these, 3 cases developed hyperinfection, and 1 died. The diagnosis of strongyloidiasis in these reported cases occurred through the finding of larvae in feces (Dulley *et al*. 2009), in other fluids (Porto *et al*. 2005; Salluh *et al*. 2005; Ferreira *et al*. 2008; Villela *et al*. 2009), at biopsy (Rodrigues *et al*. 2001; Lambertucci *et al*. 2003; Salluh *et al*. 2005; Giavina-Bianchi *et al*. 2006; Ben-Horin *et al*. 2008) and at autopsy (Godoy *et al*. 1998; Benincasa *et al*. 2007; Veloso *et al*. 2008).

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Co-infection by *S. stercoralis* and HTLV-1 has been reported to decrease in response to anti-helmintic treatment and increased severity of viral infection in these patients (Porto *et al*. 2001, 2002). In a coproparasitological survey, Chieffi *et al*. (2000) called attention to the higher prevalence of *S. stercoralis* among HTLV-1 positive blood donors in relation to the negative HTLV-1.

HIV/AIDS infection associated with *S. stercoralis* has been reported in some studies (Dias *et al*. 1992; Feitosa *et al*. 2001; Blatt and Cantos, 2003; Silva *et al*. 2005) using parasitological methods and/or serological diagnosis. However, only 3 reports demonstrated the seriousness of helminthiasis when associated with HIV/AIDS, previously considered an opportunistic parasite (Takayanagui *et al*. 1995; Ferreira *et al*. 1999; Bachur *et al*. 2008).

The association of chronic alcoholics with strongyloidiasis is an interesting aspect, since this group of patients may be suffering from severe forms of strongyloidiasis, probably due to dulled mental function, breakdown of local protective barriers, aspiration, exposure to pathogens and malnutrition caused by alcoholism (Oliveira *et al*. 2002; Zago-Gomes *et al*. 2002). The corticosteroid metabolites in alcoholics may increase the fecundity of the females, and thus the number of rhabditiform larvae coming out in the feces (Zago-Gomes *et al*. 2002). However, Genta (1992) suggested that the ecdysoid-like action of the steroids would increase the developmental rate and moulting of the larvae in the intestine causing autoinfection. The increase in autoinfection would lead to an increased number of adult female worms, leading to an increase in the number of larvae (L1) in the feces.

Complementary aspects

Domestic animals such as dogs infected with *Strongyloides*, particularly in areas where sanitary conditions are unsatisfactory, can become reservoirs for this helminth and sources of human infection (Ferreira-Junior *et al*. 2006; Gonçalves *et al*. 2007; Campos-Filho *et al*. 2008). Thus, the presence of feces from infected humans or animals contaminating the soil are epidemiological factors that may influence the onset, maintenance and propagation of human strongyloidiasis as well as favourable conditions of temperature and humidity, and inadequate hygienic habits (Costa-Cruz, 2005).

We would like to emphasize that one drawback of immunological assays for antibody demonstration is that it reflects the history of infection and not necessarily the current on-going infection. It is difficult in many cases to know whether or not low-level autoinfection is continuing. This occurs mainly because antibody levels remain detectable for years after antihelmintic treatment. (Liu and Weller, 1993; Grove, 1996).

Currently, the detection of coproantigen by ELISA, standardized in experimental models (Nageswaran *et al*. 1994; Gonçalves *et al*. 2010), and for human strongyloidiasis (El-Badry, 2009) allows the identification of cases of active infection. The development of Polymerase Chain Reaction (PCR) in faecal samples of animals with low experimental infection by *S. venezuelensis* (Marra *et al*. 2010) and also in human faecal samples (Verweij *et al*. 2009) are promising as an alternative for the diagnosis of strongyloidiasis.

CONCLUSIONS

The non-application of techniques for the accurate diagnosis of this helminthiasis, either parasitological or immunological and molecular biology in the large centres, contributes to the underestimation of the prevalence of strongyloidiasis. Thus, many epidemiological aspects of infection by *S. stercoralis* are unknown or only poorly understood, such as national endemic areas, in which prevalence rates and intensities can typically be expected in different settings and populations, the zoonotic aspects, and geographical variations involved in infection. Therefore, we recommend what we consider to be the way forward and the priorities to reducing the prevalence of strongyloidiasis. (1) Health education campaigns on the disease. (2) Parasitological diagnosis including specific methods for analysing the nematode larvae. (3) Need to screen patients from endemic areas of strongyloidiasis prior to receiving corticosteroid therapy or organ transplantation. (4) Follow-up of patients with immunosuppression. (5) Development of novel diagnostic assays, and finally (6) the notification of positive cases.

Considering that Brazil is a tropical country and the character of chronicity and auto-infection of this parasite which can result in severe forms of hyper-infection or dissemination makes strongyloidiasis an important medical and social problem that unfortunately is neglected by health authorities.

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