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The Prevalence of *Schistosoma mansoni* is affected by *Taenia* spp. and Soil-transmitted Helminths

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Abstract: The average prevalence of *Schistosoma mansoni* infections in Brazil is related to *Taenia* spp. (presence/absence) and is modulated by *Strongyloides stercoralis*, *Ascaris lumbricoides*, *Trichuris trichura*, or hookworm (*Ancylostoma* and/or *Necator*) species. The high score average prevalence of schistosomiasis was seen in strata whose *Taenia* spp. was absent. In contrast, the lower score average prevalence of schistosomiasis was seen in strata whose *Taenia* spp. was present irrespective to prevalence level of *Strongyloides*, *Ascaris*, *Trichuris,* or hookworm.

Keywords: Helminth parasites, Prevalence, Schistosomiasis, *Ascaris lumbricoides*, Hookworm, *Strongyloides stercoralis*, *Trichuris trichura*

1. Introduction

The *Taenia solium* infection was included by the World Health Organization in its strategic plans for the control of neglected tropical diseases [1]. Despite to be considered by some authors as the most neglected of the neglected tropical diseases [2, 3], the strongyloidiasis, is an important medically problem, due the parasitic helminth *Strongyloides*, an aggressive parasite, since it may cause hyperinfection and dissemination in complicated strongyloidiasis through auto-infection [3]. Additionally, human schistosomiasis is a major source of morbidity. Some situations are reported in which the schistosome and *Ascaris lumbricoides, Trichuris trichura,* or hookworm (*Ancylostoma* and/or *Necator*) infections in the human results in a pattern of schistosomiasis which differs from the isolated *Schistosoma mansoni* infections, suggesting a synergistic or antagonism relationship between these species [4-10]. In spite of the fact that *Taenia* spp., *Strongyloides stercoralis*, *A. lumbricoides*, *T. trichura,* and hookworm infections frequently occur in regions where *S. mansoni* is endemic, the statistical association of those helminth species with *Schistosoma* has not been highlight on several studies. So far, it would indicate that something should be re-examined. Using the Brazilian bibliographic database it was pursued the effect of *Taenia* spp., S*trongyloides*, *Ascaris*, *Trichuris*, and hookworm species in the average prevalence of *S. mansoni* infections.

2. Material and Methods

Scientific publications between 1974 and 2013 for surveys conducted in Brazil of all age ('entire community') and children-based surveys available in Portuguese and English-language were eligible for inclusion. The search included only studies that had sample size higher than 30 [11] and were all positive for the presence of *S. mansoni* eggs on fecal examinations and present information for *Ascaris*, *Trichuris*, hookworms, *Taenia* spp., and *S. stercoralis* using the parasitological technique. Score prevalences of all parasites are registered, and in some cases the prevalent rate was recalculated (Boxes 1 and 2).

Box 1. Primary source of analysed data from Brazilian literature showing prevalence of helminhts in areas without *Taenia* spp. transmission

Author	Localities	N	Sm	Asc	Tri	Tae	Hoo	Ss
1. Siqueira 2011	MG	201	**28.9**	0.0	1.5	0.0	0,0	0.0
2. Costa et al. 2000	AL	40	**7.7**	61.6	7.7	0.0	0.0	0.0
3. Teixeira & Moreira, 2010	MG	92	**26.7**	6.7	0	0.0	1.1	0.0
4. Massara et al. 2004	MG	1,186	**8.6**	4.2	1.8	0.0	2.1	0.0
5. Oliveira et al. 2012	SE	46	**17.4**	6.5	2.2	0.0	2.2	0.0
6. Moraes 1997	BA	32	**2.38**	9.5	7.1	0.0	2.4	0.0
7. Oliveira et al. 2012	SE	47	**4.1**	8.2	0.0	0.0	6.3	0.0
8. Ttsuyuoka et al. 1999	SE	360	**1.7**	28.7	15.6	0.0	6.4	0.0
9. Pereira 2010	BA	135	**44.4**	16.30	21.5	0.0	6.7	0.0
10. Prado et al. 2001	BA	1,131	**2.2**	31.21	38.6	0.0	8.4	0.0
11. Oliveira et al. 2012	SE	36	**2.9**	6.1	0.0	0.0	12.1	0.0
12. Neto et al. 2012	PE	310	**28.4**	3.2	1.3	0.0	18.0	0.0
13. Oliveira et al. 2012	SE	73	**2.7**	13.7	2.7	0.0	19.2	0.0
14. Rollemberg et al. 2008	SE	19,400	**10.9**	16	26	0.0	22.0	0.0
15. Oliveira et al. 2012	SE	55	**3.6**	27.3	1.8	0.0	23.6	0.0
16. Rocha et al. 2010	AL	54	**10.6**	20.5	35.9	0.0	51.3	0.0
17. Carvalho 2011	MG	487	**5.1**	0.82	0.0	0.0	8.2	0.2
18. Torres 1985	BA	77	**72.8**	9.6	4.5	0.0	4.5	1.2
19. Kanamura et al. 1998	SP	628	**0.7**	67.9	54.5	0.0	8.9	1.5
20. Santos et al. 2005	BA	258	**0.8**	55.0	79.5	0.0	28.3	1.5
21. Torres 1985	MG	124	**9.6**	2.4	0.8	0.0	21.0	1.6
22. Torres 1985	MG	119	**58.6**	44.5	21.0	0.0	23.5	1.7
23. Palmeira et al. 2010	AL	690	**24.9**	27.2	25.8	0.0	8.7	1.7
24. Ludwig et al. 1999	SP	290	**0.4**	4.3	1.8	0.0	1.8	1.9
25. Gonçalves et al. 1990	PE	140	**90.3**	59.4	73.5	0.0	11.0	2.0
26. Barbosa and Silva. 1992	PE	105	**92.0**	81.0	62.0	0.0	32.0	2.0
27. Oliveira et al. 2012	SE	44	**2.3**	18.2	4.5	0.0	2.3	2.3
28. Assis et al. 2013	MG	88	**23.9**	2.3	2.3	0.0	60.2	2.3
29. Gonçalves et al. 1990	PE	31	**75.6**	68.3	48.8	0.0	85.4	2.4
30. Seixas et al. 2012	BA	200	**1.0**	25	10.5	0.0	1.5	2.5
31. Costa et al. 2002	BA	155	**5.8**	43.1	15.3	0.0	35.8	2.6
32. Gonçalves et al. 1990	PE	34	**100.0**	29.4	26.5	0.0	50.0	2.9
33. Mati et al. 2011	MG	476	**0.2**	4,0	0.2	0.0	6.3	3.4
34. Kruschewsky 2010	BA	500	**62.0**	37.4	43.4	0.0	33.7	3.5
35. Torres 1985	BA	130	**11.5**	78.5	47.7	0.0	23.8	3.8
36. Torres 1985	BA	229	**24.4**	42.4	18.8	0.0	11.4	3.9
37. Filho et al. 2012	MG	2,161	**0.36**	21.5	9.6	0.0	12.2	4.5
38. Torres 1985	BA	96	**68.7**	10.4	15.6	0.0	25.0	5.2
39. Ferreira et al. 2002	AL	137	**1.0**	47.4	21.2	0.0	10.0	6.
40. Assis et al.2013	MG	99	**32.3**	2.0	0.0	0.0	30.3	6.1
41. Barbosa & Barbosa. 1998	PE	439	**35.1**	8.6	7.9	0.0	24.9	6.3
42. Assis et al. 2013	MG	193	**17.6**	1.0	0.0	0.0	30.1	6.7
43. Gonçalves et al. 1990	PE	193	**75.7**	66.7	76.9	0.0	83.1	7.8
44. Okazaki et al. 1988	PE	651	**11.2**	62.1	60.1	0.0	47.0	9.6
45. Cury et al. 1994	MG	864	**15.4**	11.1	0.4	0.0	8.7	12.9

Abrev. : Sm = *Schistosoma mansoni*; Asc = *Ascaris lumbricoides*; Tri = *Trichuris trichiura*; Tae = *Taenia* spp.; Hoo = Hookworm; Ss = *Strongyloides stercoralis*. Localities: AL = Alagoas; BA = Bahia; MG = Minas Gerais; PE = Pernambuco; SE = Sergipe; SP = São Paulo. Same author/year in several entries means different localities/population in the studied area of the state.

The precision of those results can be increased by stratification, so the *Taenia* spp. data was partitioned into *Taenia* spp. infection present (n=24) or absent (n=45). Because there were only a few cases registered for soil-transmitted helminths (STH) infection absent, the score prevalence of each STH species were dichotomized into two levels as follows: score prevalence values consisting of scores that are above than a median (= "More"), and scores that are not above the median (= "Less"). The score prevalence of schistosomiasis) are presented as median and stratum differences of them were compared using Minitab software to calculate the results for a Kruskal-Wallis (KW) test.

Box 2. Primary source of analysed data from Brazilian literature showing prevalence of helminhts in áreas with *Taenia* spp. transmission

Author	Localities	N	Sm	Asc	Tri	Tae	Hoo	Ss
1. Marinho 2008	MG	926	**0.8**	3.5	1.2	0.8	13.7	0.0
2. Machado et al. 1996	MG	230	**1.1**	21.6	6.4	2.0	0.8	0.0
3. Camargo-Neves et al. 1998	SP	400	**5.0**	16.5	17.7	0.2	0.2	0.0
4. Enk et al. 2010	MG	1,061	**11.2**	1.6	0.0	1.8	10.4	0.0
5. Roca 2011	MG	1,124	**11.7**	5.9	0.3	0.1	3.4	0.0
6. Webster et al. 1997	MG	534	**39.5**	1.0	1.0	1.0	57.4	0.0
7. Rocha et al. 2000*	MG	1,441	**0.0**	4.8	0.9	0.2	0.6	0.1
8. Chieffi et al. 1988	SP	913	**0.2**	40.8	31.2	0.2	1.3	0.4
9. Mati et al. 2011	MG	341	**1.5**	0.3	0.0	0.3	2.0	0.6
10. Magalhães et al. 2013	MG	93	**4.16**	34.2	0.27	0.1	2.3	1.07
11. Rocha et al. 2000	MG	1,460	**0.37**	4.9	0.4	0.2	5.0	1.1
12. Lopes et al. 2006	PR	264	**1.5**	10.2	6.1	1.1	3.4	1.1
13. Ludwig et al. 1999	SP	11,573	**0.1**	3.8	1.6	0.5	1.5	1.5
14. Cantuária et al. 2011	MG	110	**1.8**	0.0	0.0	1.8	0.0	1.8
15. Ruela 2012	MG	46	**8.7**	3.0	0.0	2.2	4.3	2.2
16. Ludwig et al. 1999	SP	2,585	**0.2**	13.1	5.9	0.1	1.6	2.2
17. Ludwig et al. 1999	SP	607	**0.2**	8.9	4.8	0.2	1.5	2.8
18. Costa et al. 1992	RN	7,012	**0.9**	31.2	27.9	11.2	11.2	3.4
19. Olveira et al. 1974	SP	895	**0.2**	10.4	13.6	1.2	17.5	6.0
20. Santos et al. 1990	GO	1,878	**0.3**	26.9	6.3	0.2	21.3	6.1
21. Jardim-botelho et al. 2008	MG	1,113	**45.2**	50.7	1.1	0.2	69.8	8.1
22. Oliveira et al. 2012	SE	36	**22.2**	52.8	5.6	2.8	22.2	8.3
23. Anaruma et al 2007	SP	162	**4.9**	16.7	11.1	0.6	4.3	8.6
24. Fontes et al. 2003	AL	1,020	**2.4**	57.0	59.1	1.4	51.3	14.0

Abrev. : Sm = *Schistosoma mansoni*; Asc = *Ascaris lumbricoides*; Tri = *Trichuris trichiura*; Tae = *Taenia* spp.; Hoo = Hookworm; Ss = *Strongyloides stercoralis*. Localities: AL = Alagoas; GO= Goiás ; MG = Minas Gerais; PR= Paraná ; RN= Rio Grande do Norte ; SE = Sergipe; SP = São Paulo. Same author/year in several entries means different localities/population in the studied area of the state.

3. Results

The method of sampling attempts to total 69 surveys positive for *S. mansoni* infection and the estimate of the average prevalence of *S. mansoni* infection is 5.46.

There were 35,832 persons in prevalence surveys where *Taenia* spp. is present and 32,836 undertaken among this parasite is absent (or in 24 and 45 sampled localities respectively, source data in boxes 3 and 4). When comparing the median prevalence of schistosomiasis in a region without *Taenia* spp. occurrence to a region with *Taenia* spp. infection (that is, 11.20 *vs* 1.51) the score prevalence of *S. mansoni* infection does exhibit different distribution (Table 1).

Table1. Median prevalence of schistosomiasis with or without *Taenia* spp. Infection in different regions

Infection by *Taenia* spp.	Number of survey	Number of persons	Prevalence of *S. mansoni**
No	45	32,836	11.20
Yes	24	35,832	1.51

**KW=12.13; P=0.000; DF=1*

Further, it was applied stratification, a sampling procedure in which the population is divided into subgroups or strata within each of which an independent sample is selected.

In such case stratification of the data is a statistical strategy for controlling variables that distorts an outcome of interest, the prevalence of *S. mansoni*. A parasite with potential granulomatous character, the *Taenia* spp. (presence/absence), was variable 1. The prevalence of zoonotic *Strongyloides* infection, another parasite with potential granulomatous character, was fitted as the second variable with two prevalence levels (either “More” or “Less”). A third variable was the major geo-helminths without noticeable granulomatous character, stratified by species namely *Ascaris*, *Trichuris*, and hookworms, also with two levels of prevalence (either “More” or “Less”). So, the data can be represented in a table format easy to visualize what happens with the average prevalence of schistosomiasis in the strata or subgroups (Table 2).

Table2. helminth species as factors that contribute to the variability in median prevalence of *Schistosoma mansoni* infection estimates

Route of infection		**Prevalence levels**	*Taenia* **spp. positive with** *Strongyloides*		*Taenia* **spp. negative with** *Strongyloides*		***p*-Value**
			"More"	"Less"	"More"	"Less"	
A) Oral	*Ascaris*	"More" *	1.6 **(8)****	2.6 (**4**)	24.4 (1**3**)	3.6 (**9**)	0.028
		"Less"	1.0 (**4**)	1.5 (**8**)	17.6 (**9**)	10.2 (**14**)	
	Trichuris	"More"	0.6 (**8**)	1.3 (**4**)	24.4 (**13**)	10.6 (**9**)	0.009
		"Less"	5.2 (**4**)	2.8 (**8**)	15.4 (**9**)	8.1 (**14**)	
B) Skin	Hookworm	"More"	3.6 (**8**)	6.0 (**4**)	33.7 (**14**)	10.1 (**8**)	0.001
		"Less"	1.0 (**4**)	1.5 (**8**)	1.6 (**8**)	7.7 (**15**)	

*The score prevalence of *Ascaris, Trichuris* and hookworm species was dichotomized into two levels: a) The score prevalence values that are above than a median (="More"), and scores that are below the median (="Less"). **Median ; (N)=samples .

Statistically, the expectation is that the median prevalence of *S. mansoni* infection does not differ from one another. However, looking at the median prevalence of *S. mansoni* infection they vary so much that one might wonder whether each group of strata distorts the association of parasite variables with the prevalence of schistosomiasis. Overall, the score prevalence of schistosomiasis in a region with *Taenia* spp. the median prevalence of *S. mansoni* infection does exhibit lower values regardless of *Strongyloides, Ascaris, Trichuris,* or hookworms. There was statistically different distribution of scores of prevalence of schistosomiasis since the *p*-value results for *Ascaris, Trichuris,* or hookworms strata were 0.028, 0.009, and 0.001, respectively.

4. Discussion

Despite *S. mansoni* infections, *S. stercoralis* and *Taenia* spp. are phylogenetically unrelated parasites them thought to be some similarities. The infections are primarily localized in the digestive tract, but the nervous system is the other involved site [12-15]. Also, anti-complement system activity has been demonstrated in the *Taenia taeniaeformis* [16] as well as separated from sera of a *S. mansoni* infection or a bacterial disease [17,18].

When data from a variety of bibliographical sources have been lumped together, such as different parasitological condition, prevalence and some others, data analysis require separating different groups or strata [4,19,20]. In this present stratified study, the lower average prevalence of *S. mansoni* infection is clear to find strata on *Taenia* spp. positive grade than negative. It was observed that a higher score average prevalence of schistosomiasis was also observed in *Taenia* spp. negative strata that have "“More”" prevalence of *Strongyloides* infection. For the first time, it was shown the risk of *Taenia* spp. and *Strongyloides* infections, as an environmental indicator to guide the prevalence of *S. mansoni* infection in a fashion major soil-transmitted helmints (*Ascaris, Trichuris,* and hookworms) dependent manner. Since *S. mansoni* and studied helminth species do not interact directly with one another, the effects of immunological response can not be excluded [7,12,21]. In another line of the study also it was referred on the possible existence of a negative association between *S. mansoni* and *Ascaris* or *Trichuris* [4,5,6].

Unfortunately, no similar studies applying collective analysis in *S. mansoni* areas with zoonotic species of helminths that induce granulomatous inflammation was found to be compared. Concerning the co-infection with *S. mansoni* and *Strongyloides* the majority of the studies have been performed mainly in HIV infection [22-24].

Lastly, in the first column in Table 2, in the *Ascaris* group, these strata were contaminated by the "hidden" occurrence of the *Trichuris* and hookworms and so on. Despite the present model of collective analysis may be important to obtain overall information about the functional form of the prevalence of *S. mansoni* infection other factors that contribute to the variability in the prevalence of *S. mansoni* infection. These factors were well known namely socio-economic, human behavior, age, nutritional, environmental, demographic, ecological characteristics, and the lack of accurate diagnostic tools could also affect the results.

5. Conclusion

We conclude from the present analysed data that the median prevalence of schistosomiasis in a region with or without infection by *Taenia* spp. does exhibit different distribution pattern regardless the infection by *Strongyloides*, *Ascaris*, *Trichuris*, or hookworm.

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AUTHORS' CONTRIBUTIONS

MC conceived, designed the study, compiled the data and with ALM drafted the first version of manuscript; GSA analyzed and interpreted the data. All authors read, critically revised and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

DATA AVAILABILITY

The authors declare that the data supporting the findings of the present study are available within the article and if necessary for further information, from the corresponding author upon request.

REFERENCES

[1] World Health Organization. Global plan to combat neglected tropical diseases 2008–2015. (2007). Available: http://www.who.int/neglected_diseases/NTD20Global20plan_20January202007.pdf. Accessed 27 January 2009.

[2] Olsen A., van Lieshout L., Marti H., Polderman T., Polman K., Steinmann P., Stothard R., Thybo S., Verweij J. J. and Magnussen P. Strongyloidiasis, the most neglected of the neglected tropical diseases? Trans. R. Soc. Trop. Med. Hyg. 103(10), 967-72, (2009).

[3] Mati V. L. T.; Raso P. and Melo A. L. *Strongyloides stercoralis* infection in marmosets: Replication of complicated and uncomplicated human disease and parasite biology. Parasite & Vectors, 7, 579-596, (2014).

[4] Chamone M., Marques C. A., Atuncar G. S., Pereira A. L. and Pereira L. H. Are there interactions between schistosomes and intestinal nematodes? Trans. R. Soc. Trop. Med. Hyg. 84, 557-558, (1990).

[5] Chamone M., Erichsen E., Atuncar G., and Melo, A. L. Hidden association between *Schistosoma mansoni* and *Ascaris lumbricoides* infections. Rev. Ciên. Méd. Biol. 10,146-153, (2012).

[6] Fleming F. M., Brooker S., Geiger S. M., Caldas I. R., Corrêa-Oliveira R., Hotez P. and Bethony J. M. Synergistic associations between hookworm and other helminth species in a rural community in Brazil. Trop. Med. Int. Health. 11, 56-64, (2006).

[7] Geiger S. M. Immuno-epidemiology of *Schistosoma mansoni* infections in endemic populations co-infected with soil-transmitted helminths: Present knowledge, challenges, and the need for further studies. Acta Trop. 108, 118–123, (2008). https://doi.org/10.1016/j.actatropica.2008.05.012

[8] Keiser J., N'goran E. K, Singer B. H., Lengeler C., Tanner M. and Utzinger J. Association between *Schistosoma mansoni* and hookworm infections among schoolchildren in Côte d'Ivore. Acta Trop. 84, 31-41, (2002).

[9] Raso G., Vounatsou P., Singer B. H., N'Goran E. K., Tanner M. and Utzinger J. An integrated approach for risk profiling and spatial prediction of *schistosoma mansoni*–hookworm coinfection. PNAS. 103, 6934–6939, (2006).

[10] Webster M., Corrêa-Oliveira R., Gazzinelli G., Viana I. R., Fraga L. A., Silveira A. M. and Dunne D. W. Factors affecting high and low human IgE responses to schistosome worm antigens in an area of Brazil endemic for *Schistosoma mansoni* and hookworm. Am. J. Trop. Med. Hyg. 57, 487-494, (1997).

[11] Brooker S., Booth M., Guyatt H. Comparisons of schistosome and geohelminth infection prevalences in school-aged children from selected areas of Africa: implications for rapid assessment and combined control. Trans. R. Soc. Trop. Med. Hyg. 93, 125-26, (1999). http://dx.doi.org/10.1016/S0035-9203(99)90281-X.

[12] Iudici Neto F., Pianetti-Filho G., Araújo R. N. and Nascimento E. Immunodiagnosis of human neurocysticercosis by using semi-purified scolex antigens from *Taenia solium* cysticerci. Rev. Soc. Bras. Med. Trop. 40,163-169, (2007).

[13] Moura E. B., Maia M. O., Ghazi M. A., Ferreira F. and Pinhati H. M. Salvage treatment of disseminated strongyloidiasis in an immunocompromised patient: therapy success with subcutaneous ivermectin. Braz. J. Infec. Dis. 16, 479-481, (2012).

[14] Pittella J. E. H. Neuroschistosomiasis. Brain Pathol. 7, 649-662, (1997).

[15] Woll F., Gotuzzo E. and Montes M. *Strongyloides stercoralis* infection complicating the central nervous system. Handb. Clin. Neurol. 114, 229-34, (2013).

[16] Hammerberg B., Williams J. F. Interaction between *Taenia taeniaeformis* and the complement system. J. Immunol. 120, 1033-1038, (1978).

[17] Nascimento B. C. and Chamone M. The separation of complement inhibitors from patients with schistosomiasis or Chagas' disease by gel filtration on Sephadex G-200: a preliminary study. Braz. J. Med. Biol. Res. 21, 295-299, (1988).

[18] Nascimento B. C., Cisalpino E. O. and Chamone M. Blocking of haemolytic complement by heterogeneous factors present in lepromatous leprosy. Lepr. Rev. 60, 68-70, (1989).

[19] Alves-Oliveira L., Chamone M., Marques C. A., Nascimento B. C. and Coelho P. M. Antibodies reactivity in human *Schistosoma mansoni* disease: detection and functional activity. Ann. Trop. Med. Parasitol. 82, 591-595, (1988).

[20] Chamone M., Atuncar G. S., Coelho P. M. Thermostability of heterophile antibodies from human sera infected with *Schistosoma mansoni* and geo-helminths. An immuno-metric statistical analysis. Rev. Inst. Med. Trop. São Paulo. 48,157-165, (2006).

[21] Geiger S. M., Douglas, N. E. A., Fujiwara, R. T. Brooker, S.; Cundill, B.; Diemert, D. J.; Correa-Oliveira, R. and Bethony, J. M. *Necator Americanus* and helminth co-infections: further down-modulation of hookworm-specific Type 1 immune responses. PLoS Neglected Tropical Diseases 5, e1280, (2011).

[22] Blatt, J. M. and Cantos, G. A. Evaluation of techniques for the diagnosis of *Strongyloides stercoralis* in human immunodeficiency virus (HIV) positive and HIV negative individuals in the city of Itajaí, Brazil. Braz. J. Infect. Dis. 7, 402-408, (2003).

[23] Paula, F. M. and Costa-Cruz, J. M. Epidemiological aspects of strongyloidiasis in Brazil. Parasitology. 138, 1331-1340, (2011). http://dx.doi.org/10.1017/S003118201100120X

[24] Sadlier C. M., Brown A., Lambert J. S., Sheehan G. and Mallon P. W. G. Seroprevalence of Schistosomiasis and *Strongyloides* infection in HIV-infected patients from endemic areas attending a European infectious diseases clinic. AIDS Res. and Ther. 10, 23-27, (2013).

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