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VERSITA

Identification of public areas with potential toxocariasis transmission risk using Geographical Information Systems

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Abstract

Geographic information system (GIS) or Health geography is a geographical identification of the spatial variation of contagion disease and zoonosis risk in certain conditions. **Objective:** Comparing the variation of environmental contamination of *Toxocara* spp. sands of lawns and public areas through the Geographic Information System. **Materials and Methods:** Were investigated 98% of Parana recreational urban areas such as, schools, public parks and squares filled with sand and/or lawn. Samples were analyzed using zinc sulphate solution centrifuge-flotation, density 1.420, and water sedimentation. Maps were developed by ESRI Arc GIS 9.2. **Results:** Total 77/98 (78,6%) of public spaces shown *Toxocara* spp. eggs presence. No significant difference was observed (p = 0,9999) between eggs prevalence in sand 44/56 (78,6%), and lawn 33/42 (78,6%), at school (p = 0,6898) and squares (p = 0,0616). Egg contamination prevailed in periphery areas in the sand 20/27 (74%) and lawn 18/21 (86%). However, no significant difference was observed between sand and lawn contamination from schools and parks to central and peripheral areas. Although schools 62/66 (93,9%) presented a higher number of enclosed spaces, did not provide a lower frequency of pollution (p = 0,3327). **Conclusion:** GIS observed a scattered pattern of zoonosis among schools and public squares sand and lawns, with predominance of contamination in the peripheral areas with presence of dogs/cats.

Keywords

Toxocara spp., Geographic information system GIS, Lawn, Sand, Public Spaces

Introduction

Geographical Information Systems (GIS) is a system design to estimate diseases distribution (Richards *et al.* 1999, Barcellos and Ramalho 2002), diseases related to environmental and socioeconomic conditions (Aronoff 1990). With this estimate is possible to draw public policies aimed at preventing the same, and consequently reduction of clinical cases. Given the health surveillance, the GIS is a useful tool for preventive health since, through the spatial distribution of certain zoonoses in environmental strategies can be implemented or improved (Medronho 1993). The geoprocessing techniques using cartographic maps to record, calculate, disclose, analyze and understand the spatial relationships that exist between different phenomena, whose geographic locations are (Cuenin 1972). It also allows you to determine specific risk situations (focus), as well as observing resources available in each area (Cuenin 1972). In summary, the Geographic Information Systems (GIS) are sets of tools used to spatially represented information (Aronoff 1990).

The toxocariasis is a zoonosis widely distributed, with different rates of environmental contamination, both in developed countries and those with poor sanitary conditions, cultural and social (Despommier 2003). Humans infection occurs by ingestion of *Toxocara canis* or *Toxocara cati* embryonated eggs, dogs and cats intestinal parasites (Beaver 1956). Toxocariasis prevalence is generally higher in tropical and developing countries (Campos Júnior *et al.* 2003). Argentina subtropical region 67% of children were seropositive (Lopez *et al.* 2005), in northeastern of Brazil, 12,1% children were seropositive (Coelho *et al.* 2005), in between 8,7% (Teixeira *et al.* 2006) Southeast of Brazil 54,8% (Figueiredo *et al.*

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2005). In Paraná state, southern Brazil, children seropositivity ranged from 28,8% to 53,8% (Paludo *et al.* 2007, Colli *et al.* 2010, Mattia *et al.* 2012).

Public urban areas, parks and gardens represent important sources of *Toxocara* spp. contamination (Overgaauw 1997, Tiyo *et al*. 2007, Manini *et al*. 2012). Children are the most vulnerable due to increased contact with sand and soil intended for recreation and in cases with habits geophagy (Lopez *et al.* 2005, Paludo *et al.* 2007, Tiyo *et al.* 2007, Manini *et al.* 2012). Recreation areas are notorious worldly investigate for soils parasitic contamination (Habluetzel *et al.* 2003, Chorozy and Richardison 2005, Matsuo and Nakashio 2005, Tiyo *et al.* 2007). In Japan public parks contamination rate is 8% (Matsuo and Nakashio 2005), Czech Republic, 20,4% (Dubna *et al.* 2007). In Brazil, parks and schools recreation areas have shown different results (Chieffi and Muller 1976, Tiyo *et al.* 2007), as 17% in Rio de Janeiro (Ferreira *et al.* 1976) and frequency exceeding 44.4% in Londrina and in the northwest, both located in the State of Paraná (Chieffi and Muller 1976, Tiyo *et al.* 2007, Colli *et al.* 2010, Mattia *et al.* 2012).

It is noteworthy that in the northwestern region of Paraná, there were different frequencies of seroprevalence among children municipalities (Paludo *et al*. 2007, Tiyo *et al*. 2007, Colli *et al*. 2010, Marchioro *et al*. 2011, Mattia *et al*. 2012). Regarding risk factors, in general, were considered aged between one and five years (Paludo *et al*. 2007, Colli *et al*. 2010) and play three to five times a week in public squares containing sand or lawn (Manini *et al*. 2012). The different results of seroprevalence did not explain the areas where children could have had greater exposure to *Toxocara* spp. However, rare cases of pulmonary toxocariasis were observed among children seen in public health services in the same region (Guilherme 2011). In view of the need to know the areas most vulnerable to environmental exposure of children is what motivated this research. This study aimed to compare the variation of environmental contamination of *Toxocara* spp. sands of lawns and public areas through the Geographic Information System.

Materials and Methods

Study area

Spaces environmental public plazas and schools intended for recreation in ten counties of northwestern Parana, Brazil (Fig. 1), population in the range of 37.76 to 801.79 inhabitants/km^2 (IBGE 2011). Investigated region is located between longitudes 52°35´42″ and 52°25´30″ and latitudes 22°40´30″ and 23°40´49″. Climate is classified as mesothermal humid subtropical with hot summers and winters with only occasional frosts. Average annual temperature is 22.1°C and rainfall is 1700 mm yr^{-1} (Silveira 2003).

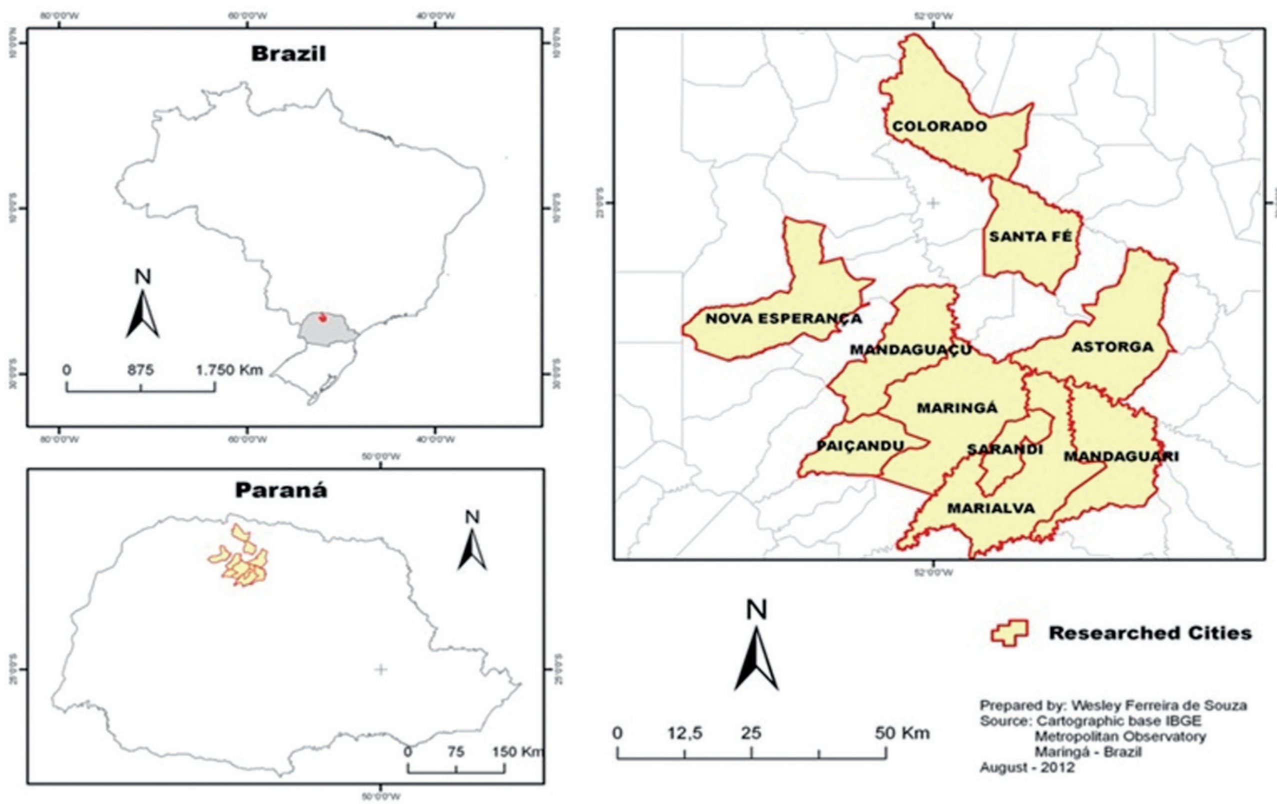

Fig. 1. Maps of investigated cities in northwest of Parana

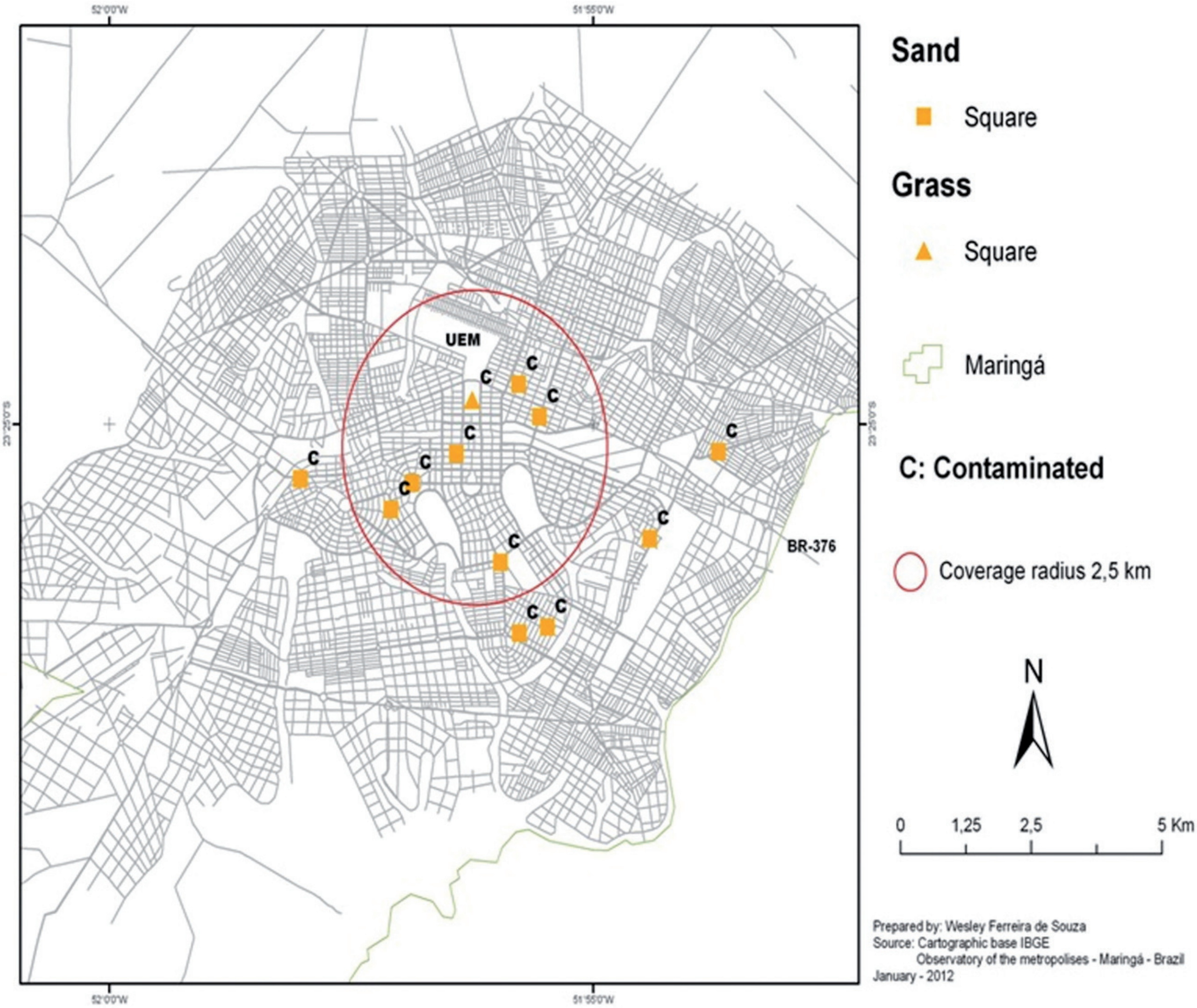

Fig. 2. Representative map with geographic locations of *Toxocara* eggs contamination in public recreational areas in Maringa Parana

Sampling and laboratory analysis

In nine municipalities were collected sand samples and/or lawn spaces for leisure or recreation in all public schools and parks and public squares of Maringa, county seat of the county. At each location searched five samples were collected 100 g sand, one at each end and one in the central part, from five centimeters deep in relation to the surface, amounting to 500 g. The lawns were observed withdrawing samples of 20 x 10 cm, in each of five sampling points. They were placed in plastic bags first use, identified and referred to the Environmental Laboratory of Parasitology, State University of Maringá (UEM) and processed at the same day. Each sample of sand and lawn were analyzed by flotation technique using zinc sulphate solution, density 1.420 (Tiyo *et al.* 2007) and sedimentation in water (Rey 2001). For the first technique have been used 35 g of sand from total of 100 g sample collected at each point. Each sample was homogenized and diluted in 150 ml distilled water, filtered in gauze and processed according Tiyo *et al*. (2007). Individual lawn sample was washed with 100 ml distilled water and filtered, 50 ml from washed sample were removed and centrifugation-flotation technique applied (Colli *et al.* 2010). Sedimentation technique in water used 35 g of sand diluted in 150 ml distilled water and for previously processed lawn 50 ml distilled water. Both were filtered through cheesecloth and allowed to settle for six to eight hours. From each sample, 2.0 ml resuspended sand, and 1 ml sediment lawn were analyzed under optical microscope. Results were expressed quantitatively number of *Toxocara* spp./grams sand per lawn m^2.

Variables studied

Using GPS (Global Positioning System) were observed at each sampling site the longitude, latitude, temperature, sampling time, observed if the access gates were closed and if there were presence of dogs and cats.

Thematic maps preparation

The map was designed from the concentration of *Toxocara* spp. in each school and the town square, the program using ESRI Arc GIS 9.2. In each map was plotted lightning to delimit the central and peripheral urban areas of each city. With this definition was inserted and analyzed the concentration distribution of *Toxocara* spp. (Fig. 2). The maps have varying ranges due to the size difference of the total area of each municipality.

Statistical analysis

Using the program Statistica 8.0 and SAS 9.1 were compared temperatures of contaminated sites and uncontaminated by student t test with significance level of 5%. At ratio test (Test Z), was compared between the concentration of eggs municipalities both in central and in peripheral reference to the results of Astorga, by owning population density similar to most municipalities surveyed (IBGE 2011). Besides this municipality had 100% environmental contamination.

Results

We analyzed 98 spaces for leisure and/or recreation in urban areas in ten cities and 77 (78.6%) showed *Toxocara* spp. Of all investigated areas, 42 sites with lawns and comprised 56 with sand. These sites were distributed among 32 schools and 66 squares, and plazas, 11 owned and 21 local lawn with sand and in schools, with 31 locations and 35 with lawn sand (Table I).

For the spatial analysis of maps could observe a higher prevalence of contamination by *Toxocara* spp. in the periphery of urban areas of the municipalities of Colorado, Mandaguaçu, Santa Fe and Paiçandu. For urban areas of Astorga, Mandaguari, Marialva, Maringá and Nova Esperança, the central region was the most prevalent. Already, the city of Sarandi, distribution was equally dispersed between central and peripheral zone. In general, the contamination for most municipalities prevailed in the peripheral region. Among the 27 local sand contaminated by *Toxocara* spp., 20 (74%) were located in the periphery. Likewise, lawns, 18 (86%) of 21 were located in the periphery contaminated.

When compared to the contamination of sand between schools located in the peripheral region and the central region, there was no difference ($p = 0{,}3707$), and between the squares of the central and peripheral ($p = 0{,}6361$). There was also no difference in contamination ($p = 0{,}1277$) between the samples lawns of schools located in the central and peripheral, and lawns of central and peripheral located in squares ($p = 0{,}9999$).

Compared contamination among local sand 44/56 (78,6%) with lawn 33/42 (78,6%) did not differ ($p = 0{,}9999$). Even expressed no difference in the contamination compared sand 27/50 (54,0%) and lawn 23/50 (46,0%) of schools ($p = 0{,}6898$), and between the sand 17/27 (63, 0%) and lawn 10/27 (37,0%) of squares ($p = 0{,}0616$).

Gated sites were more contaminated than unprotected areas ($p = 0{,}00001$). Most of protected areas were mainly located in the schools (62/66) compared to the squares (19/32), $p = 0{,}0001$. However, there were no difference in sand and lawn contamination between schools (50/66) and squares (27/32) samples ($p = 0{,}3327$).

Highest concentration of *Toxocara* spp. eggs/m^2 was observed in two cities: Paiçandu football field with 400 eggs/m^2 and Mandaguari school with 260 eggs/m^2. Both sites were located in fenced central areas, no presence of dogs and cats observed during sampling. Maringá city shown highest concentration of *Toxocara* spp. at two sand squares. One sand square was located in peripheral region, with protective fences with no animals presence during sampling, the other sand square was located in the central area, with dogs presence 7,5 eggs/g and 7,3 eggs/g, respectively.

During trial 27 dogs and 9 cats were observed aleatory in some of the 98 sites studied. Statistical analysis associated *Tox*-

Table I. *Toxocara* spp. frequency in sand and grass in recreational urban areas in the northwest of Parana, southern Brazil

Municipality	**Squares**		**Schools**		**Total contamination**	**p-value**
	Sand	Grass lawn	Sand	Grass lawn		
	C/N	C/N	C/N	C/N	C/N	
Astorga	0/0	2/2	3/3	4/4	9/9	0,9999
Colorado	0/1	0/0	3/5	0/1	3/7	0,0108*
Mandaguaçu	0/0	0/0	2/4	5/5	7/9	0,1269
Mandaguari	0/0	0/1	1/2	6/9	7/12	0,0236*
Marialva	1/1	0/0	4/4	2/4	7/9	0,1269
Maringá	11/11	1/1	0/0	0/0	12/12	Reference
Nova Esperança	1/1	0/0	5/5	1/3	7/9	0,1269
Paiçandu	1/2	3/3	4/4	1/1	9/10	0,3504
Santa Fé	0/1	2/2	2/3	1/1	5/7	0,0829
Sarandi	3/4	2/2	3/5	3/3	11/14	0,1234

C = Number of locations containated, N = Total number, *p = significative (> 0,05) *ocara* spp. contamination with areas with presence of dogs 20/27 (74,1%) (p = 0,0008) and cats 8/9 (88,9%) (p = 0,0045).

Among surveyed cities sand and grass contamination by *Toxocara* spp. were higher than 40%. Maringá and Astorga had all sites contaminated, followed by Paiçandu (90%), Sarandi (78,6%), Marialva (77,7%), Nova Esperança (77,7%) and Mandaguaçu (77,7%), Santa Fe (71%), Mandaguari (58%) and Colorado (43%). Mandaguari and Colorado had significantly lower contamination rate than Astorga city p = 0,0388, p = 0,00087, respectively (Table I).

Among investigated environmental spaces temperature were constant between 22°C to 29°C with no effect on *Toxocara* spp. (p = 0,12).

Discussion

The GIS showed that the region assessed the distribution of *Toxocara* spp. is dispersed among multiple locations investigated, and that although predominate in the peripheral areas due to the high prevalence in all areas exceeding 40%, it was not possible to determine specific foci. However, when examining each city in which we highlight some contamination predominated in the central region. Although there are numerous research studies on *Toxocara* spp. in soils (Alderete *et al*. 2003, Capuano and Rocha 2005, Dubna *et al*. 2007; Tiyo *et al*. 2007; Azian *et al*. 2008; Zibaei *et al*. 2010), in a survey conducted in PUBMED from 2001 to 2012, were not observed specific articles or GIS spatial data analysis for this zoonosis. It should be emphasized that the mapping of disease or risk factors has been seen as a key element in epidemiological research, the importance of health description of events according to the person, time and place (Werneck 2008).

Another important fact to be noted is that the sands and the lawns of northwestern Parana also has potential to be contaminated with *Toxocara* spp. Attention is drawn to the importance of contamination of lawns which according to the literature (Tiyo *et al*. 2007; Colli *et al*. 2010; Mattia *et al*. 2012) are poorly investigated.

With the exception of urban areas and Maringá Sarandi, the other municipalities are small, geared to agropastoral activities, with few recreational areas and, therefore, schools and public squares spaces are much frequented by the population. Allied to this fact, epidemiological studies conducted in the same area showed seropositivity relevant to this zoonosis in children served by public health service (Paludo *et al.* 2007, Colli *et al.* 2010, Mattia *et al.* 2012). However, these studies did not correlate seropositivity with sources of contamination (Paludo *et al*. 2007, Colli *et al*. 2010, Mattia *et al*. 2012).

Spatial analysis shown a discrete predominance by *Toxocara* spp. contamination in the peripheral regions of the municipalities, regardless of sand or grass, results corroborate with Santarém *et al.* (2010). The locations in the presence of animals, dogs and cats, were most often contaminated. Cassenote *et al.* (2011) observed an association between *Toxocara* spp. contaminated areas and the presence of dogs. Uga *et al.* (1996) observed that cats were the main responsible for *Toxocara* spp. sandboxes contamination in public parks. In this study, were observed high contamination in fenced sites, despite the low frequency of cats, Uga *et al.* (1996) explains that cats have the habit of defecating at night.

The results of this study revealed that *Toxocara* spp. are also present in samples from sand and lawns of schools and public squares, with a slight predominance of contamination in the peripheral urban areas. At geoprocessing was possible to compare different areas and this allows for control programs focused on preventive health measures in order to achieve control of this zoonosis, establish educational programs and measures in the municipalities. It should also be noted that dogs and cats are relevant in this distribution, since they are the major sources of contamination in the environment. This we observed a high prevalence of zoonotic disease in the environmental spaces of the municipalities surveyed, with a trend of increased contamination in the peripheral zone, even in enclosed spaces, because, it seems, there is no awareness of the closing of the gates.

References

Alderete J.M.S., Jacob C.M.A., Pastorino A.C., Elefant-Guita R., Castro A.P.M., Fomim A.B.F., Chieffi P.P. 2003. Prevalence of *Toxocara* Infection in schoolchildren from the Butantã region, São Paulo, Brazil. *Memórias do Instituto Oswaldo Cruz*, 98, 593–597. DOI: 10.1590/S0074-02762003000500002.

Aronoff S. 1990. Geographic information systems: a management perspective. Ottawa: WDL Publications. DOI: 10.1080/10106048909354237.

Azian N., Sakhone L., Lokman Hakim S., Yusri M.Y., Nurulsyamzawaty Y.A., Zuhaizam H., Mohd Rodi I., Maslawaty M.N. 2008. Detection of helminth infections in dogs and soil contamination in rural and urban areas. *The Southeast Asian Journal of Tropical Medicine and Public Health*, 39, 205–212.

Barcellos C., Ramalho W. 2002. Situação atual do geoprocessamento e da análise de dados espaciais em saúde no Brasil. *Revista IP – Informática Pública*, 4, 221–230.

Beaver P.C. 1956. Parasitological Reviews - Larva Migrans. Experimental Parasitology, 5, 587–621. DOI: 10.1016/0014-4894(56)90032-7.

Campos Júnior D., Rubinsky-Elefant G., Silva E.O.M., Ganolfi L., Gandolfi L., Jacob C.M.A., Tofeti A., Pratesi R. 2003. Frequência de soropositividade para antígenos de *Toxocara canis* em crianças de classes sociais diferentes. *Revista da Sociedade Brasileira de Medicina Tropical*, 36, 509–513. DOI: 10.1590/S0037-86822003000400013.

Capuano D.M., Rocha G. de M. 2005. Environmental contamination by *Toxocara* spp. eggs in Ribeirão Preto, São Paulo State, Brazil. *Revista do Instituto de Medicina Tropical de São Paulo*, 47, 223–226. DOI: 10.1590/S0036-46652005000400009.

Cassenote A.J.F., Neto J.M.P., Lima-Catelani A.R.A., Ferreira A.W. 2011. Contaminação do solo por ovos de geo-helmintos com potencial zoonótico na municipalidade de Fernandópolis, Estado de São Paulo, entre 2007 e 2008. *Revista da Sociedade Brasileira de Medicina Tropical*, 44, 371–374. DOI: 10.1590/S0037-86822011005000026.

Coelho R.A.L., Carvalho J.R., Perez E.P., Araki K., Takeuchi T., Ito A., Aoki T., Yamasaki H. 2005. Prevalence of toxocariasis in northeastern Brazil based on sorology using recombinant *Toxocara canis* antigen. *The American Journal of Tropical Medicine and Hygiene*, 72, 103–107.

Chieffi P.P., Mueller E.E. 1976. Prevalência de parasitismo por *Toxocara canis* em cães e presença de ovos de *Toxocara* spp. no solo de localidade públicas da zona urbana do município de Londrina, estado de Paraná, Brasil. *Revista de Saúde Pública*, 10, 367–372. DOI: 10.1590/S0034-89101976000400010.

Chorozy M.L., Richardison D.J. 2005. A survey of environmental contamination with ascarid ova, Wallingford, Connecticut. *Vector-Borne and Zoonotic Diseases*, 5, 33–39. DOI: 10.1089/vbz.2005.5.33.

Colli C.M., Rubinsky-Elefant G., Paludo M.L., Falavigna D.L.M., Guilherme E.V., Mattia S., Araújo S.M., Ferreira E.C., Previdelli I.T.S., Falavigna-Guilherme A.L. 2010. Serological, clinical and epidemiological evaluation of toxocariasis in urban areas of south Brazil. *Revista do Instituto de Medicina Tropical de São Paulo*, 52, 69–74. DOI: 10.1590/S0036-46652010000200003.

Cuenin R. 1972. Cartographie générale. Tome 1. Notions générales et principes d'elaboration. Paris: Eyrolles.

Despommier D. 2003. Toxocariasis: clinical aspects, epidemiology, medical ecology, and molecular aspects. *Clinical Microbiology Reviews*, 16, 265–272. DOI: 10.1128/CMR.16.2.265-272.2003.

Dubná S., Langrová I., Jankovská I., Vadlejch J., Pekár S., Nápravík J., Fechtner J. 2007. Contamination of soil with *Toxocara* eggs in urban (Prague) and rural areas in the Czech Republic. *Veterinary Parasitology*, 144, 81–86. DOI: 10.1016/j.vetpar.2006.09.023.

Ferreira L.F., Oliveira E.L., Camilo-Coura L. 1976. Sobre a presença de ovos de *Toxocara* em praças da cidade do Rio de Janeiro. *Revista da Sociedade Brasileira de Medicina Tropical*, 10, 51–54.

Figueiredo S.D.P., Taddei J.A.A.C., Menezes J.J.C., Novo N.F., Silva E.O.M., Cristóvão H.L.G., Cury M.C.F.S. 2005. Estudo clínico-epidemiológico da toxocaríase em população infantil. Jornal de Pediatria, 81,126–132. DOI: 10.2223/JPED.1317.

Guilherme E. V. 2011. Comparação entre a frequência de toxocaríase em crianças encaminhadas ao serviço público especializado em pneumologia e sua soroprevalência nas Unidades Básicas de Saúde; Dissertação (Mestrado em Ciências da Saúde) – Universidade Estadual de Maringá – UEM.

Habluetzel A., Traldi G., Ruggeri S., Attili A.R., *et al.* 2003. An estimation of *Toxocara canis* prevalence in dogs, environmental egg contamination and risk of human infection in the Marche regions of Italy. *Veterinary Parasitology*, 113, 243–252. DOI: 10.1016/S0304-4017(03)00082-7.

Instituto Brasileiro de Geografia e Estatística (IBGE) 2011. Available: http://www.ibge.gov.br/home/download/geociencias.shtm. Accessed 03 december 2011.

Lopez M.L.A., Martin G., Chamorro M.D.C., Alonso J.M. 2005. Toxocariosis em Niños de una region subtropical. *Medicina*, 65, 226–230.

Manini M.P., Marchioro A.A., Colli C.M., Nishi L., Falavigna-Guilherme A.L. 2012. Association between contamination of public squares and seropositivity for *Toxocara* spp. in children. *Veterinary Parasitology*, DOI: 10.1016/j.vetpar. 2012.03.011.

Marchioro A.A., Colli C.M., Mattia S., Paludo M.L., Melo G.C., Adami C.M., Pelloso S.M., Falavigna-Guilherme A.L. 2011. Avaliação eosinofílica e soropositividade para anticorpos IgG anti-*Toxocara* em crianças atendidas pelo Sistema Único de Saúde. *Revista Paulista de Pediatria*, 29, 80–84. DOI: 10.1590/S0103-05822011000100013.

Mattia S., Colli C.M., Adami C.M., Guilherme G.F., Nishi L., Rubinsky-Elefant G., Marchioro A.A., Gomes M.L., Falavigna-Guilherme A.L. 2012. Seroprevalence of *Toxocara* infection in children and environmental contamination of urban areas in Paraná State, Brazil. *Journal Helminthology*, 86, 440–445. DOI: 10.1017/S0022149X11000666.

Matsuo J., Nakashio S. 2005. Prevalence of fecal contamination in sandpits in public parks in Sapporo City, Japan. *Veterinary Parasitology*, 128, 115–119. DOI: 10.1016/j.vetpar.2004.11.008.

Medronho R.A. 1993. A geografia do dengue no município do Rio de Janeiro: uma análise por geoprocessamento; Dissertação (Mestrado em Saúde Publica) – Escola Nacional de Saúde Pública – Ensp: Fiocruz.

Overgaauw P.A. 1997. Aspects of *Toxocara* epidemiology: human toxocariasis. *Critical Reviews in Microbiology*, 23, 215–231.

Paludo L.M., Falavigna D.L.M., Elefant G.R., Gomes L.G., Baggio M.L., Amadei L.B., Falavigna-Guilherme A.L. 2007. Frequency of *Toxocara* infection in children attended by the health public service of Maringá, South Brazil. *Revista do Instituto de Medicina Tropical de São Paulo*, 49, 343–348. DOI: 10.1590/S0036-46652007000600002.

Rey L. (Ed.). 2001. Parasitologia. Rio de Janeiro: Guanabara Koogan.

Richards T.B., Rushton G., Brown C.K., Fowler L. 1999. Geographic information and public health: mapping the future. *Public Health Reports*, 114, 359–73. DOI: 10.1093/phr/114.4.359.

Santarém V.A., Dias A.P., Felix A., Rodenas R.S., Silva A.V. 2010. Contaminação por ovos de *Toxocara* spp. em praças públicas das regiões central e periurbana de mirante do Paranapanema, São Paulo, Brasil. *Veterinária e Zootecnia*, 17, 47–53.

Silveira L.M. 2003. Análise rítmica dos tipos de tempo no norte do Paraná aplicada ao clima local de Maringá – Paraná. Doctoral Thesis, Universidade de São Paulo, Faculdade de Filosofia, Letras e Ciências Humanas.

Teixeira C.R., Chieffi P.P., Lescano S.A.Z., Silva E.O.M., Blima Fuxb., Cury M.C. 2006. Frequency and risk factors for toxocariasis in children from a pediatric outpatient center in southeastern Brazil. *Revista do Instituto de Medicina Tropical de São Paulo*, 48, 251–255. DOI: 10.1590/S0036-46652006000500003.

Tiyo R., Guedes T.A., Falavigna D.L.M., Falavigna-Guilherme A.L. 2007. Seasonal contamination of public squares and lawns by parasites with zoonotic potential in Southern Brazil. *Journal Helminthology*, 81, 1–6. DOI: 10.1017/S0022149X07870829.

Uga S., Minami T., Nagata K. 1996. Defecation habits of cats and dogs and contamination by *Toxocara* eggs in public park sandpits. *The American Journal of Tropical Medicine and Hygiene*, 54, 122–126.

Werneck G.L. 2008. Georeferenced data in epidemiologic research. *Ciência & Saúde Coletiva*, 13, 1753–1766. DOI: 10.1590/S1413-81232008000600010.

Zibaei M., Abdollahpour F., Birjandi M., Firoozeh F. 2010. Soil contamination with *Toxocara* spp. eggs in the public parks from three areas of Khorram Abad, Iran. *Nepal Medical College Journal*, 12, 63–65.

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