Universidade do Contestado | www.unc.br/periodicos ISSNe: 2316-347X
SAÚDE & MEIO AMBIENTE
Revista interdisciplinar

SCENARIO OF THE PREVALENCE OF PARASITES IN SOIL/SAND SAMPLES IN BRAZIL: SYSTEMATIC ANALYSIS

CENÁRIO DA PREVALÊNCIA DE PARASITOS EM AMOSTRAS DE SOLO/AREIA NO BRASIL: ANÁLISE SISTEMÁTICA

Thaís Dalzochio[1]
Jaqueline Alessi Araldi[2]
Lisiana Stuani[3]

ABSTRACT

Introduction: Zoonotic diseases are transmitted from animals to humans, compromising their health. The high concentration of dogs and cats in urban areas plays an important epidemiological role on soil contamination and thus in the dissemination of zoonotic diseases. The ingestion of eggs, cysts or oocysts of parasites and the penetration of helminths larvae in the skin are frequently related to environmental contamination. **Objective:** The aim of this study was to assess the prevalence of parasites in soil and/or sand samples in Brazil by a systematic review. **Methods:** A total of 43 papers were selected from SciELO Brasil, LILACS-Bireme PubMed/NCBI and Scopus, published between 2009 and 2019. The search was performed using the tems parasites, soil, sand and Brazil. **Results:** A higher number of publications occurred from 2012 to 2017. Studies were mainly concentrated in Southeast and South regions. Hence, further studies are needed in regions where there is limited basic sanitation. Ancilostomidae (larvae or eggs) were the most frequent parasites found in 41.8% of studies, followed by *Toxocara* spp. (32.6%) and *Ascaris* spp. (14%). **Conclusion:** The knowledge on the presence of parasites in the environment and its potential of contamination to the population is essential. Thus, the promotion of educational campaigns related to the implementation of zoonotic control is required in order to avoid the dissemination of parasites in the environment.

Keywords: Parasites. Sand. Soil. Zoonoses. Brazil.

[1]Possui graduação em Biomedicina com habilitação em Análises Clínicas pela Universidade Feevale. Mestrado Doutorado em Qualidade Ambiental, e especialização em Docência Universitária no Século XXI. Atualmente é professora assistente no Centro Universitário CNEC de Bento Gonçalves. Rio Grande do Sul. Brasil. ORCID: https://orcid.org/0000-0003-1095-9111. E-mail: 2020.thaisdalzochio@cnec.br
[2]Graduação em andamento em Biomedicina. Faculdade Cenecista de Bento Gonçalves (CNEC). Rio Grande do Sul. Brasil. E-mail: jaque_araldi@hotmail.com
[3]Graduação em Biomedicina. Universidade Feevale. Rio Grande do Sul. Brasil. E-mail: lisi.stuani@gmail.com

RESUMO

Introdução: As doenças zoonóticas são transmitidas de animais para humanos, comprometendo sua saúde. A alta concentração de cães e gatos nas áreas urbanas constitui num importante papel epidemiológico na contaminação do solo e, assim na disseminação de doenças zoonóticas. A ingestão de ovos, cistos ou oocistos de parasitos e a penetração das larvas de helmintos através da pele estão frequentemente relacionadas com a contaminação ambiental. **Objetivo:** O objetivo deste estudo foi avaliar a prevalência de parasitos em amostras de solo e/ou areia no Brasil através de uma revisão sistemática da literatura. **Métodos:** Um total de 43 artigos foram selecionados a partir da pesquisa nas bases de dados SciELO Brasil, LILACS-Bireme PubMed/NCBI e Scopus, publicados entre 2009 e 2019. A pesquisa foi realizada utilizando os termos parasitas, solo, areia e Brasil. **Resultados:** Um alto número de publicações ocorreu de 2012 a 2017. Os estudos foram referentes principalmente às regiões sudeste e sul. Desta forma, estudos futuros são necessários em regiões onde existem condições limitadas de saneamento básico. Os ancilostomídeos (larvas e ovos) foram os parasitos mais frequentes, sendo os parasitos mais prevalentes em 41,8% dos estudos, seguido pelo *Toxocara* spp. (32,6%) e do *Ascaris* spp. (14%). **Conclusão:** O conhecimento sobre a presença de parasitos no ambiente e seu potencial de contaminação para a população é essencial. Desta forma, a promoção de campanhas educacionais relacionadas à implementação do controle zoonótico é necessária para evitar a disseminação de parasitos no ambiente.

Palavras-chave: Parasitos. Areia. Solo. Zoonose. Brasil.

1 INTRODUCTION

Soil-transmitted helminthiases represent a public health concern in tropical and subtropical countries, where climatic conditions and poverty-related behaviors contribute to their transmission[1]. The contamination by several species of parasites can occur in recreational areas of public parks, schools and domiciliar and peridomiciliar areas, where environmental conditions may lead to the development of parasites[2].

Zoonotic diseases are transmitted from animals to humans and may compromise the health. These diseases are widely distributed in Brazil and other developing countries according to basic sanitation conditions, socioeconomic status, education, age and hygiene habits. The number of cases has increased over the years as a result of environmental alterations caused by the humans, especially in regions where basic sanitation conditions are deficient, which favors the transmission of pathogenic agents[3]. It is estimated that 3.5 billion people are infected with parasites and that more than one million is infected with one or more species of helminths in Africa, Asia and Americas[4]. In Brazil, geohelminthiasis affect approximately 93 million of individuals[5]. In this context, the use of laboratorial

methods is important to investigate the presence of parasites in the environment and in the population for epidemiological data[6].

The main concern about zoonotic diseases is the concentration of dogs and cats in urban areas, which plays an epidemiological role in soil contamination. Nematodes, cestodes worms and other eukaryotic microorganisms may be present and represent a risk to the animals' health and, under specific conditions, they can be transmitted to humans[7]. Considering the increasing number of domestic animals present in recreational places, their feces may contaminate such areas. Geohelminths are a group of parasites distributed in tropical and subtropical regions where soil composition, heat and high humidity allow the development of eggs and larvae until the infectious stage. For instance, the nematode worms *Ascaris lumbricoides*, *Trichuris trichiura*, *Toxocara canis* and the hookworm species *Ancylostoma duodenale* and *Necator americanus* are commonly referred to soil-transmitted helminths[8,9].

Geohelminths infect mainly children from 10 months to 4 years, when more severe infections are more frequent. These parasites may affect the nutritional level and cause complications such as intestinal obstruction, rectal prolapse and neurological disorders[10]. Overall, parasitic infections reduce the life quality of population, especially where these diseases are endemic. The ingestion of helminths' eggs, cysts and oocysts of protozoa and the penetration of larvae in the skin are closely related to environmental contamination[11]. Thus, the knowledge on the occurrence of parasites in the environment is essential in the epidemiological dynamics of parasitic diseases and could further highlight the need of sanitation improvement in order to reduce the contamination of soil/sand[12]. Therefore, the present study aimed to assess the prevalence of parasites in soil/sand samples in Brazil through a systematic analysis.

2 METHODS

Surveys assessing the presence of parasites in soil/sand samples in Brazil were extracted from the following electronic databases: SciELO Brasil (Scientific Library Online), LILACS-Bireme (*Biblioteca Virtual em Saúde* – BIREME), PubMed/NCBI (US National Library of Medicine National Institutes of Health/National Center for Biotechnology Information Search database) and Scopus. The research was performed in December 2019, applying the keywords: "parasites", AND "sand" OR "soil", and "Brazil". In addition, references of the papers selected were also analyzed, and a manual search was performed to access papers related to the present study (references identified in other sources).

Eligible studies met the following criteria: i) evaluated the presence of parasites in soil/sand samples; ii) published between January 2009 and December 2019; iii) were published in scientific journals with an International Standard Serial Number (ISSN). Original papers, letters to the editor and short communications were analyzed, whereas book chapters, congress abstracts, thesis and dissertations were

not included. The exclusion criteria was: i) papers reporting the analysis of feces collected in the environment; ii) papers reporting methods to detect parasites in the environment with no clear results on the prevalence of parasites; iii) papers assessing the presence of parasites in feces and soil/sand samples which did not express the results separately; iv) review papers.

Following the recommendations of the PRISMA statement for conducting systematic reviews[13], a total of 448 were found. Among these, 264 were not relevant for the present study. Then, 121 papers were removed due to duplication in the research platforms. After reading the abstracts, 264 were removed because they were not related to the proposal. The full-text of the remaining 54 studies were reviewed. According to the exclusion criteria, 11 papers were removed. Therefore, 43 papers were selected for further analysis (fig. 1).

Once selected, the following data were extracted from each paper: author names, title of the paper, publication year, city and state where the study was performed, type of sample studied (soil/sand from school, parks, peridomiciliar areas, slums, beaches, and so forth), number of samples analyzed, percentage of positive samples, most prevalent parasite, occurrence of samples with two or more species of parasites (multiple contamination), techniques for the detection of parasites, quantification of parasites in the samples and evaluation of parasites in wet and dry seasons and if seasonal difference were found, when assessed.

3 RESULTS

Forty-three papers were included in this systematic review (frame 1). Considering the study area, 27.9% (12/43) of studies assessed more than one area concomitantly – squares, parks, schools, 18.6% (8/43) assessed peridomiciliar areas, 14% (6/43) public squares. Other studies analyzed samples from parks, schools/day care centers, beaches, riversides and plantation areas.

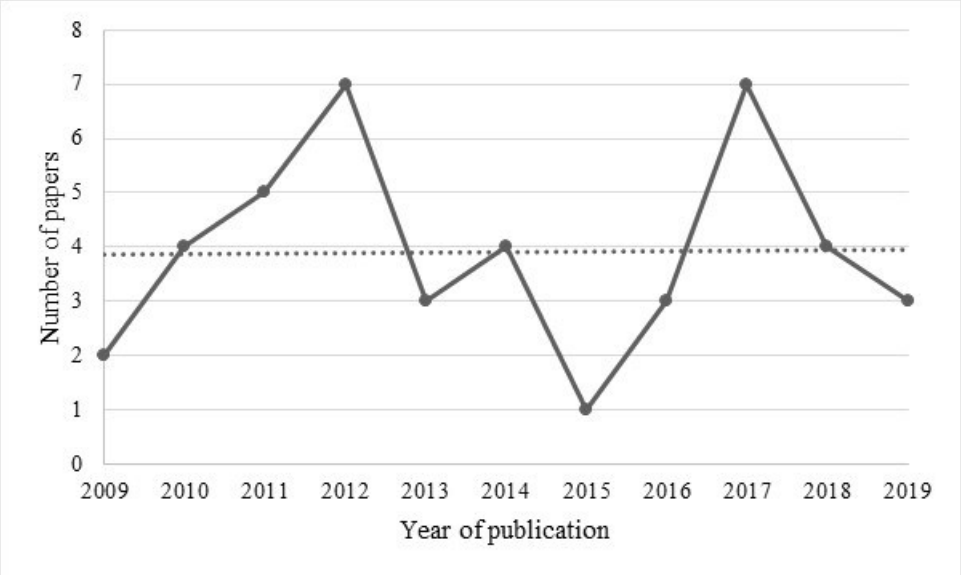
Frame 1 – Papers published between 2009 and 2018 assessing the presence of parasites in soil/ sand samples in Brazil, in chronological order

	Reference	Local where samples were collected
1	Neves and Massara, 2009[14]	Schools and parks
2	Silva et al., 2009[15]	Beaches
3	Colli et al., 2010[16]	Public schools and squares
4	Mandarino-Pereira et al., 2010[17]	Public squares
5	Moura et al., 2010[18]	Peridomiciliar areas
6	Sousa et al., 2010[19]	Day care centers, schools and parks
7	Cassenote et al., 2011[20]	Schools and squares
8	Gallina et al., 2011[21]	Leisure areas (university)
9	Matesco et al., 2011[22]	Margins of rivers
10	Mello et al., 2011[23]	Public squares
11	Rocha et al., 2011[24]	Beaches

12	Chen e Mucci, 2012[10]	Day care centers
13	Figueiredo et al., 2012[12]	Schools
14	Manini et al., 2012[25]	Peridomiciliar areas and schools
15	Marques et al., 2012[26]	Public parks and schools
16	Moura et al., 2012[27]	Public parks
17	Santarém et al., 2012[28]	Public parks
18	Saito and Rodrigues, 2012[29]	Peridomiciliar areas
19	Brilhante et al., 2013[2]	Peridomiciliar areas
20	Moura et al., 2013[30]	Public squares
21	Ribeiro et al., 2013[31]	Public parks
22	Onuma et al., 2014[32]	Peridomiciliar areas
23	Silva et al., 2014[33]	Planting areas
24	Sousa et al., 2014[11]	Beaches
25	Sprenger et al., 2014[34]	Public parks and squares
26	Prestes et al., 2015[35]	Public squares
27	Amorim and Souza, 2016[9]	Beaches
28	Maciel et al., 2016[36]	Public squares
29	Silva et al., 2016[37]	Peridomiciliar areas
30	Bortolatto et al., 2017[38]	Parks and squares
31	Fontes et al., 2017[39]	Parks and squares
32	Handam et al., 2017[40]	Schools
33	Ignácio et al., 2017[41]	Peridomiciliar areas
34	Marino et al., 2017[42]	Peridomiciliar areas
35	Neto et al., 2017[43]	Parks
36	Souza and Almeida, 2017[44]	Beaches
37	Andrade et al., 2018[45]	Peridomiciliar areas
38	Capella et al., 2018[46]	Vulnerable communities
39	Gonçalves and Paludo, 2018[47]	Public squares
40	Mota et al., 2018[48]	Parks, squares, among others
41	Vidal et al., 2019[49]	Public locations (parks, flower beds and sidewalks)
42	Silva et al., 2019[50]	Roads and public squares
43	Eisen et al., 2019[51]	Park

Regarding the number of papers published throughout the years, the peak was reached in 2012 and 2017, whereas a range of 1 to 5 papers was published in other years (fig. 2). These data show that scientific publication in the field of parasites present in soil/ sand samples is stable and without tendency of increase in Brazil.

Figure 1 – Number of papers published between 2009 and 2019 related to the detection of parasites in soil/sand samples in Brazil.



A higher number of studies carried out in Southeast and South regions were found, corresponding to approximately 80% of total studies (table 1). A lower number of studies were referred to Midwest and Northeastern regions, whereas no studies related to the North were found. Thus, studies on the detection of parasites in such regions should be encouraged.

Table 1 – Studies assessing the presence of parasites in soil and/or sand samples in Brazilian regions

Region	Number of studies	%
Southeast	19	42.4
South	15	34.9
Northeast	5	11.6
Midwest	4	9.3
North	0	0
Total	43	100

When considering the results found in the papers, hookworms (Ancylostomidae) were the most prevalent parasites in 41.8% (18/43) of studies, followed by *Toxocara* spp. in 32.6% (14/43). *Ascaris* spp. was also reported as the most prevalent parasite in 13.9% (6/43) of studies, whereas other parasites, such as non-identified coccidian oocysts and cysts of *Entamoeba* sp. were also verified. It is important to note that five studies aimed the detection of specific parasites, as *Ascaris lumbricoides* and *Toxocara* sp. in the samples. In addition, one study consisted in the first report of eggs of *Lagochilascaris* (Nematoda: Ascarididae) in a public square, where the presence of other parasitic forms was not reported. Among other parasites found, but less frequent, were the cestodes *Taenia* sp., *Hymenolepis*

nana, *Dipylidium caninum*; nematodes *Enterobius vermicularis* and *Strongyloides stercoralis*; trematodes *Schistosoma mansoni*; and protozoa.

For the detection of parasites in the samples, the method based on spontaneous sedimentation, described by Hoffman, Pons and Janer (HPJ), also known as Lutz method, was applied in 55.8% (24/43) of studies. The Faust technique, based on centrifugation-fluctuation in zinc sulphate was applied in 30.2% (13/44) of studies, whereas the Willis method, based on flotation in saturated sodium chloride solution, was applied in 23.3% (10/43) of studies. Other detection techniques included the Baermann and Moraes method, Caldwell and Caldwell, Rugai and Ritchie (table 2). In addition, 55.8% (24/40) of studies used two techniques to assess the presence of parasitic forms in the samples, whereas 27.9% (12/43) and 16.3% (7/43) used one and three techniques, respectively. The number of samples analyzed varied from 7 to 2520 samples. Yet, this information was not clear in one study. The quantification of parasites in the samples analyzed was performed in only 9.3% (4/43) of studies.

Table 2 – Techniques used for the detection of parasites in soil/sand samples in Brazil

Technique	**Principle**	**Number of studies**	**%**
Hoffman, Pons and Janer	Sedimentation	24	55.8
Faust and colleagues	centrifugation-flotation	13	30.2
Willis	Flotation	10	23.3
Baermann e Moraes	Concentration of larvae	9	20.9
Caldwell e Caldwell	Centrifugation-flotation	8	18.6
Rugai	Concentration of larvae	5	13.8
Sheather	Flotation	4	9.3
Outros	-	8	18.6

A percentage higher than 75% of positive samples was found in 30.2% (13/43) of studies. Among these, five studies reported the detection of parasites in more than 90% of samples analyzed. It is important to highlight that this information was not clear in some studies, which reported only the presence of parasites in the samples. Moreover, soil/sand samples are complex and may exhibit a variety of parasitic forms. However, only 23.3% (10/43) studies reported the occurrence of bi or polyparasitism.

Considering the assessment of the influence of seasonality in the profile of contamination of soil/sand samples, only 32.6% (14/43) of studies carried out samplings in different periods – rainy x wet and/or winter x summer and/or monitoring (samplings in different months). Among these, only two studies did not find differences between/among sampling periods. Approximately 28.6% (4/14) of studies observed a higher prevalence of parasites in soil/sand samples in the rainy season. When analyzing the presence of parasites in soil/sand samples in different seasons of the year, 21.4% (3/14) of studies reported higher contamination in spring and/or summer. In contrast, 28.6% (4/14) observed higher contamination in fall/winter. One study performed sample collections in different periods, but the results were not analyzed separately.

4 DISCUSSION

The increasing population of cats and docs infested by parasites results in raised contamination of the human environment with invasive forms of parasites. Consequently, the parasite soil contamination may determine a potential source of parasitic diseases in humans[52]. Studies on the presence of parasites in the environment, specially areas related to recreational activities – parks, beaches, schools and peridomiciliar areas, are needed, since they represent sources of contamination by helminths and protozoa.

The publication of studies related to the presence of parasites in soil and/or sand samples is stable in Brazil, considering the period analyzed in the present study (2009 to 2019). Scientific and technological advances associated to the improvement of health, basic sanitation conditions and access to health services have contributed to prolonged life expectancy in the past years. Such modifications have positively influenced the health profile of population, given the reduction of deaths caused by infectious diseases and increase of non-transmissible diseases. Nonetheless, despite the reduction of parasitic diseases, the morbidity associated to these infections is still of great concern for public health[53]. According to *Departamento de Informática do Sistema Único de Saúde* (DATASUS), infectious and parasitic diseases represented the sixth cause of morbidity in Brazil in 2014, totalizing 776.358 hospitalizations, corresponding to 7.28% of hospital morbidity in the period. In Bahia, this proportion was even more elevated, since such diseases represented 10.33% of hospitalizations, occupying the third position among the main causes of morbidity in the state, overcoming diseases of the circulatory system[53]. Therefore, studies on this area should continuously be conducted.

The Brazilian territory is marked by deep regional economic inequalities; the distribution of poor cities remains concentrated in the North and Northeast regions[54]. In the present study, it was noticed a high concentration of studies in Southeast and South regions, probably as a result of the presence of well-structured universities and research centers. On the other hand, studies on the occurrence of parasites in North and Northeast regions are necessary, since a higher dissemination of agents of parasitic infections occurs in such areas due to problematic socioeconomic conditions, mainly related to education, lack of good hygiene habits and high rates of malnutrition[55,56]. The importance of adequate basic sanitation conditions is related to the supply of potable water for the population, since several diseases can be associated to water, such as diarrhea, hepatitis A, dengue, yellow fever, leishmaniosis, lymphatic filariasis, schistosomiasis, leptospirosis, helminthiases and other emerging and re-emerging diseases in the country[3].

The most prevalent parasites found in the studies – hookworm and *Toxocara* spp. are commonly associated to zoonosis risk. In humans, the infections caused by these parasites may induce fever, hepatomegaly, eosinophilia, leukocytosis, lymphadenitis, cough and dyspnea and abdominal pain, among other diseases known as Cutaneous Larva Migrans, Visceral Larva Migrans and Ocular Larva Migrans. These syndromes can cause creeping eruption in the skin with intense

pruritus as a result of the migration of animal nematode larvae, as well as secondary infections and injury in other tissues[47]. Hence, the knowledge on the occurrence of parasites in public and domiciliary areas is fundamental to aware the population in relation to the importance of deworming of stray and domestic animals and hygiene habits.

In order to obtain information on the real scenario of the prevalence of parasites in soil and/or sand samples, as well in other types, the use of two techniques based on different principles is recommended. Parasites present specific morphological and biological characteristics and thus, some methods may be more sensitive for the detection of a certain parasite. The most frequent used technique in the studies – HPJ, is commonly used to detect eggs and cysts of parasites, although it is not indicated to larvae[6]. The Faust method was also frequently used in studies. This method is time consuming and labor expensive, but provides valuable information on the presence of protozoan cysts[57]. Moreover, a great variation in the number of samples analyzed was found. Considering the variability and the concentration of parasitic forms in the environment, well-designed studies, which include the analysis of more than one sample per local, are indicated to avoid false-negative results.

The high percentage of positive samples for parasites may reflect the hygiene habits of the population, related to not collecting feces of domestic animals, as well as the lack of sewage treatment in beaches[43]. Thus, the promotion of campaigns focused on hygiene habits should be encouraged. According to the World Health Organization (WHO), parasitic diseases represent a public health concern, resulting in functional incapability, malnutrition, learning deficiencies. These diseases are also responsible for 2 to 3 million deaths per year[58].

It is important to note that several methodological biases should be considered when comparing the percentages of positive samples between different reports[26]. During the course of sampling and laboratory analyses, many factors influence the results of soil examinations and these include: sample site selection, method of egg recovery, type of soil examined, preservation of samples and laboratory skills[59]. Therefore, results found in the studies might be under or overestimated.

The seasonality of the presence of parasites in soil/sand samples is a factor still poorly explored in the studies. The occurrence of intestinal parasites is subjected to environmental factors, such as temperature, humidity, and soil type, and the parasitic forms depend on these factors to resist the external environmental, continue their life cycle, and produce infective forms, thus reaching a new host[48,60]. As these factors are influenced by climate change, seasonality should be considered in further studies within this scope. In this context, some studies reported there were no differences between seasons/periods, probably as a result of the great resistance of nematode eggs against desiccation, which is considered to be an adaptive survival mechanism for this group of organisms, may account for their presence throughout the different seasons[17]. On the other hand, the higher occurrence of parasites in the soil/sand in the summer/hot season may be attributed to the highest permanence of children and animals in contact to the soil, which favors the soil contamination[61].

5 CONCLUSION

The present study evidenced a steady number of publications related to the analysis of parasites in soil/sand samples in the past years. Nonetheless, due to the potential of parasites of causing zoonotic diseases – mainly in children, and high prevalence of parasitic diseases in the population, studies within this scope should be encouraged. Besides, the lack of studies in Brazilian regions where there are poor basic sanitation conditions is concerning. Thus, the promotion of educational campaigns related to hygiene habits and periodic deworming of dogs and cats are necessary, in order to avoid parasitic infections.

Acknowledgements. The authors would like to thank to Natalia Bordin Andriguetti for the revision of the manuscript.

REFERENCES

1. Pullan RL, Smith JL, Jasrasaria R, Brooker SJ. Global numbers of infection and disease burden of soil transmitted helminth infections in 2010. *Parasit Vectors* 2014; 7:37.

2. Brilhante AF, Nunes VLB, Dorval MEC. Presença de *Toxocara* spp. e ancilostomídeos em áreas de peridomicílios de uma comunidade pesqueira no Centro-Oeste do Brasil. *Braz J Vet Res Anim Sci* 2013; 50(1):71-73.

3. Rodrigues CFM, Rodrigues VS, Neres JCI, Guimarães APM, Neres LLFG, Carvalho AV. Desafios da saúde pública no Brasil: relação entre zoonoses e saneamento. *Scire Salutis* 2017; 7(1):27-37.

4. Lustigman S, Prichard RK, Gazzinelli A, Grant WN, Boatin BA, McCarthy JS, Basáñez M.G. A research agenda for helminth diseases of humans: the problem of helminthiases. *Plos Negl Trop Dis* 2012; 6(4):e1582.

5. Araújo-Jorge T. *Nota técnica*. Rio de Janeiro: Instituto Osvaldo Cruz IOC, 2011.

6. Sant'Anna LML, Oliveira FJ, Melo CM. Estudo comparativo de técnicas parasitológicas baseada no princípio de sedimentação espontânea (Hoffman) e Parasitokit®. *Scire Salutis* 2013; 3(1):6-15.

7. Paul M, King L, Carlin EP. Zoonoses of people and their pets: a US perspective on significant pet-associated parasitic diseases. *Trends Parasitol* 2010; 26(4), 153-154.

8. Bethony J, Brooker S, Albonico M, Geiger SM, Loukas A, Diemert D, Hotez PJ. Soil-transmitted helminth infections: ascariasis, trichuriasis, and hookworm. *Lancet* 2006; 367:1521-1532.

9. Amorim RF, Souza MAA. Identificação de enteroparasitos na areia da praia de Guriri, São Mateus, ES. *Scientia Vitae* 2016: 3(12):1-9.

10. Chen AA, Mucci JLN. Frequência de contaminação por helmintos em área de recreação infantil de creches no município de Várzea Grande, São Paulo, Brasil. *Rev Patol Trop* 2012; 41(2):195-202.

11. Sousa JO, Santos EO, Lira EM, Sá IC, Hirsch-Monteiro C. Análise parasitológica da areia das praias urbanas de João Pessoa/PB. *Rev Bras Cie Saude* 2014; 18(3):195-202.

12. Figueiredo MIO, Wendt EW, Santos HT, Moreira CM. Levantamento sazonal de parasitos em caixas de areia nas escolas municipais de educação infantil em Uruguaiana, RS, Brasil. *Rev Patol Trop* 2012; 41(1):36-46.

13. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gotzsche P, Ioannidis JPA, Clarke M, Devereaux PJ, Kleijinen J, Moher D. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *Plos Med* 2009; 339:b2700.

14. Neves RLS, Massara CL. Contaminação do solo de áreas comunitárias do município de Caratinga, MG, Brasil, por ovos de *Toxocara* sp. e cistos de *Entaboeba* sp. *Rev Patol Trop* 2009; 38(2):126-130.

15. Silva PR, Cavalcanti IMD, Irmão JI, Rocha FJS. Common beach sand contamination due to enteroparasites on the southern coast of Pernambuco State, Brazil. *Rev Inst Med Trop Sao Paulo* 2009; 51(4):217-218.

16. Colli CM, Rubinsky-Elefant G, Paludo ML, Falavigna DLM, Guilherme EV, Mattia S, Araújo SM, Ferreira EC, Previdelli ITS, Falavigna-Guilherme AL. Serological, clinical and epidemiological evaluation of toxocariasis in urban areas of South Brazil. *Rev Inst Med Trop Sao Paulo* 2010; 52(2):69-74.

17. Mandarino-Pereira A, Souza FS, Lopes CWG, Pereira MJS. Prevalence of parasites in soil and dog feces according to diagnostic tests. *Vet Parasit* 2010; 170:176-181.

18. Moura FT, Falavigna DLM, Mota LT, Todelo MJO. Enteroparasite contamination in peridomiciliar soils of two indigenous territories, State of Paraná, southern Brazil. *Rev Panam Salud Publica* 2010; 27(6):414-422.

19. Sousa VR, Almeida AF, Cândido AC, Barros LA. Ovos e larvas de helmintos em caixas de areia de creches, escolas municipais e praças públicas em Cuiabá, MT. *Cien Anim Bras* 2010; 11(2):390-395.

20. Cassenote AJF, Neto JMP, Catelani-Lima ARA, Ferreira AW. Contaminação do solo por ovos de geo-helmintos com potencial zoonótico na municipalidade de Fernandópolis, Estado de São Paulo, entre 2007 e 2008. *Rev Soc Bras Med Trop* 2011; 44(3), 371-374.

21. Gallina T, Silva MAMP, Castro LLD, Wendt EW, Villela MM, Berne MEA. Presence of eggs of *Toxocara* spp. and hookworms in a student environment in Rio Grande do Sul, Brazil. *Rev Bras Parasitol Vet* 2011; 20(2):176-177.

22. Matesco VC, Rott MB, Mentz MB. Comparação entre métodos de centrífugo-flutuação utilizados para a recuperação de ovos de helmintos em amostras de areia. *Rev Patol Trop* 2011; 40(4):323-330.

23. Mello CS, Mucci JLN, Cutolo SA. Contaminação parasitária de solo em praças públicas da zona leste de São Paulo, SP – Brasil e a associação com variáveis meteorológicas. *Rev Patol Trop* 2011; 40(3):253-262.

24. Rocha S, Pinto RMF, Floriano AP, Teixeira LH, Bassili B, Martinez A, Costa SOP, Caseiro MM. Environmental analyses of the parasitic profile found in the sandy soil from the Santos municipality beaches, SP, Brazil. *Rev Inst Med Trop Sao Paulo* 2011; 53(5):277-281.

25. Manini MP, Marchioro AA, Colli CM, Nishi L, Falavigna-Guilherme AL. Association between contamination of public squares and seropositivity for *Toxocara* spp. in children. *Vet Parasitol* 2012; 188:48-52.

26. Marques JP, Guimarães CR, Vilas-Boas A, Carnaúba PU, Moraes J. Contamination of public parks and squares from Guarulhos (São Paulo State, Brazil) by *Toxocara* spp. and *Ancylostoma* spp.. *Rev Inst Med Trop Sao Paulo* 2012; 54(5):267-271.

27. Moura MQ, Jeske S, Gallina T, Borsuk S, Berne MEA, Villela MM. First report of *Lagochilascaris* (Nematoda: Ascarididae) eggs in a public park in Southern Brazil. *Vet Parasitol* 2012; 184:359-361.

28. Santarém VA, Pereira VC, Alegre BCP. Contamination of public parks in Presidente Prudente (São Paulo, Brazil) by *Toxocara* spp. eggs. *Rev Bras Parasitol Vet* 2012; 21(3):323-325.

29. Saito RK, Rodrigues AFSF. A importância da análise do solo nos estudos epidemiológicos sobre parasitoses intestinais. *Rev APS* 2012; 15(2):158-163.

30. Moura MQ, Jeske S, Vieira JN, Corrêa TG, Berne MEA, Villela MM. Frequency of geohelminths in public squares in Pelotas, RS, Brazil. *Rev Bras ParasitolVet* 2013; 22(1):175-178.

31. Ribeiro LM, Dracz RM, Mozzer LR, Lima WS**.** Soil contamination in public squares in Belo Horizonte, Minas Gerais, by canine parasites in different developmental stages. *Rev Inst Med Trop Sao Paulo* 2013; 55(4):229-231.

32. Onuma SSM, Melo ALT, Stocco MB, Santarém VA, Aguiar DM. Contaminação de solo por ovos de *Toxocara* spp. e outros geo-helmintos em comunidade rural do Pantanal Mato-Grossense, Brasil. *Braz J Vet Res Ani Sci* 2014; 51(1):78-81.

33. Silva SRM, Maldonade IR, Ginani VC, Lima SA, Mendes VS, Azevedo MLX, Gurgel-Gonçalves R, Machado ER. Detection of intestinal parasites on field-grown strawberries in the Federal District of Brazil. *Rev Soc Bras Med Trop* 2014; 47(6):801-805.

34. Sprenger LK, Green KT, Molento MB. Geohelminth contamination of public areas and epidemiological risk factors in Curitiba, Brazil. *Braz J Vet Parasitol* 2014; 23(1):69-73.

35. Prestes LF, Jeske S, Santos CV, Gallo MC, Villela MM. Contaminação do solo por geohelmintos em áreas públicas de recreação em municípios do Rio Grande do Sul (RS), Brasil. *Rev Patol Trop* 2015; 44(2):155-162.

36. Maciel JS, Esteves RG, Souza MAA. Prevalência de helmintos em areias de praças públicas do município de São Mateus, Espírito Santo, Brasil. *Natureza Online* 2016; 14(2):15-22.

37. Silva JB, Piva C, Falavigna-Guilherme AL, Rossoni DF, Toledo MJO. Spatial distribution and enteroparasite contamination in peridomiciliar soil and water in the Apucaraninha Indigenous Land, southern Brazil. *Environ Monit Assess* 2016; 188:217.

38. Bortolatto JM, Sniegovski MM, Bernardi ST, Crippa LB, Rodrigues AD. Prevalence of parasites with zoonotic potential in soil from the main public parks and squares in Caxias do Sul, RS, Brazil. *Rev Patol Trop* 2017; 46(1):85-93.

39. Fontes AM, Gusson VP, Souza AA, Souza MA. Identification of enteroparasites in recreation areas of elementary schools in Northern Espírito Santo, Brazil. *Rev Salud Publica (Bogota)* 2017; 19(6):795-799.

40. Handam NB, Santos JAA, Neto AHAM, Duarte AN, Alves EBS, Salles MJ, Sotero-Martins A. Sanitary quality of the rivers in the Communities of Manguinhos' territory, Rio de Janeiro, RJ. *Revista Ambiente & Água* 2017; 13(1):e2125.

41. Ignácio CF, Silva MECD, Handam NB, Alencar MFL, Sotero-Martins A, Barata MML, Neto AHAM. Socioenvironmental conditions and intestinal parasitic infections in Brazilian urban slums: a cross-sectional study. *Rev Inst Med Trop Sao Paulo* 2017; 59:e56.

42. Marino RF, Sá LCEF, Castro N, Gurgel-Gonçalves R, Maldonade IR, Machado ER. High frequency of *Ascaris lumbricoides* in public playgrounds in central Brazil. *Rev Patol Trop* 2017; 46(2):209-214.

43. Neto JJG, Farias JAC, Matos-Rocha TJ. Contaminação de areia por parasitos de importância humana detectados nas praias da orla marítima de Maceió-AL. *Arquivos Médicos* 2017; 62(2):81-84.

44. Souza MAA, Almeida CP. As parasitoses intestinais por prevalência de geohelmintos representam sérios problemas de saúde pública. *Salud(i)Ciencia* 2017; 22:318-323.

45. Andrade RS, Albuquerque WA, Miranda FS, Marques BC, Mota LHS, Santos RS, Silva IMM, Amor ALM. Presence of enteroparasites in the environment and the resident population in a rural community in Santo Antônio de Jesus in the Reconcavo da Bahia, Brazil. *Rev Patol Trop* 2018; 47(1):31-45.

46. Capella GA, Pinto NB, Perera SC, Giordani C, Moura MQ, Castro LM, Motta TO, Añaña DC, Guterres KA, Silva CC, Cleff MB. Environmental contamination by parasitic forms in a socially vulnerable community in southern Rio Grande do Sul state: a serious public health problem. *Braz J Vet Res Anim Sci* 2018; 55(2):1-8.

47. Gonçalves GV, Paludo CA. Ocorrência de parasitas zoonóticos no solo de praças públicas na cidade de Bento Gonçalves, Rio Grande do Sul. *Rev UNINGÁ* 2018; 55(2):72-80.

48. Mota KCP, Grama DF, Fava NMN, Úngari LP, Faria ESM, Cury MC. Distribution and risk factors of Ascarididae and other geohelminths in the soil of Uberlândia, Minas Gerais, Brazil. *Rev Inst Med Trop Sao Paulo* 2018; 60:e17.

49. Vidal MLB, Azevedo JC, Novaes MT, Martins IVF. Diagnostic of gastrointestinal helminths in sand and canine feces from public locations in Alegre city, Espírito Santo – Brazil. *Braz J Vet Med* 2019; 41:e104619.

50. Silva NMM, Santos MAB, Santana BB, Macedo LO, Alves LC, Ramos RAN, Carvalho GA. Soil contamination by zoonotic gastrointestinal parasites of mammals in Garanhuns, Pernambuco, Brazil. *Med Vet* 2019; 13(1):65-69.

51. Eisen AKA, Demoliner M, Oliveira KG, Troian EA, Mallmann L, Filippi M, Almeida PR, Spilki FR. Soil contamination of a public park by human and canine mastadenovirus, as well as hookworms and *Toxocara* spp. Eggs. *Rev Inst Med Trop Sao Paulo* 2019; 61:e60.

52. Blojar H, Klapec T. Contamination of selected recreational areas in Lublin Province, Eastern Poland, by eggs of *Toxocara* spp., *Ancylostoma* spp. And *Trichuris* spp. *Ann Agric Environ Med* 2018; 25(3):460-463.

53. Santos PHS, Barros RCS, Gomes KVG, Nery AA, Casotti CA. Prevalência de parasitoses intestinais e fatores associados em idosos. *Rev Bras Geriatr Gerontol* 2017; 20(2):244-254.

54. Albuquerque MV, Viana ALD, Lima LD, Ferreira MP, Fusaro ER, Iozzi FL. Regional health inequalities: changes observed in Brazil from 2000–2016. *Cien Saude Colet* 2017; 22:1055-1064.

55. Beninelo VG, Milanezes BA, Rosa ABL, Bussular JPB, Moraes NA, Vieira-Filho SA. Intestinal parasites in students 10 to 15 years of school of São Matheus's periphery, ES. Brazil. *Eur J Sci Res* 2011; 53(2):171-178.

56. Santos TGD, Silveira JACD, Longo-Silva G, Ramires EKNM, Menezes RCE. Trends and factors associated with food insecurity in Brazil: the national household sample survey, 2004, 2009, and 2013. *Cad Saude Publica* 2018; 34(4):e00066917.

57. Coronato-Nunes B, Calegar DA, Monteiro KJL, Jaeger LH, Reis ERC, Xavier SCC, Carpp LN, Lima MM, Bóia MN, Carvalho-Costa FA. *Giardia intestinalis* infection associated with malnutrition in children living in northeastern Brazil. *J Infect Dev Ctries* 2017; 11(7):563-570.

58. Leme DR, Barreto BMV. Avaliação da contaminação ambiental por parasitas em um espaço público de lazer do município de Novo Itacolomi, Paraná, Brasil. *Rev F@pciência* 2014; 10(1):22-30.

59. Mizgajska H. Eggs of *Toxocara* spp. in the environment and their public health implications. *J Helminthol* 2001; 75:147-151.

60. Neves DP, Melo AL, Linardi PM, Vitor RWA, Costa HMA, Massara CL. *Parasitologia Humana*. São Paulo: Atheneu. 2005.

61. Araújo NS, Rodrigues CT, Cury MC. Helmintos em caixas de areia em creches da cidade de Uberlândia, Minas Gerais. *Rev Saude Publica* 2008; 42:150-153.

Artigo recebido em: 25/02/2020

Artigo aprovado em: 21/08/2020

Artigo publicado em: 26/10/2020