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

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

Thaís Dalzochio¹
Jaqueline Alessi Araldi²
Lisiana Stuani³

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 terms 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.

¹Possui 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
²Graduação em andamento em Biomedicina. Faculdade Cenecista de Bento Gonçalves (CNEC). Rio Grande do Sul. Brasil. E-mail: jaque_araldi@hotmail.com
³Graduação em Biomedicina. Universidade Feevale. Rio Grande do Sul. Brasil. E-mail: lisi.stuani@gmail.com
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. 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.

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. 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. In Brazil, geohelminthiasis affect approximately 93 million of individuals. 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\textsuperscript{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

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

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of studies</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southeast</td>
<td>19</td>
<td>42.4</td>
</tr>
<tr>
<td>South</td>
<td>15</td>
<td>34.9</td>
</tr>
<tr>
<td>Northeast</td>
<td>5</td>
<td>11.6</td>
</tr>
<tr>
<td>Midwest</td>
<td>4</td>
<td>9.3</td>
</tr>
<tr>
<td>North</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>100</td>
</tr>
</tbody>
</table>

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

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

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 dogs 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. 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. 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, totaling 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. 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. 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. 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.

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\textsuperscript{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\textsuperscript{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\textsuperscript{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\textsuperscript{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\textsuperscript{58}.

It is important to note that several methodological biases should be considered when comparing the percentages of positive samples between different reports\textsuperscript{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\textsuperscript{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\textsuperscript{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\textsuperscript{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\textsuperscript{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


Scenario of the prevalence of parasites in soil/sand samples in Brazil: systematic analysis

43. Neto JJJG, 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.


**Artigo recebido em:** 25/02/2020  
**Artigo aprovado em:** 21/08/2020  
**Artigo publicado em:** 26/10/2020