

REVIEW

SOIL CONTAMINATION BY ZONOTIC PARASITES

IN LEISURE AREAS:

AN INTEGRATIVE REVIEW

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ABSTRACT

Enteroparasites are a risk to both human and animal health, and soil is an important route for their propagation and perpetuation, due to the easy animal access to leisure environments. Furthermore, the contamination of these areas is a public health problem, due to the high number of people who visit these places and can acquire these parasitoses. The purpose of this study was to research information described in the scientific literature on the prevalence of parasites with zoonotic potential in leisure areas, their distribution and associated factors. This is an integrative review of the literature in which scientific studies on parasites of zoonotic potential in leisure areas were selected from the Virtual Health Library, with MEDLINE and LILACS as its database, in addition to PUBMED, SCIELO and “Periódicos Capes” published between 2010 and 2020 in Portuguese, English and Spanish. Eleven articles were selected from the 494 found after applying criteria for inclusion, exclusion and content evaluation. *Ancylostoma* spp. and *Toxocara* spp. proved to be widely distributed, and soil contamination by parasites is directly linked to the presence of animals in these environments, due to their feces and favorable environmental conditions.

KEY WORDS: intestinal parasites; zoonoses; environmental contamination; public health.

INTRODUCTION

Health problems are often linked to the absence of sanitary infrastructure, inadequate sewage and water treatment and the accumulation of solid waste, resulting in the increased incidence and prevalence of diarrheal diseases, intestinal parasitoses and high infant mortality rates (Moura et al., 2010; Teixeira et al., 2020).

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Parasites are important components of the ecosystem, being present in a variety of substrates under numerous evolutionary forms (Gonçalves et al., 2014). They have eggs or cysts with resistant, dense and impermeable outer membranes to ensure survival, conservation and enabling adhesion to surfaces as well as benefiting contamination, maturation of larval helminths and dispersion of these structures (Bowman et al., 2010; Rey, 2013).

These organisms present risks to both human and animal health. A number of quite common vermin zoonoses present in humans can lead to several diseases easily transmitted between humans and animals (Oliveira et al., 2015). The diversity of clinical manifestations and injuries is due to the biological characteristics of the parasites in the gastrointestinal tract, the ability to invade and migrate, as well as their nutrient and blood consumption, not to mention host conditions such as nutrition, immune competence and associated diseases (Silva et al., 2019).

Soil is an important transmission route for these zoonoses and the contamination of leisure areas is a public health problem, due to the high number of people who can acquire an infection caused by pathogenic agents (Souza & Santos, 2010; Júnior et al., 2015; Bortolatto et al., 2017). The growing number of dogs and cats with access to recreational areas, especially in urban centers, can cause soil contamination by eggs and helminth larvae, since these animals deposit their feces in places visited by the population (Prestes et al., 2015).

The purpose of this study, therefore, was to select information described in the scientific literature on the prevalence of parasites with zoonotic potential in leisure areas, their distribution and associated factors.

MATERIAL AND METHODS

This is an integrative review of the literature, with a view to clarifying a problem and building hypotheses on it, as well as describing its characteristics and identifying relationships between variables (Gil, 2010).

Scientific studies on the presence of parasites with zoonotic potential in the soil of leisure areas (squares, parks and beaches) were selected from the Virtual Health Library, with MEDLINE (Medical Literature Analysis and Retrieval System Online) and LILACS (Latin American and Caribbean Literature in Health Sciences) as the database, besides PUBMED, SCIELO (Scientific Electronic Library Online) and “Periódicos Capes”. The study was performed in September and October 2020 utilizing the definition of the Descriptors in Health Sciences (DeCS): “Contaminação ambiental”, “Parasitos” and “Zoonoses”. The descriptors were also used in English (“Environmental pollution”, “Parasites” and “Zoonoses”) to search PUBMED and SCIELO. Besides these, the Boolean operator was used with the “and” connector, allowing access to intersecting articles between the different descriptors.

The articles selected centered on the presence of parasites of zoonotic potential in the soil of leisure areas around the world, published between 2010 and 2020 available in English, Portuguese and Spanish. Four hundred and ninety four related studies were found, 397 in PUBMED, 79 in the Virtual Health Library and 18 in “Periódicos Capes”. No studies were found in SCIELO. Articles that did not address the subject, that used fecal samples instead of soil, that were unavailable, that were repeated in the databases, published over ten years previously and were in languages other than English, Portuguese or Spanish were excluded, as well as expanded abstracts, dissertations, theses and monographs. Finally, eleven scientific papers were selected, classified and examined for interpretation of results and content synthesis.

RESULTS AND DISCUSSION

Following the application of inclusion and exclusion criteria, 11 articles were selected for the development of this work as shown in Chart 1.

The analyzed articles were published between 2011 and 2020, in several countries, including Spain (1 article), Venezuela (1 article), Poland (2 articles) in the Lublin region and Brazil (7 articles).

The Brazilian studies were from the South (14.3%), Southeast (57.1%) and Northeast (28.6%) regions.

Chart 1. Articles selected for discussion on the presence of parasites with zoonotic potential in leisure areas.

N°	Author / Year	Country / Region	Prevalence	Conclusion
1	Mello et al., 2011	Brazil - Southeast Region	Eggs of <i>Ascaris</i> spp., <i>Toxocara</i> spp., Hookworm-like, <i>Enterobius</i> sp., <i>Hymenolepis</i> spp., <i>Trichuris</i> sp., <i>Capillaria</i> sp., larvae of Nematode.	There is risk of parasitic contamination, intensified during the hot rainy seasons.
2	Bojar & Klapiec, 2012.	Poland - Lublin Region	Eggs of <i>Toxocara</i> spp., <i>Trichuris</i> spp., <i>Ascaris</i> spp.	Confirms other researchers regarding the need for sanitary measures to prevent the transmission of parasites on beach soil, animal treatment and introduction of educational measures.
3	Dado et al., 2012.	Spain - Madrid	<i>Toxocara</i> spp., <i>Giardia</i> sp., <i>Strongyloides</i> sp.	Environmental and health interest, due to zoonotic parasites identified in public parks. Pets have a frequent and intense relationship with humans and the high prevalence of protozoa is remarkable.

4	Marques et al., 2012.	Brazil - Southeast Region	<i>Toxocara</i> spp e <i>Ancylostoma</i> spp.	Guarulhos has a large dog population, and hence a high incidence of parasites with zoonotic potential in the soil in public areas. The importance of adopting educational measures is emphasized as well as the control of dog and cat breeding to reduce the risk of exposure to these parasites causing zoonoses in humans, especially children.
5	Sousa et al., 2014.	Brazil - Northeast Region	Eggs of <i>Ascaris</i> spp, cysts of <i>Giardia</i> sp., eggs and larvae of <i>Ancylostoma</i> spp., eggs of <i>Taenia</i> spp. and larvae of <i>Strongyloides</i> sp.	Contamination in all the researched points along the 16 km of urban beaches in João Pessoa. Most of the relevant parasites found in the sand samples from the urban beaches of João Pessoa showed helminths and/or protozoans possibly from human and/or animal feces.
6	Abreu et al., 2017.	Venezuela - Carabobo	Hookworm larvae	The absence of pathogenic parasites during the time the beach was evaluated, signifies reduced possibility of zoonotic transmission. Frequent parasitological studies are required to verify sand quality of the beaches and to be included among the parameters regarding suitability for recreational purposes. Likewise, the physicochemical parameters of sand in the public access area of El Palito beach should be determined to define impact levels on the ecosystem of the oil spills recorded over the last years.
7	Cirne et al., 2017.	Brazil - Southeast Region	Eggs of <i>Ancylostoma</i> spp.	Public squares in the municipality of Valença, Rio de Janeiro, contaminated with <i>Ancylostoma</i> spp. eggs. Although no eggs of <i>Toxocara</i> spp. were noted in the evaluated samples, the possibility of contamination by this parasite should not be excluded.

8	Souza et al., 2017.	Brazil - Southeast Region	Free-living helminths	Parasitic diseases are more frequent in less developed regions closely related to land and water use, as well as social, sanitary and environmental conditions, educational activities of the population and presence of animals in the peridomicile. Joint actions are required to ensure better quality of life for the residents of Barra Nova and the entire population that frequents this important region in the north of Espírito Santo.
9	Bojar & Klapac, 2018.	Poland - Lublin Region	Eggs of <i>Toxocara</i> spp., <i>Trichuris</i> spp.	The level of contamination with geohelminth eggs in recreational areas in the Lublin region is shown. In Poland, the constant increase in the population of parasite-infested cats and dogs results in high contamination of the human environment with invasive forms of parasites.
10	Ferraz et al., 2019.	Brazil - South Region	<i>Ancylostoma</i> spp., eggs of <i>Toxocara</i> spp.	Most of the municipal schools in Pelotas present contamination of their recreational areas, presenting a risk to children who are constantly exposed, possibly due to the free circulation of animals in these places.
11	Melo et al., 2020.	Brazil - Northeast Region	Eggs of <i>Ancylostoma</i> spp., <i>Toxocara</i> spp. and larvae of <i>Ancylostoma</i> spp.	The potential risk of zoonoses transmission to the population, especially during the dry season, when a high percentage of eggs and geohelminth larvae were noted.

Source: Adapted from: Mello et al. (2011); Bojar & Klapac (2012); Dado et al. (2012); Marques et al. (2012); Sousa et al. (2014); Abreu et al. (2017); Cirne et al. (2017); Souza et al. (2017); Bojar & Klapac (2018); Ferraz et al. (2019); Melo et al. (2020).

According to Chart 1, *Toxocara* spp. (1, 2, 3, 4, 9, 10 and 11), *Ancylostoma* spp. (4, 5, 7, 10 and 11), genus *Trichuris*. (1, 2 and 9), *Ascaris* spp. (1, 2 and 5) were noted, indicating the prevalence of *Toxocara* spp. and *Ancylostoma* spp., in most of the analyzed articles. Marques et al (2012), in Brazilian studies (4, 10 and 11) emphasize that *Toxocara* spp. and *Ancylostoma* spp. eggs are found in soil samples worldwide. They are present in public and even private places such as playgrounds, parks, sandboxes, sidewalks, streets, gardens and fields.

The Center for Disease Control and Prevention - CDC (2019) reports that *Ancylostoma* spp is the etiological agent of cutaneous migrans larvae. It's cycle starts with the elimination of eggs in animal feces, which hatch and release infective larvae into the soil. The infection occurs when people walk or sit on the beach or soil where infected cats or dogs have defecated and the skin is penetrated by the infecting larvae. This migration causes intense itching and long red lines can be seen as part of the reaction to larvae on the skin.

The geohelminth *Toxocara* spp. is the etiological agent that causes Visceral larva migrans (VLM). This occurs when the eggs of this nematode are accidentally ingested, hatching into larvae in the intestine which migrate through lymphatic capillaries or by portal circulation to various organs, mainly the liver and lungs, occasionally the heart and central nervous system, presenting permanent neurological injuries and manifestations in humans (Francisco, et al., 2008; Farias, et al., 2013).

Environmental contamination is evidenced by the fact that a single female can produce about 200,000 eggs per day. Considering the presence of thick capsules of *Toxocara* spp. eggs, these can survive in soil for up to 10 years, despite unfavorable environmental conditions, without losing their invasive ability (Bojar & Klapac, 2018). The absence in some analyzed articles can be justified by the fact that the infection is better known in dogs and with a higher incidence in pregnant and lactating bitches, as well as in puppies, with the highest parasite infestations observed in puppies aged three to six months (Carvalho & Rocha, 2011).

Mello et al. (2011), reported the presence of *Hymenolepis* spp., Hookworm-like, *Capillaria* sp. and *Enterobius* sp. Eggs. A large diversity of parasitic genera was noted, so that in addition to verifying the presence of parasites with zoonotic characteristics in the squares, there are also those that cause human infections.

Sousa et al. (2014), still report the presence of *Giardia* sp. cysts, *Taenia* spp. eggs and *Strongyloides* sp. larvae, and highlight that most of the relevant parasites found in sand samples from urban beaches presented helminths and/or protozoa probably from human and/or animal feces. In their investigation, the data presented contributed to modifications in the design of the work of the Zoonosis Control Center.

The presence of *Giardia* sp. cysts in domestic animal feces is obviously important since the cyst remains viable in the environment for up to 60 days, only being destroyed at temperatures higher than 64°C. In addition, this protozoan presents some circulating species and genotypes shared by dogs and humans in urban areas (Mota et al., 2014; Santana et al., 2014).

Dado et al. (2012) found *Giardia* sp. and *Strongyloides* sp. inferring that the presence of the protozoan suggests a real risk regarding human infection, mainly because *Giardia* cysts are infectious, since they are released in feces, especially for young children who share playgrounds with pets. In addition, they point out that there are few studies to assess the degree of soil contamination in Spain and throughout Europe when compared to published data.

Abreu et al. (2017) only reported the presence of free-living helminths with the justification that soil characteristics are influenced by climatic factors, such as rain, wind and humidity favoring the dispersion and survival of zoonotic parasitic forms. Physical-chemical modifications in the soil may also affect the viability of parasite evolutionary forms of health interest.

The factors associated with the presence of these parasites, reported in the studies include: the presence of dogs and cats (reported in all); precarious hygiene habits (63,6%); climatic conditions (90,9%); parasite resistance mechanisms (27,3%); use of the site for child recreation (81,8%); presence of feces in the site (81,8%); direct contact with the soil (45,4%); geophagy (9,1%) and the need for sanitary measures (90,9%), as shown in Chart 2.

According to Chart 2, there was no considerable discrepancy in the aspects related to the presence of parasites in leisure places regarding the country, with the exception of direct contact with the soil, which was not reported in overseas studies (2, 3, 6 and 9). Likewise, the explicit homogeneity in the Polish articles (2, 9) was noticed because they deal with the same region, noting the scarcity of sanitary changes in the studied site.

The Brazilian studies (1, 4, 5, 7, 8, 10 and 11) presented different proportions, the studies in the Southeast region (1, 4, 7 and 8) were similar, the articles on the Northeast region (5, 11) were heterogeneous, and the research of the South region (10) presented a proportion similar to the Spanish study (3). Researchers from all over the world conducted surveys on geohelminthes and found distinct results that can be attributed to the different epidemiological and environmental conditions, the socio-economic and cultural context of the population and the diversity of methodologies and collection applied (Cirne et al., 2017).

Chart 2. Factors associated with the presence and permanence of parasites of zoonotic potential in leisure areas reported in selected articles.

N°	Author/ Year										
	1	2	3	4	5	6	7	8	9	10	11
Associated factors	Mello et al., 2011	Bojar & Klapac 2012	Dado et al., 2012	Marques et al., 2012	Sousa et al., 2014	Abreu et al., 2017	Cirne et al., 2017	Souza et al., 2017	Bojar & Klapac 2018	Ferraz et al., 2019	Melo et al., 2020
Presence of dogs and cats	X	X	X	X	X	X	X	X	X	X	X
Poor hygiene habits	X		X		X	X		X		X	X
Climatic conditions	X	X	X	X		X	X	X	X	X	X
Parasite resistance mechanisms		X							X		X
Use of the site for children's recreation	X	X	X	X	X		X		X	X	X
Presence of feces on site	X		X	X	X	X	X	X		X	X
Direct contact with the soil				X	X		X	X			X
Geophagics											X
Need for sanitary measures	X	X	X		X	X	X	X	X	X	X

Source: Adapted from: Mello et al. (2011); Bojar & Klapac (2012); Dado et al. (2012); Marques et al. (2012); Sousa et al. (2014); Abreu et al. (2017); Cirne et al. (2017); Souza et al. (2017); Bojar & Klapac (2018); Ferraz et al. (2019); Melo et al. (2020).

Chart 3. Methodologies used in parasitological analysis of the soil in recreational areas reported in the selected articles.

Author / Year	Methodology used
Mello et al., 2011	Flotation technique in saturated sodium chloride solution and technique produced by Yanko (1987) modified.
Bojar & Klapac, 2012	Flotation method according to the Polish standard (2001) and the Quinn et al. (1980) flotation method.
Dado et al., 2012	Modified Teleman methods and MIF (merthiolate-iodo-formalin).
Marques et al., 2012	Modified Baermann method and centrifugal flotation technique with sodium dichromate and zinc sulfate.
Sousa et al., 2014	Faust technique and Rugai technique modified by Carvalho et al. (2005).
Abreu et al., 2017	Washing techniques with 0.85% saline solution and subsequent spontaneous sedimentation, Willis technique and modified Rugai technique.
Cirne et al., 2017	Centrifugal-flotation technique (Figueiredo et al. 1984) in a saturated solution of sugar and Hoffman, Pons e Janer (1934).
Souza et al., 2017	Spontaneous sedimentation (HPJ) and flotation techniques (Willis methods).
Bojar & Klapac, 2018	Flotation method according to the Polish standard (2001) and the Quinn et al. (1980) flotation method.
Ferraz et al., 2019	Centrifugal-flotation method with hypersaturated sugar.
Melo et al., 2020	Flotation method with hypersaturated sugar solution and Rugai et al. (1954).

Source: Adapted from: Mello et al. (2011); Bojar & Klapac (2012); Dado et al. (2012); Marques et al. (2012); Sousa et al. (2014); Abreu et al. (2017); Cirne et al. (2017); Souza et al. (2017); Bojar & Klapac (2018); Ferraz et al. (2019); Melo et al. (2020).

According to Chart 3, a number of methods were used, corroborating the results found. Most of the techniques used originate in feces analysis and underwent modifications to suit soil, thus, they were not specific but alternatives. Comparing the surveys, standardization can be seen in the forms of collecting, storing and transporting the samples, except in relation to the quantity and number of samples, due to the variation in size of the studied sites.

The Willis method consists of floating eggs in a saturated sodium chloride solution, ideal for lighter eggs such as hookworms. The Rugai and Baermmann techniques are based on the positive thermo-hydrotropism of the larvae. Faust Method (1939), for research of protozoan cysts and oocysts by means of centrifugal-flotation and fluctuation technique in saturated sugar solution. In the Hoffman method (1934), spontaneous sedimentation occurs in order to show heavy eggs. The Telemann method is an indirect technique, based on the concentration of parasitic forms (Pastorio et al., 2009; Mascarenhas & Silva, 2016).

A few studies use sensitive parasitological methods to search for parasitic forms in soil. Since some parasitic forms can remain viable and potentially infectious for more than 14 years in the environment, it is not enough to treat all human cases of infection. In the integrated control of parasites, it is important to evaluate the conditions that favor environmental contamination (Holanda & Vasconcelos, 2015).

Soil characteristics, temperature and high humidity, as well as modifications caused by human activity, can directly or indirectly influence the parasite-host relationship, favoring the creation of environments conducive to the transmission of parasite agents, allowing, in the case of geohelminths, the development of eggs and larvae up to the infective stage (Pedrosa et al., 2014; Sotero-Martins et al., 2014).

Melo et al. (2020) found that the occurrence of geohelminthes in public areas is sensitive to seasonality. A high percentage of parasite evolutionary forms were found in the dry season while rainfall indices in the region negatively influence the total parasite index, suggesting that soil leaching by rainwater might transport these evolutionary forms far from their origin.

Among the associated factors, dogs and cats were most related to the presence and permanence of parasites of zoonotic potential in leisure areas, being reported in all the studies analyzed.

Marques et al. (2012) observed that many animals defecated on the ground in most parks and public squares. These animals are definitive hosts of some zoonotic parasites and many owners are unaware of the need for vermifuges for systematic endoparasitosis control, or simply use drugs inappropriately, causing antihelminthic resistance and perpetuating the parasite through environmental contamination.

Dado et al. (2012), infer that these animal populations present a great zoonosis risk, especially for young children who acquire parasites by accidental ingestion of soil and contaminated toys, considering they are in direct contact with sand, precarious hygiene habits and in some cases geophagy (Sousa & Santos, 2014; Martins & Alves, 2018).

The large number of dogs and cats not domiciled or semi-domiciled in cities and the inadequate protection of leisure areas contribute to the high prevalence of parasites in the feces of these animals, increasing the risk of

infection. Although animal access to public places is limited or prohibited in several countries, the population of street animals is constantly growing in underdeveloped and emerging countries. Animals are often abandoned, not only in Brazil, but also all over Latin America, causing a series of problems resulting from their presence in public places, without any type of supervision, restriction or veterinary care (Guimarães, et al., 2005; Alves et al., 2013).

Cirne et al. (2017), emphasize that people should be educated, especially children, on the importance of hand hygiene after recreational practices. It is essential that the population be made aware of the significance of collecting their animal's feces in recreation sites; moreover, the authorities responsible for local public health should outline and carry out effective sanitary measures as well as implementing health education campaigns for the prevention of infection by zoonotic agents in these areas.

CONCLUSION

This review shows that the parasites *Toxocara* spp. and *Ancylostoma* spp. are widely distributed, and that the occurrence and proportion of parasites in soil are predominantly related to the free access of animals, domestic or not, the use of areas for child leisure, the presence of human and/or animal feces, and environmental conditions.

The importance of the owners' responsibility regarding adequate vermifuge use and animal waste collection, as well as public administration negligence regarding wandering animals in need of health control and canine and feline reproduction is highlighted here.

Although parasitoses are widespread, there are few studies on parasitological soil analysis regarding environmental contamination in public recreational facilities, to monitor the soil of these areas and consequently the health of individuals who visit them, in addition to serving as a basis for implementing health measures to prevent the transmission of these parasites in the locations cited.

CONFLICTS OF INTEREST

The authors declare no conflict of interest related to this article.

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