Parasitic contamination in the soil of beaches from Mosqueiro Island, Pará State, Brazil

Contaminação parasitária no solo de praias da Ilha do Mosqueiro, Estado do Pará, Brasil

Juscelino Carvalho de Azevedo Junior[1] ⓘ, Beatriz Modesta Moreira[1] ⓘ, Beatriz Lopes de Oliveira[1] ⓘ, Kássia Larissa Pinto Carvalho[1] ⓘ
Danielle Cristinne Azevedo Feio[1] ⓘ, Sylvia de Fátima dos Santos Guerra[1] ⓘ, Laine Celestino Pinto[2] ⓘ

1. Centro Universitário Metropolitano da Amazônia (UNIFAMAZ), Belém, PA, Brasil. 2. Laboratório de Neuropatologia Experimental, Universidade Federal do Pará (UFPA), Belém, PA, Brasil.

Abstract

Objective: We aimed to evaluate the prevalence of intestinal parasitic in the soil of three beaches of Mosqueiro Island, located in the State of Pará, Brazil, as well as to compare the frequency of helminths and protozoa, pathogenic and non-pathogenic parasites according to the beaches analyzed. **Methods**: This is a cross-sectional analytical study conducted during August and September 2019, in which 155 soil samples were analyzed by Hoffman's method. **Results**: The results showed that 16.1% of samples were contaminated from 61.3% of collection points. Murubira beach and Farol beach presented the highest prevalence of parasites, however, there was no significant difference between beaches. Also, it was observed a predominance of protozoa (63%) and non-pathogenic parasites (55.6%) in analyzed samples, but there was no statistically significant difference according to the investigated location. *Endolimax nana* 25.9% (7/27) and hookworms 18.5% (5/27) were the most detected parasites on the beaches. **Conclusion**: Thus, this study showed parasitic contamination on the beaches from Mosqueiro Island, which may be associated with a lack of sanitation infrastructure and personal hygiene in these places. Therefore, these results reinforce the need to adopt educational and preventive measures to reduce parasitic agents.

Keywords: Soil Analysis; Intestinal Diseases; Parasitic Diseases; Sandy Soils.

Resumo

Objetivo: Avaliar a prevalência de parasitos intestinais no solo de três praias da Ilha de Mosqueiro, localizada no estado do Pará, Brasil, além de comparar a frequência de helmintos e protozoários, parasitos patogênicos e não patogênicos de acordo com as praias analisadas. Metdodos: Este é um estudo transversal, analítico, realizado durante agosto e setembro de 2019, no qual 155 amostras do solo foram analisadas pelo método de Hoffman. Resultados: Os resultados revelaram que 16,1% das amostras estavam contaminadas em 61,3% dos pontos de coleta. As praias do Murubira e do Farol apresentaram a maior prevalência de parasitos, porém não houve diferença significativa entre os diferentes locais de coleta. Além disso, foi observada a predominância de protozoários (63%) e parasitas não patogênicos (55.6%) nas amostras analisadas, mas não houve diferença estatística significativa entre os locais investigados. *Endolimax nana* 25,9% (7/27) e Ancilostomídeos 18,5% (5/27) foram os parasitas mais detectados nas praias. Conclusao: Desse modo, este estudo mostrou contaminação parasitária nas praias da Ilha de Mosqueiro, o que pode estar associada à falta de infraestrutura de saneamento e higiene pessoal nesses locais. Além disso, esses resultados reforçam a necessidade de se adotar medidas educacionais e preventivas para a redução desses agentes parasitários.

Palavras-chave: Análise do Solo; Enteropatias; Doenças Parasitárias; Solos Arenosos.

INTRODUCTION

Parasitic diseases caused by intestinal protozoa and helminths are public health problems around the world especially in developing countries and represent one of the major causes of increased morbidity and mortality among people, suggesting the relationship of these diseases with the sanitary and socioeconomic conditions of the population[1,2].

Parasitic infections can be spread in several ways and the soil is an important vehicle for pathogen dissemination. Soil contamination can occur by incorrect eviction of human and animal waste, untreated sewage, and precarious basic sanitation. Furthermore, the proliferation of parasites in the environment can be influenced by ambient factors such as humidity, temperature, and pH. These conditions favor the eggs and helminths' development and increase larvae survival time[3,4,5,6].

Among the favorable environments for parasitic infections are the beaches, especially in the summer periods, because sand is an excellent means of transmitting parasites, transported by infected animals and humans[7]. Studies carried out on Brazilian beaches have been reported the presence of soil contamination by parasites including *Ancylostoma* sp., *Toxocara* sp., *Ascaris lumbricoides*, *Entamoeba* sp., and *Strongyloides* sp.[6,8,9,10].

However, the studies about prevalence of parasites in northern region of Brazil are limited, which reinforces the need for preventive policies to avoid parasitic contamination in those

places. Moreover, the lack of data on intestinal parasitic on the beaches directly influence decision-making by public managers, as they are indicators of the basic sanitation conditions in which the population lives[11].
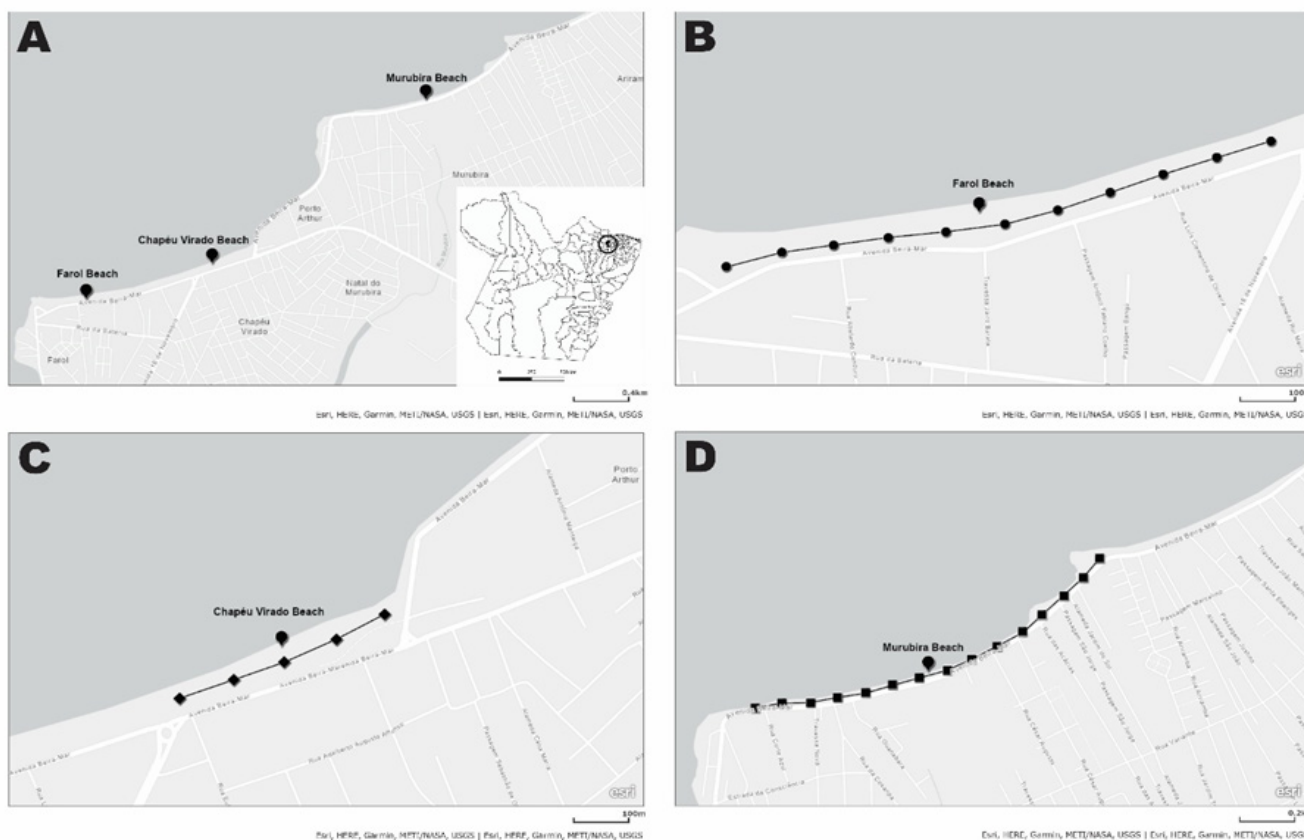
Therefore, this study aimed to evaluate the prevalence of intestinal parasitic in the soil from beaches of Mosqueiro Island, located in the State of Pará, Brazil, as well as to compare the frequency of helminths and protozoa, pathogenic and non-pathogenic parasites according to the beaches analyzed.

METHODS

Study area

Mosqueiro Island is located about 80 kilometers away from Belém, the capital of the State of Pará, which has more than 17 kilometers of beaches, with an area of 212 km^2 and an estimated population of 27 thousand inhabitants. It is the biggest island in the Belém metropolitan region and is composed of 15 freshwater beaches[12].

This is a cross-sectional analytical study was carried out on sample soil from Murubira beach (1º 07'11" S 48º 26'53" W a 1º 06'56" S 48º 26'16" W), Chapéu Virado beach (1º 07'56" S 48º 27'23" W a 1º 07'51" S 48º 27'12" W) and Farol beach (1º 08'03" S 48º 27'58" W a 1º 07'56" S 48º 27'26" W) located in the Mosqueiro Island (Figure 1). The beaches have a distance of about 1.5 km, 500 m, and 1.1 km, respectively. Beaches were selected by the intense circulation of people, either tourists or locals and there are no parasitological studies on soil from these beaches[13].

Figure 1. Map of the beaches and their respective collection points. A: Location of all analyzed beaches, B: Farol Beach, C: Chapéu Virado Beach, D: Murubira beach.

Collection, processing, and sample analysis

Samples were collected from August to September 2019. Therefore, we established collection points with a distance from each other of 100 m, aiming to engage all territorial extensions from the beaches. Thirty-one collection points were analyzed: 15 in Murubira beach, 5 in Chapéu Virado beach, and 11 in Farol beach. We collected five samples in each collection point with a distance from each other of 1 m, a total of 155 samples, based on sample calculus for infinite samples[14].

Each sample had 100 g of sand: 50 g from the surface and 50 g at a depth of 30 cm, on which a ruler was used to perform the measurement[9]. The samples were collected with a garden shovel and then weighed. Samples were stored in sterile plastic bags, properly labeled, and transported immediately in a refrigerated thermal box at 4°C to the Laboratory of Parasitology of Centro Universitário Metropolitano da Amazônia (UNIFAMAZ).

Sample processing was previously described by Neto et al.[11]. The method was based on the spontaneous sedimentation described by Hoffman, Pons, & Janer[15], which is employed to

find parasites eggs, cists, and larvae. Each sample was put in a becker and was mixed with distilled water. Then, the material was deposited in a sedimentation cup and left resting for twenty-four hours. The supernatant was discarded and the sediment analyzed.

For microscopic analysis, we prepared two slides from each sample, with 10μL of the sediment and stained in Lugol's solution (Newprov®). Finally, we examined the sediment in the optical microscope Eclipse E100 (Nikon®) using a 10x and 40x objective. Images were acquired using Coolpix L840 Camera (Nikon®) to perform the double observer with aim of validate the results found.

Statistical analysis

Data analysis was performed using statistical software Bioestat

5.23. The results were analyzed using G-test to compare the prevalence of parasitic contamination, helminth and protozoa frequency, pathogenic and nonpathogenic parasites frequency in different beaches. The differences were considered statistically significant when $p < 0.0516$. Graph design was obtained from GraphPad Prism 8.0 software.

RESULTS

We found that 61.3% (19/31) of collection sites were parasitized. Murubira beach presented the highest prevalence of collection points parasitized ($p = 0.8331$). A total of 155 samples were analyzed from beaches, 16.1% (25/155) contained parasitic structures. Farol beach and Murubira beach had a predominance of a parasitic contamination. However, there were no significant differences in the contamination between different beaches ($p = 0.6061$), as shown in table 1.

Table 1. Prevalence of parasitic contamination in collection points and samples soil, prevalence of helminths and protozoan, pathogenic and non-pathogenic parasites on the beaches from Mosqueiro Island, Pará, Brazil.

Farol	Farol N (%)	Chapéu virado N (%)	Murubira N (%)	Total N (%)	P value
Collection points					
Parasitized	6 (54.6)	3 (60.0)	10 (66.7)	19 (61.3)	0.8331*
Non-parasitized	5 (45.4)	2 (40.0)	5 (33.3)	12 (38.7)	
Total	11 (100.0)	5 (100.0)	15 (100.0)	31 (100.0)	
Samples soil					
Parasitized	11 (20.0)	3 (12.0)	11 (14.6)	25 (16.1)	0.6061*
Non-parasitized	44 (80.0)	22 (88.0)	64 (85.4)	130 (83.9)	
Total	55 (100.0)	25 (100.0)	75 (100.0)	155 (100.0)	
Helminth	5 (41.6)	1 (33.3)	4 (33.3)	10 (37.0)	0.9158*
Protozoan	7 (58.4)	2 (66.7)	8 (66.7)	17 (63.0)	
Total	12 (100.0)	3 (100.0)	12 (100.0)	27 (100.0)	
Pathogenic	6 (50.0)	1 (33.3)	5 (41.6)	12 (44.4)	0.8586*
Non-pathogenic	6 (50.0)	2 (66.7)	7 (58.4)	15 (55.6)	
Total	12 (100.0)	3 (100.0)	12 (100.0)	27 (100.0)	

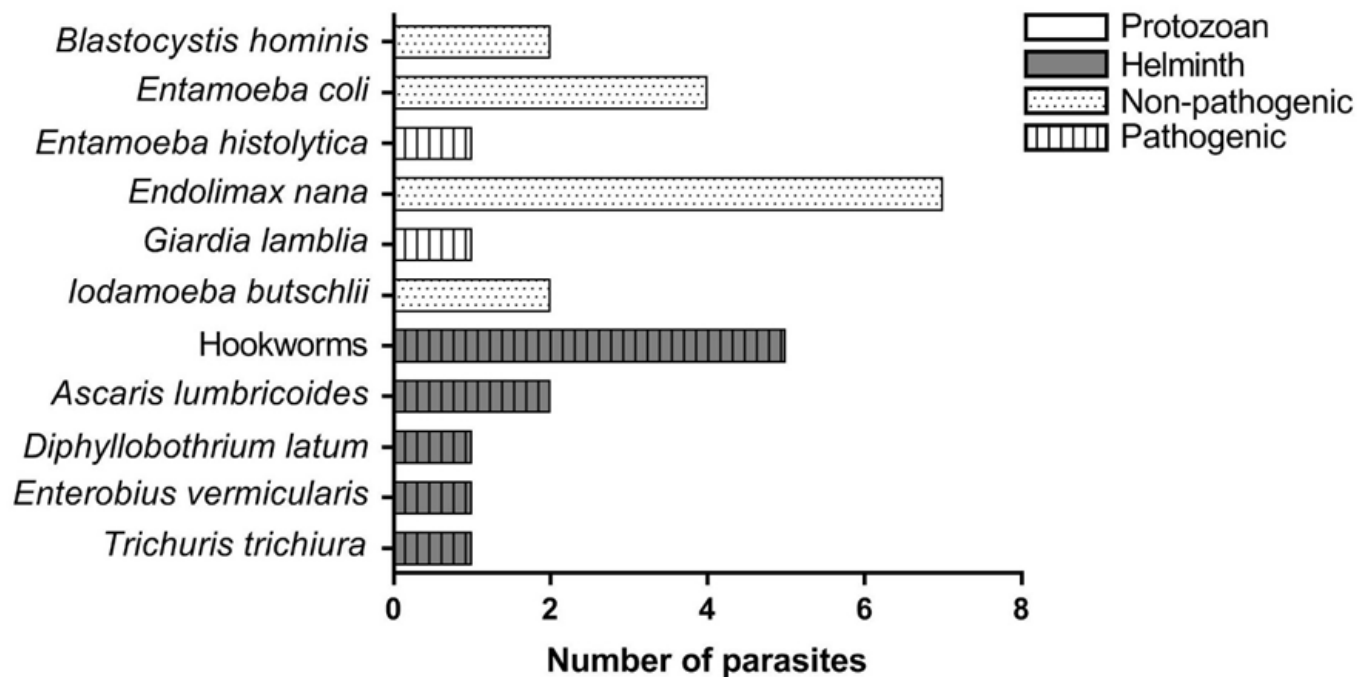*Comparation between the values founds in beaches by G-test (p<0.05).

In the positive samples, protozoa 63% (17/27) were most frequent on the beaches. However, there was no significant difference between beaches analyzed (p = 0.9158). Furthermore, 55.6% (15/27) were contaminated with non-pathogenic parasites, which showed no statistically significant difference to the beaches (p = 0.8586) (Table 1).

Concerning protozoan, the most detected parasite on the beaches was *Endolimax nana*, corresponding to 25.9% (7/27). The second most prevalent was *Entamoeba coli* 14.8% (4/27). About helminths, the predominant parasites in the beaches were hookworms 18.5% (5/27) and *Ascaris lumbricoides* 7.4% (2/27) (Figure 2).

Figure 2. Number of parasites, by species, on the beaches in Mosqueiro Island, Pará, Brazil.

DISCUSSION

The beaches can be important sources of parasitic contamination for the population due to the flow of contaminated people and animals mainly in the vacation period[7,8]. We identified parasitic forms in 16.1% of analyzed samples from 61.3% of collection points in the post-vacation period.

Other studies conducted in soil from beaches in Brazil reported a low prevalence of parasites in these samples[6,10,17,18], in accordance with our results. However, the data about parasitic contamination of beaches are limited in the Northern region of Brazil[17]. In this way, a parasitological analysis performed at the public parks onshore of beaches from Rio Grande do Sul showed 8.3% (10/120) of positivity in soil samples using the Caldwell & Caldwell's technique adapted by Pessoa and Martins (1988)[18].

Also, on the beaches of Santos, São Paulo was detected 18.2% (458/2520) of positive samples from seven beaches using Faust, Rugai, and Hoffman methods for analysis[6]. Similarly, in São Vicente, São Paulo has observed the prevalence of parasites in 32.7% (36/110) of samples analyzed by the Hoffman technique[10]. The same was detected on the beach from Outeiro, Pará, in which 33.33% (3/9) of samples were contaminated with enteroparasites by the Hoffman and Rugai technique[17].

The present study was developed in a post-vacation period which may have influenced the percentage of positive samples. This can be justified due to a decrease in people's circulation as observed in a study carried out in El Palito beach, Venezuela which detected 63% of positivity in June and this prevalence decreased to 55.3% in the period after vacation[7].

Although the study has shown a low prevalence of parasites, the contamination found in the sands of Mosqueiro may be associated with a lack of sanitation infrastructure and personal hygiene in these places. Furthermore, animal feces not collected, human fecal waste, presence of domestic sewage, as well the intense flow of people and domestic dogs in these beaches contribute to the propagation of parasites and represent a risk for the health of the population[6,13,19].

In contrast with our findings, studies conducted in the Northeastern region revealed a high frequency of parasites when performing more than one method for parasitological analysis at different collection periods. A parasitological evaluation using the sample soils of four beaches of the seafront from Maceió, Alagoas showed 83.75% (67/80) of positive samples[11]. In urban beaches in the municipality of João Pessoa, Paraiba was observed 75.4% (132/175) of positivity for parasites in the same period analyzed in our study[8]. Another study carried out in three beaches in the municipality of Fortaleza, Ceará detected 72.2% (39/54) of positivity[9].

In our study, protozoa were most frequent in 63% of parasitized samples, 55.6% were contaminated with non-pathogenic parasites, including *E. nana* (25.9%) and *E. coli* (14.8%) which were the most found species. These results are in concordance with a study conducted in João Pessoa which exhibited the presence of protozoa in 60.6% (106/175) of samples and prevalence of amoebas in 84% (89/175)[8]. Likewise, in João Pessoa beaches was detected a prevalence of protozoa in 62.5%

(70/112) of samples, being *E. nana* and *E. coli* most frequent with 28.1% and 25% positive samples, respectively[20].

Besides, hookworms (18.5%) was the most frequent helminth detected in our study, as was found in soil samples in beaches from Fortaleza, Ceará and São Vicente, São Paulo, which showed a prevalence of 64.8% (35/54) and 31.8% (35/110) of hookworms in contaminated samples, respectively[9,10].

This result indicates a possible route of parasitic contamination for regulars in these places, due to its transmission occurring by skin penetration or ingestion of infecting larvae mainly in regions with poor access to sanitation infrastructure. Hookworms are responsible for clinical manifestations such as cough, nausea, gastrointestinal discomfort, nutritional status compromise, and sometimes serpentine tracks, characteristic of larva migrans[21,22,23].

A. lumbricoides (7.4%) was the second most frequent helminth. Similarly, in Santos beaches were revealed a higher prevalence of *A. lumbricoides* (11.6%) on contaminated samples[6]. In the same way, in João Pessoa beaches were showed 56.6% of contaminated samples with A. lumbricoides[8].

The helminth *A. lumbricoides* is an indicator of fecal-oral contamination and the transmission occurs by ingestion of water or foods contaminated with eggs. This parasite can cause pain abdominal, diarrhea, nausea, bronchospasm, and intestinal obstruction[21,24].

Regarding helminths, an important finding was *Diphyllobothrium latum* eggs, causer agent of a parasitic zoonosis that can be transmitted through aliments and affects humans, and it is associated with lags and rivers areas together with ingestion of poorly cooked freshwater fish. This disease can cause gastrointestinal discomfort, vomiting, nausea, anorexia, and diarrhea[25,26,27].

The results obtained in this study evidenced the contamination parasitic on the soil of beaches from Mosqueiro Island. Thus, anthropic actions can impact the environmental quality and health of residents and tourists that visit these places in the summer period. Therefore, it is necessary to perform educative and preventive actions to promote the reduction of parasitic agents in these locations responsible for people's illnesses.

ACKNOWLEDGMENTS

REFERENCES

1. Harizanov R, Rainova I, Tsvetkova, N, Kaftandjiev, I, Borisova, R, Ivanova, A. et al. Prevalence of intestinal parasitic infections among the Bulgarian population over a three year period (2015 – 2017). Helminthologia. 2020 Jan; 57(1):12-18. doi: 10.2478/helm-2020-0002.

2. Speich B, Croll D, Fürst T, Utzinger J, Keiser J. Effect of sanitation and water treatment on intestinal protozoa infection: a systematic review and meta-analysis. Lancet Infect Dis. 2016 Jan; 16(1): 87-99. doi: 10.1016/S1473-3099(15)00349-7.

3. Visser S, Giatti LL, Carvalho RAC, Guerreiro JCH. Estudo da associação entre fatores socioambientais e prevalência de parasitose intestinal em área periférica da cidade de Manaus (AM, Brasil). Cien Saude Colet. 2011 Ago; 16(8): 3481-3492. doi: https://doi.org/10.1590/S1413-81232011000900016.

4. Rodrigues JRDD, Jorge AOC, Ueno M. Avaliação da qualidade das águas de duas áreas utilizadas para recreação do Rio Piracuama-SP. Rev. Biociênc. 2009; 15(2): 88-94.

5. Pullan RL, Brooker SJ. The global limits and population at risk of soil-transmitted helminth infections in 2010. Parasit Vectors. 2012 Apr; 5(81):1-14.

6. Rocha S, Pinto RMF, Floriano AP, Teixeira LH, Bassili B, Martinez A. et al. Environmental analyses of the parasitic profile found in the sandy soil from the Santos municipality beaches, SP, Brazil. Rev Inst Med Trop São Paulo. 2011 Oct; 53(5): 277-281. doi: https://doi.org/10.1590/S0036-46652011000500007.

7. Abreu AMG, Rodrigues N, Romero, D. Estudio de parasitos geohelmintos en arena de playa "El Palito", Municipio Puerto Cabello, Carabobo, Venezuela. Comunidad y Salud, 2017 Jun; 15(1):1-8.

8. Sousa JO, Santos EO, Lira EM, Sá IIC, Monteiro-Hirsch, C. Análise Parasitológica da Areia das Praias Urbanas de João Pessoa/PB. Rev. Bras. Ciênc. Saúde. 2014; 18(3):195-202.

9. Pedrosa ÉEFNC, Cabral BL, Almeida PRSF, Madeira MP, Carvalho BD, Bastos KMS et al. Contaminação ambiental de areia de praias de Fortaleza - Ceará. J Health Biol Sci. 2014 Jan-Mar; 2(1): 29-35. doi: http://dx.doi.org/10.12662/2317-3076jhbs.v2i1.43.p29.2014.

10. Santiago AC, Gagliani LH. Estudo da prevalência de enteroparasitas em areia de praias nos municípios de São Vicente – SP - Basil. UNILUS Ens Pes. 2011; 8(15): 6-19.

11. Graciliano JJ Neto, Farias JAC, Matos-Rocha TJ. Contaminação de areia por parasitos de importância humana detectados nas praias de orla marítima de Maceió-AL. Arq Med Hosp Fac Cienc Med Santa Casa de São Paulo. 2017 Maio-Ago; 62(2): 81-84.

12. Instituto Brasileiro de Geografia e Estatística. Biblioteca: [Ilha] do Mosqueiro: Belém (PA) [Internet]. Rio de Janeiro: IBGE; 2020 [cited 2019 Sep 09]. Available from: https://biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?id=42472&view=detalhes.

13. Ribeiro WO, Costa MAF, Tavares MGC. As práticas turísticas na Orla Oeste da ilha de Mosqueiro, Região Metropolitana de Belém, PA. Rev. Rosa dos Ventos. 2013 Jul-Set; 5(3): 528-544.

14. Miot HA. Tamanho da amostra em estudos clínicos e experimentais. J. vasc. bras. 2011 Dez; 10(4): 276-278. doi: https://doi.org/10.1590/S1677-54492011000400001.

15. Hoffman WA, Pons JA, Janer JL. The sedimentation-concentration method in schistosomiasis mansoni. J Public Health. 1934; 9:281-298.

16. Hernandes JC, Corrêa EK, Corrêa LB, Dias DG, Baccega B, Nagel AS et al.

Comparação de duas técnicas parasitológicas na detecção de enteroparasitos em catadores no sul do Brasil. Semina. 2018 Jan-Jun; 39(1):29-40. doi: 10.5433/1679-0367.2018v39n1p29.

17. Silva TR, Parente MF, Moreira LVL, Brígida RTSS, Watanabe AKT, Almeida RVC, et al. Contaminação ambiental por enteroparasitas presentes em areias na Praia do Amor, Distrito de Outeiro, Belém, Pará, Brasil. Braz Appl Scienc Review. 2020; 4(3): 1334-1342. doi: https://doi.org/10.34115/basrv4n3-046.

18. Leon II, Strothmann AL, Islabão CL, Jeske S, Villela MM. Geohelminths in the soil of the Laguna dos Patos in Rio Grande do Sul state, Brazil. Braz J Biol [Internet]. 2019 Aug [Access 2020 Jun 03] In press. Available from: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1519-69842019005020103&lng=en&nrm=iso. doi: http://dx.doi.org/10.1590/1519-6984.222590.

19. Belém. Plano Municipal de Saneamento Básico de Abastecimento de Água e Esgotamento Sanitário de Belém – Pará [Internet]. Pará: Prefeitura de Belém; 2014 Out [Cited 2019 Apr 09]. Available from: http://ww3.belem.pa.gov.br/www/wp-content/uploads/PMSB-Bel%C3%A9m-PA_Volume-I2.pdf.

20. Oliveira AA Filho, Fernandes HMB, Alcântara NDF, Assis TJCF, Freitas FIS. Frequência de enteroparasitas nas areias das praias da paraíba. BioFar. 2011; 6(2): 108-113.

21. Ministério da Saúde [BR]. Guia Prático para o controle das geo-helmintíases [Internet]. Brasília: Ministério da Saúde; 2018 [cited 2019 Sep 09]. 33 p. Available from: http://bvsms.saude.gov.br/bvs/publicacoes/guia_pratico_controle_geohelmintiases.pdf.

22. Guimarães BCS, Teixeira BT, Toleto LV, Damasceno LS, Almeida MEWC, Martins MA et al. Infecções por parasitas: ancilostomíase. Braz J Surg Clin Res. 2019 Mar-Maio; 26(3) :84-88.

23. Wang CH, Lee SC, Huang SS, Chang LC. Hookworm infection in a healthy adult that manifested as severe eosinophilia and diarrhea. J Microbiol Immunol Infect. 2011 Dec; 44(6): 484-487. doi: https://doi.org/10.1016/j.jmii.2011.04.010.

24. Nag HH, Ji R. Ascariasis presenting as acute abdomen - a case report. Indian J Surg. 2013 Jun; 75(Suppl 1): 128-130. doi: 10.1007/s12262-012-0514-8.

25. Lee EB, Song JH, Park NS, Kang BK, Lee HS, Han YJ et al. A case of Diphyllobothrium latum infection with a brief review of diphyllobothriasis in the Republic of Korea. Korean J. Parasitol. 2007 Sep; 45(3): 219-223. doi: 10.3347/kjp.2007.45.3.219.

26. Oliveira SSS, Nunes EFC, Sousa APP, Marques FHD, Ramos IS, Silva MB et al. Estudo do número de casos de difilobotriase no Brasil. J. Biol. Pharm Agricutural Manag. 2017; 13(2): 29-38.

27. Choi HJ, Lee J, Yang HJ. Four Human Cases of Diphyllobothrium latum Infection. Korean J. Parasitol. 2012 Jun; 50(2): 143–146. doi: 10.3347/kjp.2012.50.2.143.