OCCURRENCE OF INTESTINAL PARASITES IN PAPER MONEY CIRCULATING IN THE LOCAL TRADE OF THE CITY OF SÃO MATEUS, ESPÍRITO SANTO, BRAZIL

OCORRÊNCIA DE PARASITOS INTESTINAIS EM CÉDULAS DE DINHEIRO CIRCULANTES NO COMÉRCIO DO MUNICÍPIO DE SÃO MATEUS, ESPÍRITO SANTO, BRASIL

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ABSTRACT

Helminth eggs and protozoan cysts have great resistance to aggressions and environmental factors. In order to verify the involvement of inanimate objects in the transmission mechanisms of parasitic infections, a parasitological study was carried out with paper money circulating in the city of São Mateus, ES, Brazil, among September 2010 and September 2012. Notes were sent to Laboratório de Análises Clínicas of the Universidade Federal do Espírito Santo, distributed in plastic containers containing distilled water, stirred and scraped manually. The material from scraping and rinsing was centrifuged and the pellet fraction was analyzed in a light microscope. From a total of 270 samples analyzed, 22 (8.15%) were positive for eggs or cysts of intestinal parasites and R$ 2.00 bill was the most contaminated. Among the parasite species found *Giardia duodenalis* was the most frequently, which was observed in 2.22% of the samples, followed by *Entamoeba coli* and hookworm, both with 1.48%, *Ascaris lumbricoides*, *Taenia* sp., *E. histolytica*/*E. dispar* and free-living nematode larvae all with 0.74% positivity. From the 30 shops analyzed, 10 (33.33%) had paper money positive for parasitic forms and the greater positive frequency was observed in downtown establishment. Considering the large resistance of eggs/cysts of intestinal parasites to environmental conditions and the importance of paper money as transmitting disease, it is noteworthy the imminent need for investments in studies in São Mateus in order to provide better epidemiology survey for parasitic infections.

Key words: intestinal parasites. transmission. disease. money.

RESUMO

Ovos de helmintos e cistos de protozoários são dotados de grande resistência às agressões e fatores ambientais. Com o objetivo de verificar a participação de objetos inanimados nos mecanismos de transmissões de parasitoses procedeu-se um estudo parasitológico em cédulas de dinheiro circulantes na cidade de São Mateus, ES, entre setembro de 2010 e setembro de 2012. Cédulas foram encaminhadas ao Laboratório de Análises Clínicas da Universidade Federal do Espírito Santo, distribuídas em recipientes plásticos contendo água destilada, agitadas e raspadas

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manualmente. O material proveniente da lavagem e raspagem foi centrifugado e toda a fração do sedimento foi analisada em microscópio de luz. Do total de 270 amostras analisadas, 22 (8,15%) estavam positivas para ovos ou cistos de enteroparasitos e as cédulas de R$ 2,00 reais foram as mais contaminadas. Entre as espécies de parasitos encontradas *Giardia duodenalis* foi a mais frequente, observada em 2,22% das amostras, seguido de *Entamoeba coli* e Ancilostomídeos, ambos com 1,48%, *Ascaris lumbricoides*, *Taenia* sp., *E. histolytica/E. dispar* e larva nematoide de vida livre com 0,74% de positividade. Dos 30 estabelecimentos comerciais analisados 10 (33,33%) apresentaram cédulas de dinheiro positivas para formas parasitárias e nos estabelecimentos do bairro Centro foi maior a frequência de positividade. Considerando a enorme resistência de ovos/cistos de parasitos intestinais às condições ambientais e a importância de cédulas de dinheiro como veiculadoras de doenças, ressalta-se a iminente necessidade de investimento em estudos em São Mateus, que forneçam um melhor dimensionamento epidemiológico das infecções parasitárias.

Palavras-chave: parasitos intestinais. transmissão. doença. dinheiro.

INTRODUCTION

Intestinal parasites are considered as a serious public health problem especially in underdeveloped and developing countries, where their prevalence reaches rates of up to 90% (LUDWING *et al*., 1999), due to lack of investment in sanitation or the lack of health education of the population (FERREIRA; FERREIRA; MONTEIRO, 2000; RASELLA, 2013).

Specifically in South America, the findings in desiccated or mineralized feces and other organic materials identified the presence of several intestinal parasites such as hookworm, *Ascaris lumbricoides, Trichuris trichiura, Enterobius vermicularis, Hymenolepis nana, Entamoeba* spp., *Giardia duodenalis* and possibly *Entamoeba coli* (GONÇALVES; ARAÚJO; FERREIRA, 2003). Moreover, inanimate objects especially those with large circulation are important in the transmission process of parasites forms, who are able to resist for a long time on environment (PICCOLO; GAGLIANI, 2008; SUDRÉ *et al*., 2012; BARREMAKER; FRIGHETTO; DAMBRÓS, 2013).

From the parasitological point of view, lower socioeconomic classes and places with poor hygiene and sanitary conditions are where intestinal parasites find fertile environment for development (REY, 2001; MACEDO, 2005).

In Brazil, it is estimated that half of the populations analyzed in epidemiologic studies shows positive results for some parasite, either helminths or protozoa. Among them, the most common are *A. lumbricoides, T. trichiura, E. histolytica/E. dispar, E. coli* and *G. duodenalis* (FERREIRA; FERREIRA; MONTEIRO, 2000; MONTANHOLI *et al*., 2008). Overall, helminth eggs and protozoan cysts have great resistance to aggressions and environmental factors, which remain viable, even when exposed to adversity or when external to the human body (LEVAI *et al*., 1986).

In this sense, due to the spreading power and high diffusion and considering that paper money is an fundamental element in the process of transmission of parasitological diseases (MOTA, 1982; MONTANHOLI *et al*., 2008), it was thought to carry out studies focused on the possible involvement of this inanimate object in the spread of parasitic diseases among the population of São Mateus, Espírito Santo, Brazil.

METHODS

This present study was conducted from September 2010 to September 2012 in the city of São Mateus, northern state of Espírito Santo (W18°42'58'' S 39°51'32'), distant about 222 km from the state capital Vitória (ES), with an estimated population of 109 067 inhabitants (IBGE, 2010).

This is an observational cross-sectional study with qualitative analysis of parasites present in paper money.

To conduct this study, R$ 2.00, R$ 5.00 and R$ 10.00 bills were collected from 30 shops in the city of São Mateus/ES, including 3 bookstores, 3 butchers, 3 cafes, 3 street vendors, 3 bakeries, 3 ice cream shops, 3 fairs, 3 bars, 3 supermarket and 3 restaurants, located in São Mateus city, which were selected taking into account the wide circulation of money and people. In each of these shops, three samples of the bills were collected, since they present the largest circulation in the local market. All the bills used in the research were exchanged for new notes.

After collected in plastic containers of first use, the money bills were sent to the Clinical Laboratory of the "Norte do Espírito Santo" University Center - Federal University of Espírito Santo (CEUNES/UFES) and processed as described by Levai et. al (1986) with some modifications. Initially, the money bills were distributed into plastic containers previously acclimated with 100 ml of distilled water and manually shaken for 10 minutes. Then, the samples remained at rest for 10 minutes. After this time, the money bills were lightly scraped off one at a time with a glass slide to remove of the largest amount of material as possible.

Finally, money bills were removed from the plastic container and placed in an oven for drying. The material from washing and scraping was equally distributed in conical plastic tubes and centrifuged at 4000 rpm for 5 minutes. Every fraction from the centrifugation sediment was examined under light microscope, after staining with Lugol using 10x and 40x magnification for parasite research.

RESULTS

From the total of 270 money bills analyzed, 22 (8.15%) were positive for intestinal parasite eggs or cysts and the R$ 2.00 bills showed the highest rate of contamination (5.18%). The other bills (R$ 5 and R$ 10) showed 1.48% of contamination. It is noteworthy that no bill showed contamination by more than one parasite. *G. duodenalis* was the most frequent parasite, being observed in 2.22% of the samples, followed by *E. coli* and hookworm, both with 1.48% and *A. lumbricoides*, *Taenia* sp., *E. histolytica/E. dispar* and free-living nematode larvae, all with 0.74% positivity.

With respect to the districts of origin of positive samples, downtown was the most frequent, with a total of ten. Boa Vista, Cohab, Guriri, Ideal, Litorâneo, Santa Tereza, Sernamby, Santo Antônio and Universitário were the other districts which samples were collected, and positive samples were found in Ideal, Boa Vista, Santo Antônio and Sernamby districts (Table 1).

Table 1 - Relationship between origin district, value of money bills and intestinal parasites found in São Mateus, Espírito Santo, Brazil, 2010-2012

Bills origin districts	Money bill value	Number of contaminated bills	Parasites
Sernamby	2,00	2	*Entamoeba coli*
Downtown	2,00	2	*Entamoeba coli*
Sernamby	2,00	2	*Giardia duodenalis*
Downtown	2,00	2	*Giardia duodenalis*
Santo Antônio	2,00	2	Hookworm
Sernamby	2,00	2	*Ascaris lumbricoides*
Downtown	2,00	2	*Taenia* sp.
Boa Vista	5,00	2	*Entamoeba histolytica/dispar*
Downtown	5,00	2	*Free-living nematode larvae*
Downtown	10,00	2	*Giardia duodenalis*
Ideal	10,00	2	Hookworm

From the 30 shops analyzed, 10 (33.33%) showed money bills positive for parasitic forms. The type of shop and infection frequency are shown in Table 2.

Table 2 - Relative frequency of contamination of paper money by type of shop in São Mateus, Espírito Santo, Brazil, 2010-2012

Type of shop	Total analyzed shops	Number of shops with positive sample	Relative frequency
Butchers	3	2	66.66%
Cafes	3	2	66.66%
Fairs	3	1	33.33%
Bakeries	3	2	66.66%
Bookstores	3	1	33.33%
Street vendors	3	2	66.66%

DISCUSSION

Intestinal parasites have wide geographic and population distribution, being responsible for the appearance of a number of diseases. They are often cited as indicators of socioeconomic development of a locality (WHO, 2012). Although efforts by health agencies have been made to reduce the rates and impact of diseases caused by intestinal parasites, poor hygiene conditions of the population represents one of the factors that most contribute to the spread of parasitic diseases (COSTA-MACEDO et al., 1998).

Under favorable conditions, parasites can survive in a wide range of reservoirs (BARREMAKER; FRIGHETTO; DAMBRÓS, 2013) and are subsequently transmitted in various forms to individuals. Besides the problems inherent to poor sanitary conditions of the population, there is lack of knowledge of the importance of fomites in the dynamics of the spread of parasites, bacteria and fungi (BORGES; COSTA-CRUZ; PAULA, 2009; MURTA; MASSARA, 2009).

In an attempt to improve the recognition of objects in the transmission of intestinal parasites, the present study used techniques similar to those described by Levai et al. (1986), who analyzed money bills from shops in the city of São Paulo and found eggs of *A. lumbricoides, Meloidogyne, Taenia* sp., cysts of *E. coli*, mites and free-living larva. Similarly, Montanholi et al. (2008) analyzed 500 R$ 1.00 bills in the city of Catanduva, state of São Paulo, and found viable embryonated eggs of *A. lumbricoides, Ancylostoma* sp. cysts of *Microsporidium*, and groups of bacteria. Both the results of Levai et al. (1986) as Montanholi et al. (2008) pointed out a low incidence of parasites in circulating money bills (1.09% and 1.0%, respectively) when compared to the study conducted in São Mateus (7.41%).

On the other hand, the frequency data recorded in São Mateus were lower than those found in the studies by Piccolo & Gagliani (2008) in the city of Santos, Brazil. In that year, R$ 1.00 and R$ 2.00 bills showed an extremely worrying result, where the frequency of parasites was 48.6%. High frequencies were also found in a study by Brito et al. (2006), who found that 40% of the money bills analyzed were contaminated with some species of parasites in São José dos Campos, São Paulo.

It is noteworthy that in the study in São José dos Campos, samples were restricted to R$ 1.00 bills and in the study in Santos, the highest positivity was found in R$ 1.00 bills and these were no longer available for circulation since they had been replaced by coins. These studies showed

that circulating paper money can be a reservoir for spreading parasitic forms for the human population.

Specifically in São Mateus, the frequency of intestinal parasites in samples is worrisome, taking into account the parasitic species found. Among them, *E. histolytica* causing amebiasis, a disease that annually leads to death 40-100 thousand individuals worldwide and is considered the second leading cause of death among parasitic diseases. Its most frequent clinical manifestation is acute amoebic colitis (SANTOS; SOARES, 2008), with also the manifestation of invasive intestinal and extraintestinal forms. The presence of *E. histolytica/E. dispar* in this study is worrisome since the differential diagnosis between these species is difficult and the presence of *E. histolytica* indicates risk of infection by this parasite since the sanitation deficiency is notorious among populations of the municipality.

On the other hand, the presence of *E. coli*, despite not being capable of producing pathogenic forms, provides an excellent indication of paper money contamination by other protozoa, since people with lack in their national health systems can transmit this and other parasites through direct manipulation of paper money.

Another intestinal parasite found in the study conducted in São Mateus was *G. duodenalis*. When an individual is infected, it leads to acute or persistent diarrhea, with evidence of malabsorption and weight loss (BOSKOVITZ; PARDO, 1976; MACHADO *et al*., 1999). Importantly, among Protozoa, *G. duodenalis* is the one whose cyst remains viable longer in the external environment and presents resistance to habitual water chlorination (ANDRADE et al., 2010), and therefore plays an important role in the transmission dynamics of parasites by objects.

Among the species of helminths found, *A. lumbricoides* is an intestinal parasite quite common among children. Their eggs are large compared to protozoan cysts and have three membranes (outer, middle and inner), which confer great resistance to adverse conditions in the external environment. In addition, have a great capacity for adhesion to surfaces (GOULART *et al*., 1985) and can be adhered to circulating paper money (MONTANHOLI *et al*., 2008; PICCOLO; GAGLIANI, 2008), remaining viable there for a long time.

The presence of eggs of *Taenia* sp. should also be mentioned, which is another parasitic form extremely resistant to the external environment (LEVAI *et al*., 1986; IASBIK *et al*., 2010). This finding is worrisome, since the embryos of this parasite migrate mainly into the central nervous system, to the eyeball or muscle tissue causing cysticercosis (SILVA *et al*., 2007).

Another geo-helminth found was hookworm, which is capable of infecting the small intestine of humans, causing anemia and hypoproteinemia. The eggs of this parasite require favorable environmental conditions such as good oxygenation, humidity and temperature for embryogeny to occur (REY, 2001; CASSENOTE et al., 2011; COELHO, 2011). Positivity for this helminth in the city of São Mateus probably indicates the environmental contamination of the notes, indicating the need for greater hygiene care of the population. The meeting of free-living nematode larvae is an important finding given that some parasites as *Strongyloides stercoralis* and hookworms (ROCHA, MENDES, BARBOSA, 2008; BRANDÃO FERRO, COSTA CRUZ, BARCELOS, 2012) have part of their life cycles in the external medium in contact with the ground. However, the morphological conditions of the larvae found did not allow a definitive diagnosis.

The vast majority of contaminated money bills were from shops related to the food area, located in downtown - butcher, fairs, cafes, bakeries and street vendors - where the flow of individuals is significantly higher when compared to distant districts. In fact, considering the habit of a portion of the population to carry the money close to your body and not in portfolios (Sudré, 2012), and not sanitize it properly when handling this material, as also observed by Uneke and Ogbu (2007) in Nigeria, may represent a major risk to transmission of parasitic forms. Regarding the mechanism of parasite transmission, besides the intake of eggs present in the soil and contaminated water and larval penetration through the skin, especially in feet, food contamination is a major means of spread of these diseases. Accordingly, the studies of Takizawa et al. (2009) were aimed at contamination through the hands of food handlers by analyzing fecal and subungual material of this working class in the state of Paraná. In 343 food

handlers analyzed, the subungual material was positive in 17 of them (5%) and the parasites found were the following: *Endolimax nana* (2.9%), *E. coli* (1.2%), *G. duodenalis* (0.3%) and association between *E. nana* and *E. coli* in 0.6%.

The diversity of parasites found in paper money circulating in São Mateus and their frequencies, *G. duodenalis* (2.22%), *E. coli* (1.48%), hookworm (1.48%), *E. histolytica/E. dispar* (0.74%) and *Taenia* sp. (0.74%), *A. lumbricoides* (0.74%), free-living larvae (0.74%) suggests that the geographical distribution of parasites is dependent on a multiplicity of factors: lack of hygiene by the population, poor health education and favorable environmental conditions for the development of the cycle of parasites such as humidity, temperature and oxygenation.

Indeed, the lack of health education programs reflects in the lack of information about diseases and their prevention mechanisms, especially in low-income populations. In addition the climate conditions in Brazil, a tropical country, and especially in São Mateus whose average annual temperature is around 26°C (IBGE, 2010) contribute significantly to the development of parasitic forms, directly related to higher temperatures.

Thus, it is expected that simple health education actions related to basic hygiene principles such as washing hands before meals, after using the toilet and handling money, wash and disinfect raw vegetables, keep nails short to prevent the accumulation of contaminated material are extremely important and crucial as measures to significantly reduce the likelihood of disease spread, among them, those caused by parasites.

CONCLUSIONS

Paper money with large circulation, such as R$2, R$5 and R$10 in São Mateus trade showed contamination levels by parasitic structures.

Food courts showed paper money circulating contaminated by parasitic structures.

The diversity of parasitic forms found indicates the real possibility of transmission of intestinal diseases.

Considering the large resistance of eggs/cysts of intestinal parasites to environmental conditions and the importance of paper money as transmitting disease, it is noteworthy the need for investments in studies in the city of São Mateus in order to provide better epidemiology survey for parasitic infections.

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