JOURNAL HEALTH NPEPS

http://dx.doi.org/10.30681/252610106228 ORIGINAL ARTICLE

Socio-environmental factors and schistosomiasis hospitalizations in Minas Gerais, Brazil (2007-2017)

Factores socioambientales y hospitalizaciones por esquistosomiasis en Minas Gerais, Brasil (2007-2017)

Fatores socioambientais e internações por esquistossomose em Minas Gerais, Brasil (2007-2017)

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ABSTRACT

***Objective**: to present a spatial analysis of hospitalizations for schistosomiasis in Minas Gerais (2007-2017). **Method**: ecological study, with spatio-temporal distribution. Data collection was carried out in 2019, at DataSUS, for the period between 01/01/2007 and 12/31/2017. The average rates, Moran Local Bivariate rates and thematic maps were performed using the QGis program. **Results**: higher hospitalization rates were observed in the North, East and Northeast parts of the state. Lower rates were observed in the Southeastern portion. The variables MHDI and percentage of households without garbage collection had higher values of Local Moran Index. Municipalities in the eastern and southeastern portions of the state were classified under the "high-high" stratum. **Conclusion**: hospitalizations were associated with lack of basic sanitation, conditions of poverty and inequality and strong presence of water collections. There are still regions where schistosomiasis remains endemic, having a focused character.*

***Descriptors**: Schistosomiasis; Brazil; Basic Sanitation.*

RESUMEN

***Objetivo**: presentar un análisis espacial de las hospitalizaciones por esquistosomiasis en Minas Gerais (2007-2017). **Método**: estudio ecológico, con distribución espacio-temporal. La recolección de datos se realizó en 2019, en DataSUS, para el período comprendido entre el 01/01/2007 y el 31/12/2017. Las tasas promedio, las tasas Bivariadas Locales de Moran y los mapas temáticos se realizaron mediante el programa QGis. **Resultados**: se observaron mayores tasas de hospitalización en las zonas Norte, Este y*

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*Noreste del Estado. Se observaron tasas más bajas en la parte Sureste. Las variables IDHM y porcentaje de viviendas sin recolección de basura presentaron valores más altos de Índice Moran Local. Los municipios de las partes este y sureste del estado se clasificaron en el estrato "alto-alto". **Conclusión**: las hospitalizaciones se asociaron a la falta de saneamiento básico, condiciones de pobreza y desigualdad y fuerte presencia de captaciones de agua. Todavía hay regiones donde la esquistosomiasis sigue siendo endémica, teniendo un carácter focalizado.*
***Descriptores**: Esquistosomiasis; Brasil; Saneamiento Básico.*

RESUMO
Objetivo: apresentar análise espacial das internações por esquistossomose em Minas Gerais (2007-2017). **Método:** estudo ecológico, com distribuição espaço-temporal. A coleta de dados foi realizada em 2019, no DataSUS, referente ao período entre 01/01/2007 e 31/12/2017. As taxas médias, as taxas de Moran Local Bivariado e os mapas temáticos foram realizados com uso do programa QGis. **Resultados:** foram observadas maiores taxas de internação nas partes Norte, Leste e Nordeste do Estado. Menores taxas foram observadas na porção Sudeste. As variáveis IDHM e porcentagem de residências sem coleta de lixo tiveram maiores valores de índice de Moran Local. Municípios das porções Leste e Sudeste do Estado foram classificados sob estrato "alto-alto". **Conclusão:** as internações estiveram associadas à falta de saneamento básico, condições de pobreza e desigualdade, e forte presença de coletas de água. Ainda há regiões onde a esquistossomose permanece endêmica, tendo caráter focalizado.
Descritores: Esquistossomose; Brasil; Saneamento Básico.

INTRODUCTION

Schistosomiasis mansoni is a parasitic disease, caused by Schistosoma mansoni (helminth belonging to the class of Trematoda, family Schistossomatidae, genus Schistosoma), with man as the main definitive host, where it reproduces sexually and allows the elimination of S. mansoni eggs in the environment, via faeces, contaminating water collections[1].

It originated in the basins of the Nile (Africa) and Yangtze (Asia) rivers, being dispersed to other continents from migratory flows, with the evolution of means of transport. It was introduced in Brazil by the arrival of African slaves, mainly in the ports of Recife and Salvador. Initially, the disease spread across Northeast Brazil, later introducing itself in Minas Gerais due to the gold and diamond cycle. Due to its magnitude, it is currently considered an important public

health problem, especially the Northeast and Southeast regions of Brazil[2].

Studies on schistosomiasis are not recent in Brazil[3], mainly involving the state of Minas Gerais[4-9] and even states in the Brazilian Amazon Region[10]. There is evidence that the disease affects all age groups (especially those aged 60 years and over), and that deaths are rare in those under 20 years of age. Furthermore, data on hospitalization for schistosomiasis provide an estimate of the occurrence of severe forms of the disease when those affected seek hospital care[11,12], and may have a different distribution profile where the disease is characterized as endemic, as in Minas Gerais[11].

Thus, the present work aims to present a spatial analysis of hospitalizations for schistosomiasis in Minas Gerais (2007-2017).

METHOD

With a territorial area of 586,513,983 km², the state of Minas Gerais has an estimated population of 21,411,923 people (2021) and a population density of 33.41 inhabitants/km² (2010), in addition to an HDI of 0.731 (2010) and a monthly household income per capita of BRL 1,325.00 (2021)[13]. The state is formed by eight hydrographic mesoregions: Paranaíba, Grande, Alto São Francisco, Médio São Francisco, Paraíba do Sul, Doce, Itanhaém/Mucuri/São Mateus and Jequitinhonha/Pardo[14]. It should be noted that watersheds represent favorable ecological conditions for the transmission of schistosomiasis[15], which probably explains the persistence of the disease in the state[16,17].

Descriptive ecological study, based on secondary data. Collection of records of hospitalizations for the disease (IDC-10 B65.1) was carried out by municipality of residence, with the Brazilian Ministry of Health[18] (Hospital Information System - SIH/DataSUS). The use of hospitalization records is justified by the fact that this information is an epidemiological indicator of the disease, a methodology used by several studies[19-21], considered as a representation of inequality both

in the field of health and in social characteristics[22].

Data referring to the percentage of the population in households with garbage collection, Municipal Human Development Index (MHDI), percentage of people in households with inadequate water supply and sanitation, fertility rate, Gini Index, percentage of the population in households with piped water, percentage of people in households with inadequate water supply and sanitation, percentage of the population in households with running water are for the year of 2010, being collected from the Atlas of Human Development in Brazil[23], which uses data from the IBGE Demographic Census. The percentage of people without water was obtained by complementing the percentage of people in households with water supply (1 - percentage value, by municipality). After making the spatial distribution map of the rates, bivariate correlations were made between the explanatory variables and the response variable. All were statistically significant (5% significance level). The same occurred with the Moran Local Bivariate Index. However, the variables with the highest values of this index were selected: MHDI (-0.241) and percentage of households without garbage collection (0.137), these variables were chosen as explanatory variables for making thematic maps, with the hospitalization rate as a variable response. The other Moran Local Bivariate Index values observed were: fertility rate (0.074), Gini Index (0.034), percentage of the population in households with piped water (0.065), percentage of people in households with inadequate water supply and sanitation (0.121).

The ten municipalities with the highest numbers of hospitalizations, which are located in different parts of the state (notably the central-eastern and northwestern portions of the state), were selected. It was sought to show that the disease is endemic in the state (even under different environmental conditions) and with different socioeconomic conditions among these municipalities (MHDI,

inadequate supply, no running water and no garbage collection).

Schistosomiasis hospitalization rates were calculated by municipalities in the state of Minas Gerais, per year (2007 to 2017), with the division of the number of hospitalized schistosomiasis patients by that of residents, multiplied by 100,000, in the year considered. In order to provide an overview of the epidemiology in the state, all hospitalizations during the period in question were included. Subsequently, the average hospitalization rate for the period was calculated, adding all fees per year and dividing the result by 11 (number of years in the study period).

Pearson's bivariate correlations were performed using the SPSS Program version 20 and the digital grid of the municipalities of Minas Gerais was obtained from IBGE (http://www.ibge.gov.br). The strata were selected based on the distribution of the average municipal rates, namely: rates of value 0 (275 municipalities, 32.2% of the total municipalities), rates from 0.01 to 2.65 (152 municipalities, 17.9 %), 2.66 to 21.09 (170 municipalities, 19.9%), 21.10 to 171.72 (171 municipalities, 20.0%) and 171.73 to 1694.03 (85 municipalities, 10, 0%), totaling 853 municipalities in the state of Minas Gerais. This division is justified as a way of showing on the map municipalities where the highest average rates were observed.

The maps of the average rates by municipality and those of Moran Local Bivariate were made using the QGis Program, version 2.18.20, with scale 1: 7640022. The Moran Local Bivariate maps had the queen contiguity, with a contiguity/neighborhood order of 1. The spatial associations of the Moran Local Bivariate maps have values from 0 to 4, namely: non-significant, high-high (municipalities with rates above average, with the same occurring in neighboring municipalities), low-low (municipalities with below average rates, with the same occurring in neighboring municipalities), low-high (municipalities with below average rates and their neighbors with

rates above medium) and high-low (municipalities with above-average rates and their neighbors with below-average rates), respectively.

By using secondary and public domain data, it was not necessary to send this work for evaluation by the ethics committee.

RESULTS

There were observed a total of 71,214 cases in the study period. It should be noted that 30.4% of households in the municipality of Novorizonte (hospitalization rate of 47.63) had inadequate sanitation and that the municipalities of Bonito de Minas, Wenceslau Braz and Berilo had about 59.39%, 55.04% and 52.09% (respectively) of their households without running water. As for garbage collection, Santa Fé de Minas and Açucena had more than 50% of their households (56.02% and 50.62%, respectively) without this service.

Table 1 contains the 10 municipalities with the highest number of cases for the study period, accompanied by their respective MHDI, percentage of people in households with inadequate water supply and sanitation, percentage of the population in households without running water and percentage of the population in households without garbage collection (referring to the year 2010). We highlight the percentages of households without garbage collection in Januária (28.27%), Inhapim (19.92%) and Poté (14.34%), in addition to 16.30% of the households in Ladainha having water supply and inadequate sanitation.

As for the spatial distribution of hospitalization rates for schistosomiasis, higher values (strata from 171.73 to 1694.03) were observed in the North, East and Northeast of the state. The same occurred for the values of the second largest stratum (21.10 to 171.72), which was also observed in some municipalities in the center of the state. The lowest rates of hospitalization were observed in the southern portion of Minas Gerais (Figure 1).

Table 1 - Municipalities with the 10 largest number of cases for the study period (2007-2017), and their respective socioeconomic characteristics.

Municipalities	*Number of cases*	*MHDI*	*Inadequate supply*	*No running water*	*No garbage collection*
Belo Horizonte	*2695*	*0.81*	*0.15*	*0.3*	*0.54*
Teófilo Otoni	*2555*	*0.701*	*2.61*	*5.22*	*3.28*
Inhapim	*2124*	*0.658*	*0.96*	*14.78*	*19.92*
Itambacuri	*1841*	*0.634*	*7.53*	*8.34*	*8.37*
Poté	*1299*	*0.624*	*10.81*	*10.46*	*14.34*
Januária	*1294*	*0.658*	*8.22*	*23.99*	*28.27*
Raul Soares	*1290*	*0.655*	*0.63*	*7.62*	*4.49*
Ipatinga	*1245*	*0.771*	*0.12*	*1.86*	*0.15*
Ladainha	*1195*	*0.541*	*16.30*	*18.35*	*9.47*
São João do Oriente	*1190*	*0.648*	*0.13*	*1.19*	*2.99*

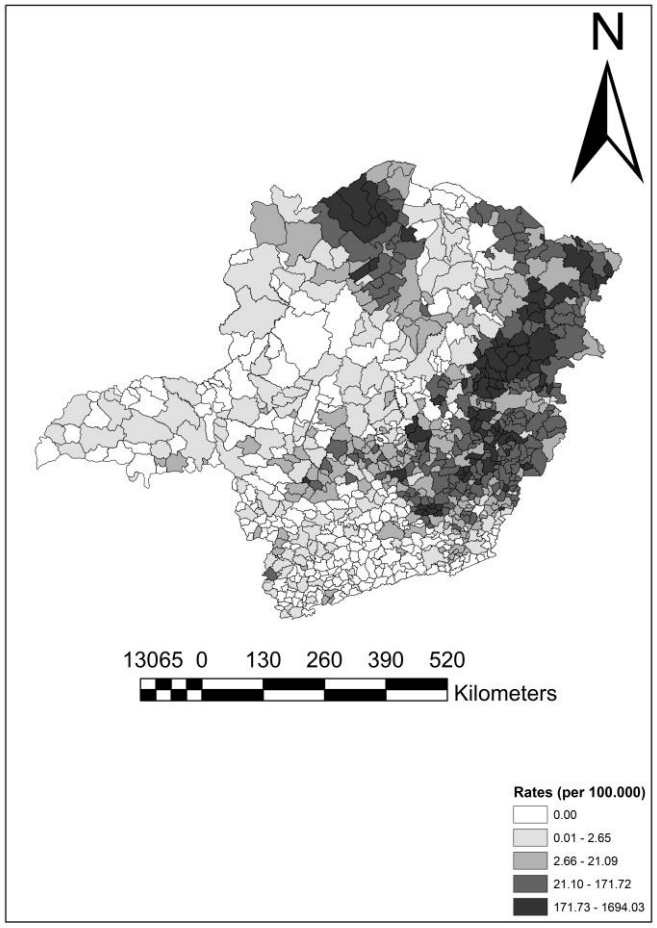

Figure 1 - Map of hospitalization rates for schistosomiasis in Minas Gerais (2007 to 2017).

According to Figure 2, the highest concentration of "high-high" was observed in some municipalities in the East and Southeast of the state, the same occurring with the "low-low"

strata. In the South and Southwest portions of the state, there was a greater concentration of municipalities classified as "high-low".

According to the variable percentage of households without garbage collection, the highest concentration of municipalities in the "high-high" stratum was located in the East and Southeast portions of the state, a behavior similar to that observed in the "low-high" stratum. The "high-low" strata was observed in municipalities in the North and Midwest portions of the state. There was a concentration of municipalities in the south and southwest of the state under the "low-low" stratum (Figure 3).

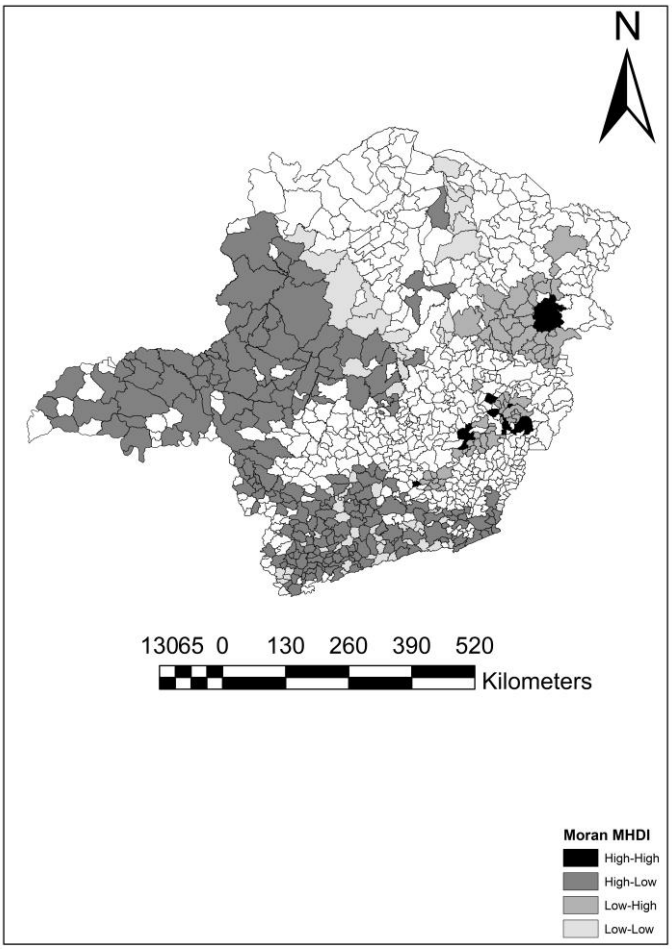

Figure 2 - Map of Moran Bivariate Location (MHDI variable) from 2007 to 2017.

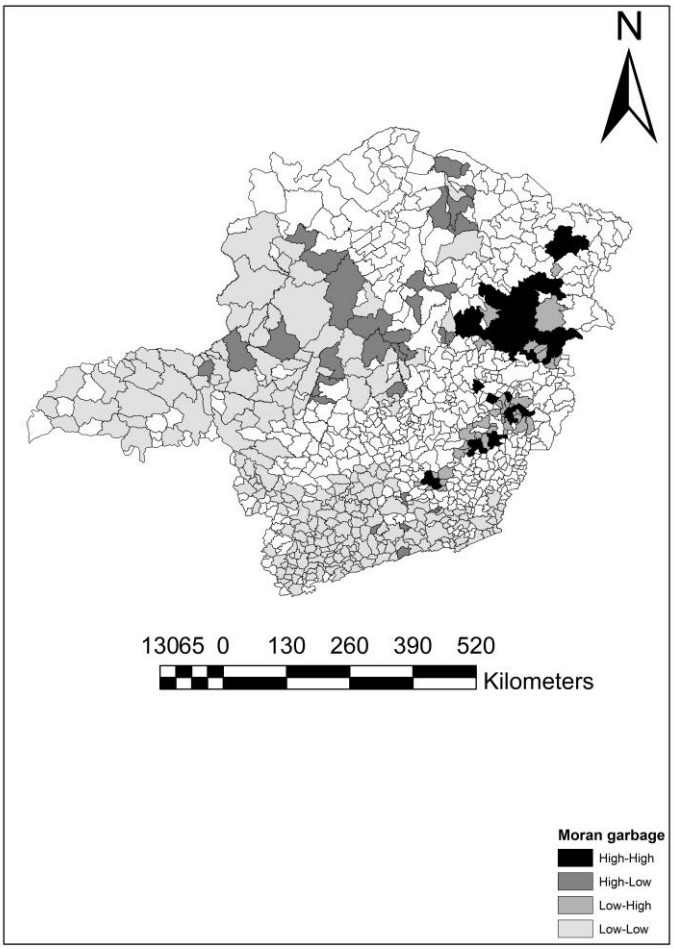

Figure 3 - Map of Moran Local Bivariate (variable percentage of households without garbage collection) from 2007 to 2017.

DISCUSSION

A neglected disease with a strong social determination, schistosomiasis requires making the socio-spatial environment healthier to overcome it, since it is one of the inequities that reproduce socially in Brazil[24]. As main symptoms, the disease causes abdominal pains, diarrhea, abdominal discomfort, bloody diarrhea, cutaneous pruritis, bloody stools, hepatomegaly, and elimination of worms in stools[25].

For its control and subsequent elimination, environmental sanitation creates conditions that reduce proliferation/contamination of intermediate hosts, reducing contact between humans and transmitting agents (infected snails). The main measures to achieve this objective are landfill, drainage or channeling of water courses, water supply for human consumption, sanitary sewage, improvement of sanitary infrastructure, water and home sanitary facilities[1]. Bio-socio-ecological factors and difficulties in accessing health services are still a reality in Brazil, partially explaining the presence of individuals with acute/toxemic forms of the disease, causing the disease to become concrete and everyday experiences of people[26].

Within this context, the dumping of waste in rivers (generated by the lack of basic sanitation) is a serious public health problem, as it promotes the increase and worsening of waterborne diseases such as schistosomiasis[27]. Therefore, the installation of piped water in homes and basic education of the population are fundamental measures for the control of the disease[28].

A study[29] showed high prevalence of schistosomiasis in Pernambuco, observed in rural locations where precarious conditions of basic sanitation existed, since sanitation situations (sewage, septic tank, sewage collection and treatment) were considered almost nonexistent, with the pipes of houses pouring waste directly into / near the river, facilitating the spread of worms. Another study[30] highlighted the transmission of the disease also

in urban areas, with people who can involuntarily expose themselves to their sources of transmission.

These considerations are in agreement with the findings of the present study, since the four socioeconomic variables (MHDI, percentage of people with inadequate water supply and sanitation, percentage of the population in households without running water and percentage of the population in households without garbage collection) had a significant correlation with rates of hospitalization for schistosomiasis. In addition, municipalities with more than 50% of their households without garbage collection or running water stand out. Even in almost entirely urbanized municipalities (case of Belo Horizonte), a large number of schistosomiasis cases were observed.

Although large cities or capitals have few areas of infection in the center and in more affluent neighborhoods, their peripheries reproduce the inadequate sanitation conditions that allow the installation of outbreaks of the disease, as it occurs in rural regions or in smaller communities[11].

In recent studies, it has been demonstrated that the disease presents itself in persistent foci of transmission[16,17], reinforcing the hospitalization findings of the present study, which are possibly linked to the highlighted socioeconomic and environmental conditions.

Ratifying these findings of the present study, there was performed a multivariate analysis, with their results demonstrating that the presence of the hepatosplenic (palpable spleen) form of the disease in children was strongly associated with the worst socioeconomic level of the family, the absence of running water at home and the habit of bathing in children[31].

Another study[32] highlight the importance of strengthening the population's knowledge about the disease. The authors carried out a study in four municipal schools on the outskirts of Belo Horizonte, where initially most students were unaware of the ways in which schistosomiasis was

transmitted and only a small part of the teachers included the disease as existing among their students. After explanatory classes on the disease, there was an increase in the knowledge of students and teachers about the disease, accompanied by a reduction in the prevalence of the disease. Even after two decades of this work, there are still studies that reinforce the need for health education activities for communities[33].

Authors[26] highlight that as schistosomiasis is most of the time asymptomatic, its meaning is not necessarily experienced by the population, generating the need for a discursive practice from health agents and professionals, who must try to explain the world from a perspective of some sometimes alien to the socio-cultural situation of the target population, aiming at social transformation. Therefore, programs to control / combat the endemic disease must take into account the process by which individuals are guided to think about this endemic disease.

It must be taken into account that Minas Gerais is a state with great regional disparities, considering its GDPs per capita by development territories, with values that varied (in 2016) from R$ 9,460.00 (Jequitinhonha) to R$ 39,120, 00 (Triângulo Mineiro/Alto Paranaíba), as evidenced by Figures 2 and 3, where there was a higher concentration of hospitalization rates and spatial autocorrelation in municipalities in the Vale do Rio Doce and Jequitinhonha regions. These regions had high hospitalization rates associated with a lack of garbage collection and a low IDHM, characteristics that may influence disease prevention habits, such as hand washing and wearing shoes, which were associated with significantly lower chances of infection[34].

Reinforcing the findings of this work, inadequate sanitation conditions are considered as a lack of effectiveness of political and public actions by the local society[35]. In general, better health, housing and economic conditions (mainly related to basic sanitation and water supply) are suggested to

reduce hospitalizations for schistosomiasis[36].

Thus, as it is a waterborne disease, the conditions of poverty and inequality combined with environmental factors can help to understand the causes associated with the incidence of schistosomiasis in Minas Gerais[37] (the same is true for hospitalizations). As seen, Minas Gerais has an infinity of water bodies (these are even used for tourist purposes)[38], creating favorable conditions for the transmission of the disease in question.

As possible limitations of this study, it should be noted that possible limitations regarding biases/confusions may have occurred in the present study, to the extent that secondary data were used, leading to changes in information regarding health conditions. Additionally, the use of aggregated data from existing databases with ecological design does not represent individual information, making more difficult a refined investigation of the health-disease process[39-41]. This may be a possible explanation for the associations with socio-environmental variables of this work.

CONCLUSION

The present study sought to associate hospitalizations for schistosomiasis in the state of Minas Gerais with socioenvironmental factors of the state, notably lack of basic sanitation, conditions of poverty and inequality and strong presence of water collections. This association was observed in the results of this study, where correlations between hospitalization rates and low socioeconomic levels were highlighted in several municipalities in the state.

Although there is already great knowledge of the forms of prophylaxis and prevention of this disease, there are still regions where schistosomiasis remains endemic, having a focused character. Another issue that should be highlighted is the greater number of hospitalizations in the capital Belo Horizonte, the city that has the greatest economic

power in Minas Gerais, which contrasts with the characteristics of exposure to the disease (low social indicators), and which demonstrates that the disease is a public health problem in the state.

Far from being understood as a problem of resolved situation, new studies are encouraged that use new methodologies to approach the disease, including the collection of primary data, enabling more refined analyzes that seek its eradication. Additionally, actions aimed at improving the socioeconomic status of some cities in the state are encouraged, as evidenced by the low development rates observed in some municipalities.

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Funding: The author declare that there was no funding.

Conflict of interest: The author declare no conflict of interest.

Author participation:
- **Design:** Alves MR.
- **Development:** Alves MR.
- **Writing and proofreading:** Alves MR.

How to cite this article: Alves MR. Socio-environmental factors and schistosomiasis hospitalizations in Minas Gerais, Brazil (2007-2017). J Health NPEPS. 2022; 7(1):e6228.

Submission: 30/01/2022
Accepted: 30/05/2022