

SCHISTOSOMA MANSONI IN EUNÁPOLIS, BRAZIL: AN INTEGRATED ANALYSIS OF EPIDEMIOLOGICAL, ENVIRONMENTAL, AND MALACOLOGICAL DATA

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Abstract: Schistosomiasis caused by *Schistosoma mansoni* remains a significant public health issue in Brazil, particularly in areas with poor sanitation and frequent exposure to contaminated water bodies. In the municipality of Eunápolis, located in southern Bahia, historical records of the disease indicate the persistence of endemic transmission and underreporting in official health information systems. In this context, the present study aimed to carry out an integrated analysis of epidemiological, environmental, and malacological data to identify risk factors for the maintenance and possible reactivation of the schistosomiasis transmission cycle in the region. This is an observational, cross-sectional study with a quantitative-qualitative approach, conducted between 2023 and 2024. Secondary data were collected from SINAN, SIAB, and DATASUS, as well as primary data obtained through physicochemical and microbiological analyses of water samples and malacological surveys at 11 strategic points in the municipality. The results revealed the presence of fecal coliforms in water bodies used for bathing and recreation, along with the identification of *Biomphalaria* snails in areas of frequent human activity. The analyses highlight the coexistence of environmental and social factors that contribute to vulnerability to schistosomiasis, underscoring the need for intersectoral control

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actions, improved sanitation, and health education.

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Introduction

The relationship between human health and the environment has been shown to be one of the most relevant interfaces for understanding the processes of illness in contemporary societies. In particular, the environmental impacts caused by anthropogenic activities have contributed to the aggravation of water-based diseases, such as schistosomiasis mansoni, which remains a neglected disease in several regions of Brazil. In this context, environmental health emerges as an interdisciplinary field that allows the identification of risk factors associated with sanitary, social, and ecological conditions, which are fundamental for the formulation of public prevention policies.

According to Philippi Jr. (2005), the environmental problems resulting from the degradation of natural resources, especially water, cause direct consequences to public health. Water, as an essential resource for life, is also a vehicle for numerous diseases when contaminated, and its inadequate use reflects inequalities in access and basic sanitation conditions. The transmission of schistosomiasis, caused by the parasite *Schistosoma mansoni*, occurs precisely in environments with contaminated water collections, in which mollusks of the genus *Biomphalaria*, intermediate hosts of the disease, are present.

The World Health Organization (WHO, 2013; 2020) estimates that more than 240 million people worldwide are at risk of contracting schistosomiasis, with most cases occurring in low-income countries, especially Brazil. According to the Ministry of Health (Brasil, 2014), the disease is still considered endemic in at least 12 federated units, with a high prevalence in the Northeast Region, which demands constant attention from surveillance and control services. The persistence of the disease in urban and rural areas reveals structural flaws in the supply of sanitation and epidemiological surveillance.



In the State of Bahia, studies indicate that schistosomiasis has presented complex epidemiological patterns, with cases recorded even in urbanized areas (Cruz et al., 2020). The literature also indicates that factors such as low education, absence of continued public policies, inadequate use of water and lack of health education potentiate the transmission of the disease. In municipalities with disorderly population growth, such as Eunápolis, these conditions can be aggravated by peripheral urbanization without adequate sanitary coverage.

The transmission of schistosomiasis is directly associated with contact with contaminated water bodies. According to Neves (2005), this cycle involves the release of eggs in human feces, which, when they reach water collections, release larvae (miracidia) capable of infecting mollusks of the genus *Biomphalaria*. These, in turn, release cercariae, which penetrate the human skin at the slightest contact with water. This dynamic, according to Coura-Filho et al. (1995), is influenced by sociocultural and economic factors, such as work activities, leisure and domestic practices involving water, showing that the risk is not only biological, but profoundly social.

The present study is justified by the need to identify and map the environmental, epidemiological and malacological indicators that influence the occurrence of schistosomiasis in the municipality of Eunápolis-BA, considering its historical condition as an endemic area. DATASUS records indicate that, between 2006 and 2007, the municipality showed a significant increase in confirmed cases, reaching a peak of 52 cases in 2007. In the recent period, studies by Lima et al. (2025) report that between 2017 and 2022, 113 new cases were registered, with one death in 2020, according to data from the Schistosomiasis Control Program (PCE).

The relevance of the study is also due to the absence of recent scientific productions focusing on schistosomiasis in Eunápolis, making it difficult to develop educational actions and local surveillance strategies. In addition, the evidence points to a possible underreporting of the disease, since, in certain years, no cases were recorded, despite the maintenance of environmental risk factors. This gap can compromise the effectiveness of the actions of the Unified Health System (SUS) and reinforces the importance of locally-based studies to support technical decisions.



The research adopts an observational, cross-sectional and quantitative-qualitative approach, articulating secondary data from SINAN, SIAB and DATASUS with primary data obtained through water and mollusk collections at 11 points in the municipality, distributed between urban and rural districts. Physicochemical and microbiological variables of the water were analyzed, such as turbidity, pH, chlorine, iron, dissolved oxygen, total and fecal coliforms, in addition to the malacological survey for the detection of the mollusk *Biomphalaria* sp. Such procedures sought to identify environmental vulnerabilities associated with the risk of infection.

In this study, incidence and prevalence were calculated based on the estimated population of Eunápolis between 2017 and 2022. The estimated prevalence in the period was 10 cases per 100,000 inhabitants, while the annual incidence ranged from 38.28 per 100,000 inhabitants in 2018 to only 0.87 in 2022, showing a reduction, but with the risk remaining. The highest concentration of cases occurred among male adults, especially in the age group of 30 to 49 years, possibly associated with the recreational and labor use of contaminated water bodies.

Therefore, this article aims to contribute to the strengthening of environmental health surveillance and schistosomiasis control at the local level, through the systematization of empirical data and the critical analysis of risk factors present in Eunápolis. The theoretical foundation anchored in classical and technical authors, such as Neves (2005), Ferreira (2003) and the reports of the Ministry of Health, supports the understanding of the parasitological, environmental and epidemiological aspects that permeate the disease cycle. The results intend to support more effective intersectoral actions, which articulate health, environment and sanitary education.

Methodology

This is an observational, cross-sectional research with a quantitative-qualitative approach, which integrated secondary data from official health information systems with primary data obtained through environmental analysis and malacological survey. This methodological combination allowed



a broader approach to the occurrence of schistosomiasis mansoni in the municipality of Eunápolis-BA, by considering epidemiological, environmental and biological aspects of the disease cycle.

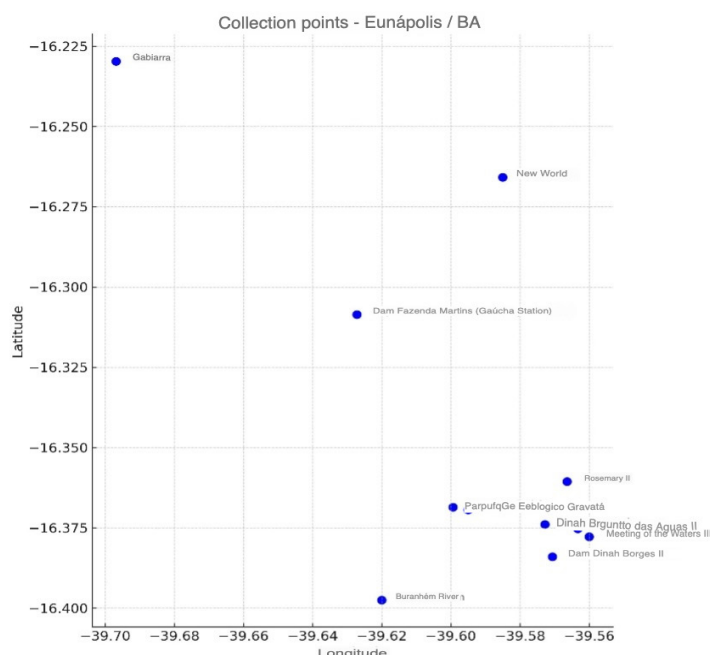
The quantitative aspect of the research was applied to the analysis of epidemiological data extracted from the Notifiable Diseases Information System (SINAN), the Primary Care Information System (SIAB), the Mortality Information System (SIM) and the Schistosomiasis Control Program (PCE), referring to the period from 2017 to 2022. These data supported the calculation of indicators such as prevalence, incidence and distribution by sex, age group and location of the notified cases of schistosomiasis in the municipality.

The qualitative component consisted of field observation and recording of the environmental and sanitary conditions of the sampled sites, allowing the characterization of risk factors not captured by the computerized systems.

The research was developed in the municipality of Eunápolis, located in the extreme south of Bahia, with a total area of 1,179.1 km², belonging to the Microregion of Porto Seguro. Eleven collection points were selected, covering urban and rural areas: Mundo Novo, Gabiarrá, Fazenda Martins Dam (Gaucha Station), Alecrim II, Dinah Borges I, Encontro das Águas II and III, Dinah Borges II Dam, Buranhém River, Colonial Park and Gravatá Ecological Park. The selection of sites was based on criteria of socio-environmental vulnerability, history of recreational use of water sources, lack of adequate sanitary infrastructure, and reports of confirmed cases in adjacent areas. The geographic coordinates of each point were recorded by GPS and mapped for territorial analysis and epidemiological surveillance purposes.



Figure 1 – Cartography of the Vector Points of Collection of the Research



Source: Field Research, 2024.

For the analysis of water quality, physicochemical and microbiological parameters were used, as recommended by Ordinance GM/MS No. 518/2004. The physicochemical variables evaluated were: turbidity, pH, residual chlorine, iron, dissolved oxygen, ammonia, hardness and alkalinity. The collection was carried out with properly sterilized polyethylene bottles, packed in thermal boxes, following the protocols described by the American Water Works Association (AWWA, 1970). The analyses were made by colorimetric comparison, with the use of Ecokit kits.

The microbiological evaluation was performed using the colipapper technique, with plates containing culture medium that were immersed in the samples and incubated in an acclimatized incubator for 15 hours, allowing the identification and counting of total coliforms and fecal coliforms per colony-forming unit (CFU/100ml). This technique was applied in loco with subsequent laboratory



support for data validation.

The malacological survey took place simultaneously with the collection of water samples. Active search was used with the use of shells and visual inspection in backwater areas, aquatic vegetation and surface sediments. According to Neves (2005), the term “malacological” refers to the study of mollusks, especially in the context of public health, to those that act as intermediate hosts of parasites of medical importance, such as those of the genus *Biomphalaria*, transmitters of schistosomiasis. The collected mollusks were taxonomically identified from morphological keys and classified according to the transmission potential of schistosomiasis. The specimens were kept in individual containers to observe the release of cercariae, although the etiological agent was not identified in the analyzed samples.

Data analysis was performed using Microsoft Excel spreadsheets, through the calculation of prevalence and incidence (expressed per 100,000 inhabitants), analysis of the relative frequency of cases by sex, age group and region, in addition to the systematization of environmental and biological results. The data were organized into tables and graphs, allowing an integrated visualization of the risk factors at the points investigated.

From an ethical point of view, the study mostly used secondary data in the public domain, available on the official platforms of the Ministry of Health, and did not imply direct risks to the privacy of individuals. However, the field activities involved environmental collection in public spaces and observation of local water use practices. Therefore, the team followed the principles of Resolution No. 510/2016 of the National Health Council, which deals with research in the Human and Social Sciences, and Resolution No. 466/2012, regarding ethics in research with human beings.

Analysis and Discussion of Results

The analysis of epidemiological data regarding schistosomiasis mansoni in the municipality of Eunápolis, from 2017 to 2022, revealed the persistence of the endemic as a chronic challenge



to local public health. Although the number of confirmed cases has fluctuated over the years, the occurrence of one death in 2020 and the maintenance of new cases until 2022 show the permanence of the active transmission cycle in the region, as also observed by Vasconcelos et al. (2023), who warn of the need for continued surveillance in areas with a history of endemic.

The distribution of cases by sex and age group indicated greater involvement among male individuals, especially in the group between 20 and 49 years old, coinciding with the findings of Lima et al. (2022), which relate this profile to greater exposure to risk environments during work activities. This pattern highlights the importance of considering the social determinants of the health-disease process, such as occupation and sanitary conditions, in line with the analyses of Carvalho et al. (2021).

The incidence of cases in urban areas of Eunápolis, such as in the Dinah Borges and Encontro das Águas neighborhoods, challenges the social imaginary that associates schistosomiasis exclusively with rural and riverside areas. According to Amaral et al. (2018), the advance of unplanned urbanization and the precariousness of basic sanitation services are factors that favor the urbanization of the disease, a reality that was also observed in the present study.

Physicochemical and microbiological analyses carried out at 11 points in the territory confirmed the presence of fecal coliforms in environments widely used for bathing and recreation. The presence of fecal coliforms in urban water bodies such as the Dinah Borges I Dam, the Meeting of the Waters II and III and the Colonial Park suggests a persistent health risk in spaces of collective use, especially for children and young people. These data confirm the absence of adequate sanitary infrastructure, as pointed out by Faria and Molevade (2008), when they associate the precariousness of sanitation with vulnerability to waterborne diseases. This finding is reaffirmed by Lima et al. (2025), who demonstrated, in a recent epidemiological analysis, the relationship between the high incidence of schistosomiasis and the lack of basic sanitation in the peripheral neighborhoods of Eunápolis, reinforcing the correlation between precarious infrastructure and continuous exposure to the parasitic cycle.

In addition to bacteriological contamination, the physicochemical parameters analyzed,



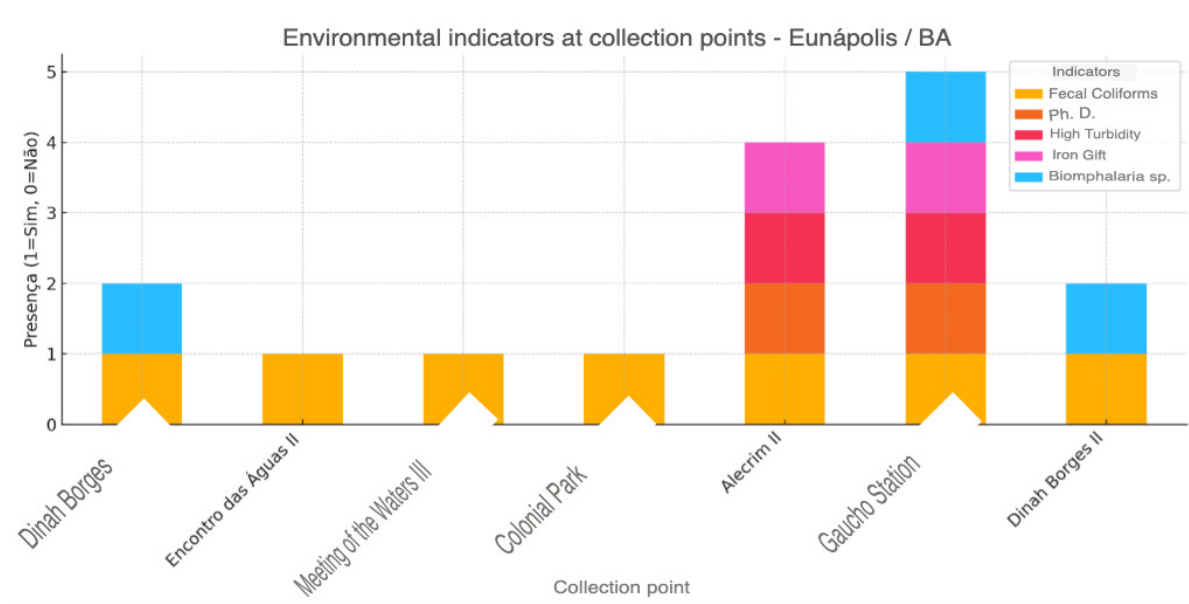
such as pH, turbidity, dissolved oxygen, and the presence of iron, revealed non-compliance with the standards established by Ordinance GM/MS No. 888/2021, especially in the samples from Alecrim II and Estação Gaúcha. These parameters indicate conditions conducive to the maintenance of suitable habitats for host mollusks, as highlighted by Souza et al. (2021), who highlight the importance of water quality in the ecology of schistosomiasis.

The presence of *Biomphalaria* sp., identified at the Dinah Borges I and II points and at the Gaucho Station, reinforces the vulnerability of these areas and the need for intersectoral control actions. In addition to the biotic and microbiological factors already discussed, the soil analysis revealed relevant environmental information to understand the distribution of *Biomphalaria* sp. in the springs studied. It was observed that the only two points with confirmed presence of the mollusk, the Dinah Borges I and II dams, share a common geological characteristic: predominantly clayey soils with a superficial sandy layer and significant presence of decomposing organic matter. This composition facilitates the accumulation of water, creates stable microhabitats and allows the burial of mollusks during periods of drought, favoring their survival and reemergence during rains

The findings dialogue with the evidence presented by Costa et al. (2019), which indicate that the mere presence of the mollusk, even without active infection, already represents an imminent risk for the reactivation of the parasitic cycle, especially in environments with recreational use of water.



Graph 1 – Environmental Indicators at the Collection Points – Eunápolis/BA



Source: Field Research, 2024.

The convergence between the presence of mollusks, microbiological contamination and the frequency of human use of water bodies in Eunápolis reveals a scenario of high socio-environmental risk. Similarly, Silva et al. (2023) demonstrated that environments where leisure practices, lack of sanitary infrastructure, and the presence of vectors coexist form critical zones for urban schistosomiasis.

Although some points, such as the Gravatá Ecological Park and the Colonial Park, do not have the presence of *Biomphalaria*, the high amount of aquatic vegetation and the decomposition of organic matter observed in these places make them ecologically favorable to future colonization, as already discussed by Souza et al. (2021). This finding points to the importance of continuous monitoring.

Another relevant aspect is the use of water by residents in vulnerable situations, especially in the Colonial Park, where practices such as bathing and washing clothes were observed, in a total absence of infrastructure. These data reinforce the argument of Faria and Molevade (2008) that equity in access to safe water is a fundamental right and a minimum condition for health promotion.



When considering the socioeconomic profile of Eunápolis, marked by significant inequalities and an illiteracy rate of 14.8% in the population over 15 years of age, according to data from the IBGE (2010), it is understood that living and working conditions contribute to the perpetuation of neglected diseases, such as schistosomiasis. This analysis converges with the understanding of Costa et al. (2019) about the social determinants of health as structuring elements of risk.

In addition, the use of contaminated natural resources as a source of supply by water trucks, identified in the Dinah Borges II Dam, reveals the fragility of public policies for sanitation and water supply in peripheral urban areas. Such use exposes entire populations to contamination by several pathogens, in addition to *Schistosoma mansoni*, as pointed out by Amaral et al. (2018).

This correlation between soil type and vector occurrence reinforces the hypothesis that the soil quality of the environment is a silent conditioning factor for the maintenance of the schistosomiasis cycle. According to data from the IBGE and the Government of the State of Bahia, the clay soils of the municipality of Eunápolis, rich in iron and aluminum, have a soft texture and high water retention capacity, creating conditions conducive to the reproduction of *Biomphalaria*. This environmental aspect, added to the low sanitation coverage, constitutes a complex risk scenario for local populations, especially in peripheral urban regions where there is greater anthropogenic pressure on water resources.

In the case of epidemiological surveillance, relevant underreporting was identified in the analyzed databases, especially in years with a total absence of formal records, which compromises the effectiveness of control actions. This operational fragility is also highlighted by Lima et al. (2022), who point to the inconsistency in SINAN data as an obstacle to the formulation of effective intervention strategies.

The cross-referencing of environmental and biological data with epidemiological records showed significant discrepancies. For example, places with critical environmental indicators, such as Alecrim II and Estação Gaúcha, have not had recent records of human cases, which may be a reflection of the absence of active search and mass coproparasitological tests, as proposed by Costa



et al. (2019).

The concept of “amplified environmental vulnerability”, used by Faria and Molevade (2008), helps to understand these contradictions, to the extent that it incorporates the socio-territorial dimension to the analysis of risks. This allows us to affirm that, in Eunápolis, there are territories silently exposed to schistosomiasis, even without the visible occurrence of outbreaks.

The literature reviewed and the data obtained converge to the understanding that the persistence of schistosomiasis in the municipality is due to the combination of ecological factors (presence of the mollusk and water quality), socioeconomic (poverty, social vulnerability) and institutional factors (failures in surveillance and public policies).

At the same time, there is divergence among authors as to the emphasis that should be given to the role of sanitation. While Faria and Molevade (2008) prioritize physical infrastructure, Costa et al. (2019) defend the centrality of health education and community mobilization as effective instruments for the transformation of risk practices.

Another point of theoretical tension identified is related to the role of recreational use of water in the spread of the disease. For Souza et al. (2021), recreation is a central factor in human-mollusk-parasite contact; for Lima et al. (2022), work activities (such as agriculture) continue to be the main routes of exposure in rural areas of the Northeast.

In summary, the findings of this study reinforce the thesis that Eunápolis is experiencing a process of urbanization of risk, marked by the overlapping of historical vulnerabilities and new territorial dynamics. This requires intersectoral responses, ranging from urban planning to environmental health actions and promotion of access to drinking water.

The integrated analysis allowed not only to identify the critical points of schistosomiasis in the territory, but also to propose a replicable approach to health surveillance that considers local singularities. This proposal is in line with the recommendations of Vasconcelos et al. (2023) on territorial models for coping with neglected diseases.

Finally, it is observed that, although the data show a reduction in the absolute number of



cases, the complexity of the factors involved points to the urgency of new prevention strategies. This includes strengthening malacological surveillance, improving information systems and, above all, valuing communities as protagonists in caring for the territory.

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