Background. Intestinal parasites are a major source of health problems in developing countries, where socioeconomic, cultural, and environmental conditions contribute in maintaining the biological cycles of various parasites and facilitating their spread [3, 4]. Furthermore, the escalation of predatory practices against the environment, compounded by detrimental aspects of political and economic frameworks, collaborates to increase the occurrence of parasitic and other diseases [5, 6].

Despite the current status of the Pantanal wetlands as a World Natural Heritage site, owing to its vast biogeographical area and great biodiversity of plant and animal species, many human residents in the region experience difficulties that hamper survival, including the absence of sanitation and healthcare services.

The aim of this study was to investigate the occurrence of enteroparasites among dwellers of three riverside communities in the Pantanal ecosystem, seeking to elucidate key epidemiological factors involved in transmission and perform educational interventions to raise awareness on enteroparasitosis prevention and environmental preservation.
2. Materials and Methods

For this analytical cross-sectional study based on primary data and benchwork research, parasitological stool tests were performed among dwellers of three riverside settlements from July 2008 to July 2009. The communities studied—Barra de São Lourenço, Paraguai Mirim, and Porto da Manga—are located on the Paraguai river in Corumbá county, Mato Grosso do Sul state. Barra de São Lourenço (17°54′00″S; 57°27′39″W) and Paraguai Mirim (21°04′54″S; UTM 7953009) can only be reached via a 250 km boat trip from Corumbá, while Porto da Manga (19°15′33.15″S; 57°14′7.13″W), 385 km away from Campo Grande (the state capital), is served by the Parque Pantanal state highway (Figure 1).

This study was part of the project entitled Crianças das Águas, Pantanal: Identidade e Cidadania [Children of the Waters, Pantanal: Identity and Empowerment], supported by the Criança Esperança Program (a privately sponsored social mobilization initiative in partnership with the UNESCO). All residents of the area were invited; a total of 196 adults and children (male and female) who voluntarily agreed to participate and provided written informed consent were enrolled in the study. Sample size ($n = 196$) was calculated in the Epi-Info version 7 program, according to the following parameters: population of 400 residents, prevalence of 50% ($\pm 5\%$), and significance level of 5%.

The project was approved by the Universidade Federal de Mato Grosso do Sul (UFMS) Committee for Ethics in Research in Humans (permit 1612). For the participation of minors (under 18), written approval was obtained from parents or guardians.

Stool samples were collected in merthiolate-iodine-formaldehyde solution, stored in suitable containers, and tested at the UFMS Laboratory of Clinical Parasitology using techniques proposed by Blagg et al. [7] (merthiolate-iodine-formaldehyde concentration) and Hoffmann et al. [8] (spontaneous sedimentation). Individuals diagnosed with pathogenic parasites were prescribed specific treatment. The educational activities consisted of lectures, a stage play presentation, and individual guidance.

The data were initially treated using descriptive statistics. Chi-squared and chi-squared trend tests were employed to detect associations between variables at a significance level of 5%. The data were keyed into in Microsoft Excel 2010 spreadsheets (Microsoft, Redmond, WA, USA) and treated using Epi-Info 7.1.14 (Centers for Diseases Control and Prevention, Atlanta, GA, USA) and BioEstat 5.3 (Sociedade Mamirauá, Belém, PA, Brazil) software.

3. Results

The study comprised 196 subjects (83 male, 42.3%; 113 female, 57.7%). Age ranged from 10 months to 88 years.

Participants reported lack of basic sanitation and garbage collection in the communities (Paraguai Mirim, $n = 110$; Barra de São Lourenço, $n = 50$; Porto da Manga, $n =$
Table 1: Distribution of subjects, by presence or absence of enteroparasites, sex, age, and place of abode (n = 196).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Enteroparasites</th>
<th>Present</th>
<th>Absent</th>
<th>P</th>
<th>PR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>84</td>
<td>74.3</td>
<td>29</td>
<td>25.7</td>
<td>(1.0383)</td>
</tr>
<tr>
<td>Male</td>
<td>57</td>
<td>68.7</td>
<td>26</td>
<td>31.3</td>
<td>1.08 (0.90–1.30)</td>
</tr>
<tr>
<td>Age range (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;40</td>
<td>16</td>
<td>94.1</td>
<td>1</td>
<td>5.9</td>
<td>1</td>
</tr>
<tr>
<td>21–40</td>
<td>22</td>
<td>78.6</td>
<td>6</td>
<td>21.4</td>
<td>1.20 (0.95–1.50)</td>
</tr>
<tr>
<td>11–20</td>
<td>23</td>
<td>79.3</td>
<td>6</td>
<td>20.7</td>
<td>1.19 (0.95–1.48)</td>
</tr>
<tr>
<td>6–10</td>
<td>34</td>
<td>72.3</td>
<td>13</td>
<td>27.7</td>
<td>1.30 (1.05–1.61)</td>
</tr>
<tr>
<td>≤5</td>
<td>16</td>
<td>50.0</td>
<td>16</td>
<td>50.0</td>
<td>1.88 (1.31–2.72)</td>
</tr>
<tr>
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<td>30</td>
<td>69.8</td>
<td>13</td>
<td>30.2</td>
<td></td>
</tr>
<tr>
<td>Place of abode</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraguai Mirim</td>
<td>80</td>
<td>72.7</td>
<td>30</td>
<td>27.3</td>
<td>1</td>
</tr>
<tr>
<td>Barra de São Lourenço</td>
<td>36</td>
<td>72.0</td>
<td>14</td>
<td>28.0</td>
<td>(1.0930)</td>
</tr>
<tr>
<td>Porto da Manga</td>
<td>25</td>
<td>69.4</td>
<td>11</td>
<td>30.6</td>
<td>1.05 (0.82–1.34)</td>
</tr>
</tbody>
</table>

PR: prevalence ratio; (1) chi-squared test; (2) chi-square test of trends. Category "no data" was excluded from statistical calculations.

Of the samples investigated, 72% tested positive for enteroparasites (65.6–78.2%, 95% CI). Eleven species were identified, comprising 79.7% protozoa (Giardia lamblia, Entamoeba histolytica/Entamoeba dispar, Entamoeba coli, Endolimax nana, Iodamoeba bütschlii) and 20.3% helminths Hymenolepis nana, Strongyloides stercoralis, Trichuris trichiura, Ascaris lumbricoides, hookworms, and Taenia sp. (Figure 2).

Among the 141 individuals infected, monoparasitism (48.2%) prevailed over cases of biparasitism (31.9%) or polyparasitism (19.9%). Infection by protozoa predominated. Entamoeba coli was the most prevalent parasite (70.2% of the 141 positive cases), followed by Endolimax nana (32.6%), hookworms (17.7%), Giardia lamblia (16.3%), Strongyloides stercoralis (6.4%), Trichuris trichiura (6.4%), Entamoeba...
A high prevalence of enteroparasites was also reported in other intestinal mucosa, and decreased absorption [3, 17]. A larval infection can lead to iron-deficiency anemia, raises concern, given their hematophagous behavior. Particularly in children, infection with pathogenic or commensal reflects the exposure of these communities to soil and water contamination and their poor hygiene habits, demonstrating that transmission and maintenance of parasitic infections are part of an interactive process involving infective agent, environment, and susceptible host.

5. Conclusion

The high positivity rate for enteroparasites detected in these riverside settlements in the South Pantanal wetlands reflects the absence of basic sanitation and poor personal and environmental hygiene habits.

This study, the first to investigate the occurrence of enteroparasitosis in riverside communities in this region, revealed the need for the implementation of effective measures in environmental and health education, as well as investment in sanitation infrastructure, to improve the quality of life of this population.

Ethical Approval

The project was approved by the Universidade Federal de Mato Grosso do Sul (UFMS) Committee for Ethics in Research in Humans: 438.257-28/10/2013.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Authors’ Contributions

Maria Elizabeth Cavalheiros Dorval participated in writing and revision of the manuscript and gave final approval of the version to be published. Patricia Vieira da Silva participated in analysis and interpretation of data and writing of the manuscript. Lucimare dos Santos Maciel participated in analysis and interpretation of data and writing of the manuscript. Ludiele Souza Castro, Paula Murat, Minoru German Higa Junior, Patricia Zerlotti, and Ana Rita Coimbra Motta Castro participated in data collection and writing of the manuscript. Elenir Rose Jardim Cury Pontes participated in analysis and interpretation of data.

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References


