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Original Research Articles

Anemia and its correlation to parasite infections in children's of riverside communities in Brazilian Amazonia: one public health problem?

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ABSTRACT

Aims: To identify the prevalence and the determinants of anemia as well as its correlation to enteroparasitosis in a population of Riverside children living at two communities at the Northeast region of Pará, Brasil.

Study Design: Population based cross-sectional and epidemiological study.

Place and duration of the study: Pharmacy College, at Federal University of Pará, and Lights in the Amazon program, between May/2013 and June/2015.

Methods: The biological material (blood) for the blood screening was chosen by a technician in clinical analysis and undergraduate students properly trained for that purposed. It was obtained through venal aspiration in a tube containing EDTA and anticoagulant. Later, these samples were taken to the Hematology Lab at the Pharmacy College of Federal University of Pará. Were considered anemia any samples with hemoglobin concentrations lower than 11 g/dL to individuals between 6 and 60 months; and lower than 11.5 g/dL to individuals older than 60 months. To determinate the presence and type of enteroparasitosis, feces samples were collected and sent to the Parasitology Lab of the Pharmacy College at Federal University of Pará, Later being subjected to the qualitative method of Lutz or Hoffman Pons and Janer. The correlation between anemia and its determinants was analyzed using PRISMA 5.0.

Results: Out of 98 children, 16 (16.32%) were anemic, out of which 14 (87.5%) were infected by parasites, 3 of them by one type and 11 by two or more different parasites. The non-anemic and infected by at least one parasite ones were 47 (47.96%). Regarding the incidence of parasites, *Trichuris trichiura* (67%), followed by *Ascaris lumbricoides* (26%), were the most prevalent. The multiple logistic regression between anemia and infection by one or multiple parasites showed significance for multiple-parasite infections ($P = .05$). The association between anemia and infection by parasites, measured by the Odds Ratio test among the four groups was statistically significant (OR: 5.21; IC 95%:1.11-24.43; $P = .05$).

Conclusion: The present study demonstrated that the incidence of anemia on the target riverside children population is still a persistent public health issue as well as the increased prevalence of enteroparasites.

9

10 *Keywords:* Anemia, Riverside children. Enteroparasitosis. Pará.

11

12 1. INTRODUCTION

13 Anemia is considered the most prevalent disease worldwide, specially its iron
14 deficiency variation, responsible for 95% of all the anemia cases.^[1] In Brazil, the iron
15 deficiency anemia is isolated the commonest of the nutritional deficiencies, presenting as a
16 final outcome the decrease in the hemoglobin blood concentration.^[2,3] It attacks mainly
17 children, women in reproductive age and pregnant ones. OMS estimates demonstrate the
18 anemia affects 54.9% of children under age 5, in Brazil.^[4] Also, most regional studies pointed
19 rates bigger than 40%.^[3]

20 The iron deficiency takes an important place in the anemia cases with
21 malnourishment as the main background. Although, some enteroparasitosis can be
22 responsible for anemia cases or for its worsening.^[5,6]

23 Due to its increased frequency in many regions of Brazil, enteroparasitosis have
24 been a public health issue.^[6] Parasites, such as *Ascaris lumbricoides*, *Trichuris trichiura* and
25 *Entamoeba sp.*, affect around one billion people, spreading across 150 countries and
26 territories, hitting around 800 million children. These parasites are considered endemic in
27 Brazil, once they spread largely across the country and present high prevalence.^[7]

28 Nutritional factors are considered the most important cause of iron deficiency
29 anemia, due to both inadequate ingest and bioavailability of iron.^[5] In children, its lack is
30 related to cognitive damage, as iron has many cerebral important functions, as mielinization
31 of neuronal fibers, energetic metabolism and acting as a cofactor for many enzymes
32 involved in neurotransmitters synthesis. The absorption of this mineral hits its maximum
33 levels during child growth.^[8] In the literature, it's well-known that iron bioavailability is as
34 important as fulfill its need. Iron presents in two forms: heme, in meat and viscera with high
35 absorption (40%) and non-heme, in cereal and vegetables with lowered absorption (10%),

36 which demand other components present in diet to increase its absorption, such as vitamin
37 C, from citric fruits.^[5,9]

38 Children are presented as the most vulnerable group to be infected by
39 enteroparasitosis once they usually do not display adequate personal hygiene and expose
40 themselves to soil and water, carriers of contaminants.^[10] Epidemiological studies in Pará
41 and Amazonas regarding enteroparasitosis occurrence and anemia cases in riverside infant
42 population are rare. This leads to difficulties in measuring this public health problem and in
43 creating means to effectively benefit these populations.^[7]

44 In this context, this study aimed to verify the prevalence and determinants of anemia as well
45 as to correlate them with parasite infections in a population of riverside children of two
46 communities from the northeast of Pará, Brasil.

47

48 **2. MATERIAL AND METHODS**

49 This is an epidemiological and cross-sectional study. The target population is
50 compounded by infant habitants of two riverside communities: Genipaúba and Furo do Aurá.
51 These communities are located in the northeast of Pará. This study was made possible by
52 the “lights in the amazon” program, a partnership between the biblical society of Brazil and
53 the Federal University of Pará. This program has volunteers developing health promotion
54 activities in riverside communities.

55 The number of interviewed families was 96 and they should have at least one child
56 fulfilling the age criteria. The sample population was calculated from the total of children
57 assisted by the program in-between 1 and 10 years old, a total of 98 individuals. The period
58 of data collection was from May/2013 to june/2015 during monthly visits to the
59 aforementioned communities. To analyze the social and economic condition of their families,
60 they were presented to questionnaire with the following items: monthly income, sanitation
61 conditions (if there is a septic tank and trash collection), water treatment and nutrition.

62 The children data was obtained through questionnaires filled by their parents or legal
63 tutors. The including criteria were: a) proper age (between 1 and 10 years old); b) being a
64 habitant of one of the two previous defined communities; c) having gotten through both blood
65 and parasites screening. The following excluding criteria were applied: a) having gone
66 through only one of the two screenings (blood and parasites); b) the sample have been
67 compromised. Due to human beings involvement, it was used an informed consent, as
68 stated in the chapter IV of CNS Resolution 196/96.^[11] This term stated about the use of
69 biological material, characteristics of epidemiological data, non-disclosure of the obtained
70 data and free will of the individuals regarding their participation on this research.

71 The biological material (blood) for the blood screening was chosen by a technician in
72 clinical analysis and undergraduate students properly trained for that purposed. It was
73 obtained through venal aspiration in a tube containing EDTA. Later, these samples were
74 taken to the Hematology Lab at the Pharmacy College of Federal University of Pará. Were
75 considered anemia any samples with hemoglobin concentrations lower than 11 g/dL to
76 individuals between 6 and 60 months; and lower than 11.5 g/dL to individuals older than 60
77 months.^[12]

78 The samples were screened by semi-automatic method, using an ABX micros 60
79 counter, running through for the following parameters: red blood cells, hemoglobin,
80 hematocrit, Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin
81 Concentration (MCHC), Redcell Volume Distribution Width (RDW) and total white blood
82 cells. To possibility the detection of any cell alteration, such as poikilocytosis, a blood smear
83 was made for each sample, using the panoptic dye, and analyzed on the optic microscope.

84 To determinate the presence and type of enteroparasitosis, feces samples were
85 collected and sent to the Parasitology Laboratory of the Pharmacy College at Federal
86 University of Pará, later being subjected to the qualitative method of Lutz or Hoffman Pons
87 and Janer (spontaneous sedimentation), aiming to detect the eggs or larvas, for the
88 helminths, and cists, for the protozoa.

The data collected through the questionnaires and screenings were stored using Microsoft Excel 2013. The correlation between anemia and its determinants was analyzed using PRISMA 5.0. The children were initially, divided in 4 groups: anemic and infected by parasites (AP); anemic and non-infected by parasites (ANP); non-anemic but infected by parasite (NAP); and non-anemic and non-infected by parasites (control group). For the statistical analysis, were used parametric tests such as the mean for blood parameters between the groups and non-parametric tests, Odds Ratio and Logistic regression, in order to verify the association and correlate anemia in the infection by parasites.

3. RESULTS AND DISCUSSION

The present study assessed 98 children, from ages 1 to 10, 47 (48%) females and 51 (52%) males. 16 (16.32%) samples displayed anemia, from which 14 (87.5%) also displayed infection by parasites, being 3 infected by one parasite only and 11 by two or more different parasites. There were 35 (35.71%) children without both anemia and parasite infection and non-anemic but infected by at least one type of parasite were 47 (47.96%). Regarding the incidence of specific parasites, the most prevalent was *Trichuris trichiura* (67%), followed by *Ascaris lumbricoides* (26%). *Entamoeba Coli* (42%) was the most prevalent, followed by *Giardia lamblia* and *Endolimax nana* displayed in 34% and 27% of the aforementioned cases, respectively. Out of the total amount of children infected by parasites, 80% were infected by more than one type of parasites. The multiple logistic regression between anemia and parasite infection displayed statistical significance only for the infection by two or more parasites ($P = .05$).

Table 1 shows the distribution of parasites by genus on children with and without anemia. Among the anemic children, 14 had parasites, most females (9) than males (5). The parasites that were most found in the screening were *T. trichiura*, 78%, followed by *E. coli*, 57%, out of all the children in this group. There was a more homogenous distribution

115 between the sexes regarding infection by parasites amongst non-anemic children (28.05% in
116 males, 29.27% in female).

117 The NAP group, the helminth *T. trichiura* was the most prevalent (64%). *G. lamblia*
118 has the second largest incidence (42%), followed by *E. coli*, 38%. By the simple logistic
119 regression test it was demonstrated a strong correlation with the parasite infection and
120 eosinophilia, which probability was 90% of children presenting an increased number of
121 eosinophils when infected by parasites.

122

Table 1. Distribution of enteroparasites according to the occurrence of anemia on riverside children. Source: Research, 2013-2015.

Enteroparasites	Anemics n (%)	Non-anemics n (%)	Total n (%)
Absence of parasites	2 (12.5)	35 (42.68)	37 (37.75)
Presence of parasites	14 (87.5)	47 (57.32)	61 (62.25)
<i>T. trichiura</i>	11 (68.75)	30 (36.58)	41 (29.28)
<i>G. lamblia</i>	1 (6.25)	20 (25.39)	21 (15)
<i>A. lumbricoides</i>	2 (12.5)	14 (17.07)	16 (11.43)
<i>E. histolytica</i>	-	2 (2.43)	2 (1.43)
<i>E. coli</i>	8 (50)	18 (21.95)	26 (18.57)
Ancilostomídeo	-	6 (7.31)	6 (4.28)
<i>I. butshilli</i>	4 (25)	6 (7.31)	10 (7.14)
<i>E. nana</i>	4 (25)	13 (15.85)	17 (12.14)
<i>E. estercoralis</i>	-	1 (1.21)	1 (0.71)

Convention: - Numerical data resultant in zero non-obtained by rounding off

123

124 The association between anemia and parasite infection, obtained by the Odds Ratio
125 test among the four groups was statistically significant (OR de 5.21; IC95%: 1.11-24.43; $P =$
126 .05). Hence, the probability of finding anemia in individuals infected by parasites was 5 times
127 higher than amongst the ones not infected, with an increase of 17.55% on relative risk.

128 The incidence of anemia and its relationship to gender and the parasite infection
129 was assessed by the multiple logistic regression test. The presence or absence of anemia

130 considering the aforementioned antecedents was significant ($P = .05$). The probability of
 131 female children infected by parasites having anemia was 27.25% while same-sex non-
 132 infected children displayed just a 7.20% probability. When it comes to male children, the
 133 probabilities were 17.9% and 4.31% among infected and non-infected children, respectively.

134 Table 2 displays the comparison between the group of children that showed blood
 135 parameters within normal values for age and sex and the other group (AP, NAP, ANP) using
 136 mean and standard deviation. There was a significant difference between the groups AP and
 137 ANP regarding the following parameters: hemoglobin, hematocrit, MCV, MCH and RDW,
 138 with $P = .05$. Among the other groups, there was no significant difference.

139

Table 2. Comparison of bloodparameters between tests groups (mean $\pm$ SD) and control group. Source: Research, 2013-2015.

Bloodparameters	Control*	AP ¹	NAP ²	ANP ³
Hemoglobin	14.4 $\pm$ 0.62	10.6 $\pm$ 1.15	12.68 $\pm$ 0.76	10.2 $\pm$ 1.41
	-	$P = .05$	N.S	$P = .05$
Hematocrit	37.68 $\pm$ 1.88	32.82 $\pm$ 2.54	38.06 $\pm$ 2.09	31.55 $\pm$ 3.6
	-	$P = .05$	N.S	$P = .05$
MCV	79.67 $\pm$ 9.58	72.95 $\pm$ 8.18	80.83 $\pm$ 8.18	65.95 $\pm$ 7.14
	-	$P = .05$	N.S	N.S
MCH	26.67 $\pm$ 1.48	23.55 $\pm$ 3.11	27.34 $\pm$ 1.69	21.35 $\pm$ 2.89
	-	$P = .05$	N.S	$P = .05$
RDW	13.19 $\pm$ 0.15	15.77 $\pm$ 2.08	13.36 $\pm$ 0.92	15.7 $\pm$ 4.38
	-	$P = .05$	N.S	$P = .05$
Red Blood Cell	4.65 $\pm$ 0.31	4.49 $\pm$ 0.26	4.62 $\pm$ 0.35	4.78 $\pm$ 0.03
	-	N.S	N.S	N.S
Eosinophils	8.37 $\pm$ 5.20	10.57 $\pm$ 5.66	10.9 $\pm$ 5.28	17 $\pm$ 5.65
	-	N.S	N.S	N.S
Neutrophils	50 $\pm$ 9.75	43.71 $\pm$ 14.78	48.86 $\pm$ 8.08	54.8 $\pm$ 11.03
	-	N.S	N.S	N.S
Lymphocytes	35.69 $\pm$ 9.11	40.21 $\pm$ 13.3	35.68 $\pm$ 7.88	30 $\pm$ 4.24
	-	N.S	N.S	N.S

*Control Group:Non-anemic and non-infected by parasites ¹Anemic infected by parasites;
²Non-anemic infected by parasites; ³Anemic non-infected by parasites; n.s: non-significant.

140 About the social and economic characteristics of the families residing at the two
 141 riverside communities, 96 families were interviewed (Table 3). Out of those, 52 (54.16%) had
 142 a family monthly income inferior than the minimum wage, 37 (38.54%) within one and two
 143 minimum wages, 4 within 2 and 3 minimum wages and only 3 (3.12%) above 3 minimum
 144 wages. The low income reflects the substandard sanitation, out of which only 17.70% of the
 145 houses had a septic tank. The water obtained for consumption and cooking would come
 146 straight from the river (37.5%) without any previous treatment and through other forms such
 147 as: well (14.58%) and bigger solid particles filtration 19.79%. Only 9.37% of those families
 148 would put the water through boiling and 13.54% through chemical treatment with sodium
 149 hypochlorite. These two procedures match the best water treatment against enteroparasites.
 150 Still, on Table 3, there is food intake habits data for the families.
 151

Table 3. Social, economic and nutritional characteristics of two riverside communities' families from Northeast of Pará. Source: Research, 2013-2015.

Variables	N (96)	(%)
Family Monthly Income		
Less than the minimum wage	52	54.16
Within 1 and 2 minimum wages	37	38.54
Within 2 and 3 minimum wages	4	4.16
Above 3 minimum wages	3	3.12
Form of obtaining water for consumption		
Straight from the river	36	37.5
Boiled	9	9.37
Filtered	19	19.79
Well	14	14.58
Chemically treated with Sodium hypochlorite	13	13.54
Others	5	5.21
Septic tank		

Yes	17	17.70
No	79	82.39
Trash collection		
Burnt	82	85.42
Thrown at the woods	9	9.37
Thrown at the river	5	5.21
Main food intake		
Fish	84	87.5
Chicken	70	72.9
Pork	14	14.58
Bovine meat	70	72.9
Eggs	46	47.91
Shrimp	47	48.95
Dried Meat	55	57.29
Beans	78	81.25
Rice	76	79.16
Açaí	96	100
Citric Fruits	44	45.83

152

153 The prevalence of anemia was 16.32%. Oliveira *et al.* (2011), assessing the prevalence of
 154 anemia on children from 6 to 59 months old at the North region of the country, city of Jordão,
 155 noticed a 57.3% prevalence. Gama *et al.* (2009), verifying the prevalence of anemia and its
 156 correlation to parasite infections on riverside children from 6 months to 12 years old at the
 157 Medium Solimões, state of Amazonas, confirmed a 63% prevalence of anemia.^[14] Out of all
 158 studies about prevalence of anemia in the North region, Muniz *et al.* (2007). Verified a 30.6%
 159 prevalence of anemia on children younger than 60 months old at urban area of Assis Brasil
 160 and Acrelândia.^[15]

161 Making comparisons between this and other studies, its notable it presented a low
 162 incidence of anemia. This result matches with the estimates of low anemia prevalence
 163 publicized for Brazil, from data out of the National Research for Demographics, Women and
 164 Children Health (PNDS, in Portuguese) which hit the 20.9% mark. Although, compared to

the estimates to the Northe region, it has been observed that the results of this study were higher than those estimates.^[16] On the other hand, PND5 results do not discriminate specific situations according to the epidemiologic context, specially, regarding this region which is the focus of just a few studies about the prevalence of anemia on the infant population.^[13,17]

Comparing the blood parameters, it showed lower hemoglobin, hematocrit, MCV and MCH values than the reference values for the age group on focus. 86% presented microcytic anemia. Osório (2002) stated this type of anemia is characteristic of iron deficiency and display the most advanced stage of hyposiderosis, the occurrence of lowered levels of hemoglobin and low values for hematocrit, changes in blood cell morphology, which present themselves as microcytic and hypochromic, leading to a abnormal oxygen transportation.^[5]

In the present study, due to resource limitations, it was not possible to apply tests to determine the iron concentration, which could distinguish amongst microcytic and hypochromic anemia due to iron deficiency or to thalassemia.^[2] Although, the heterogeneity of the red blood cells in the group of children which presented microcytic and hypochromic anemia helps to make the difference between the iron deficiency and thalassemia backgrounds, since this last one has homogenous small red blood cells.^[18] Amongst the determinants for microcytic and hypochromic anemia are some parasites which can lead to a lowered absorption of the iron from food intake in about 20%.^[19]

From the children with this type of anemia, 78% were infected by *T. trichiura*. This parasite usually leads to bleedings by causing a lesion on the intestinal mucosa. In severe infection scenarios, this could lead to anemia.^[20] This results suggest that the infection by *T. trichiura* could have been a risk factor for microcytic/hypochromic anemia (or iron deficiency anemia). Even though quantitative tests to determine the parasite loads were not performed, this parasite usually shows high load during the infection.^[20] In association with a low iron intake, this infection could have developed into anemia on the riverside children population.

Hence, there is a correlation ($P = .05$) between anemia and the presence enteroparasitosis. Cantos *et al.* (2003) confirmed an association between anemia and parasite infections since 11% of their patients presented microcytic and hypochromic anemia when infected by enteroparasites. In addition, 87.5% of the anemic individuals were infected by parasites.

In a similar study, Gama *et al.* (2009) demonstrated a very alike prevalence with 88.8% of anemic children being infected by parasites.^[14] Oliveira & Amor (2012) presented a 74.6% prevalence of anemia and parasite infections in a rural community at Araci.^[21] It is evident that the similar results between these studies regarding the relationship between parasites and anemia suggest a direct correlation among them.

Even though the factors, causes and consequences involved are not very clear, the enteroparasitosis for helminths and protozoa is considered a risk factor to be taken in relevance on the development of anemia and worsening of it, specially, when it has a nutritional background.^[14]

The results regarding the incidence of anemia and its correlation with gender and the enteroparasitosis were significant ($P = .05$). In the present study, female children infected by parasites showed a 27.25% probability of having anemia while male children in the same conditions had a 17.9% probability. In similar studies developed in the Southeast region of Brazil, it was noticed female children are more prone to be infected by enteroparasites than male ones.^[22]

Regarding the incidence of enteroparasites on the riverside children, 62% were infected. These results are similar to other epidemiological studies developed in Brazil.^[23] Silva *et al.* (2014) observed, in studies developed in Igarapé-Miri, state of Pará, *Ascaris lumbricoides* (55.5%) and *Trichuris trichiura* (24.07%) as the most prevalent helminths, and *Giardia intestinalis* (35.18%) as the most prevalent protozoan in the population.²³ Santos *et al.* (2010) studied the prevalence of enteroparasitosis on riverside children from Coari, Medium Solimões, state of Amazonas. *A. lumbricoides* and *T. trichiura* appeared as the

most helminths amongst that population, 66.3% and 16.3%, respectively; while *Entamoeba coli* (35%) and *Giamblia lamblia* (6%) appeared as the most common protozoa.^[7]

It is important to highlight the increased presence of *T. trichiura* infection amongst the youngest such as the high prevalence of enteroparasites. Personal hygiene and cooking habits as well as the consumption of those, considering the main form of infection for those parasites is the fecal-oral way. Furthermore, the location and environment in which these communities are inserted, hot weather, gritty soil and poor sanitation ease the biological cycle of this parasite.^[7,23]

A major factor that should be considered is the parasites load and its correlation with the clinic manifestations of anemia. According to Araújo *et al.* (2011), developing anemia depends on a series of variables such as parasite species, duration of the infection, internal iron stocks, bioavailability, iron needs and parasites load, also taking in relevance the species and associations with other parasites.^[10,24] Considering the infant nature of the analyzed population, the intensity of complications is stronger as an elevated parasites load could cause a decrease in the nutrient absorption, increased catabolism and sequestration of nutrients that are required for normal tissue synthesis and growth.^[25] Research on malnourished children showed a significant higher load of parasites and gravity of the disease when compared to well-nourished ones.^[25]

In this population, there was statistical relevance for infection for multiple parasites ($P = .05$), with 78% of anemic individuals being infected by two or more parasites. The multiple-parasite infection, according to Ezeamama *et al.* (2008) in Leyte, Phillipines, represented an increased risk of anemia in children. It suggest that these parasites could interact synergistically even in different anatomic sites.^[26] This could be due to the immune competition between the parasites which could depress the immune system, reduce the number of cells that control hemoglobin levels and leading to eosinophilia, for example.^[14,27]

In an infected person, the eosinophilia can be expressed as an immune response to a parasitic infection, especially against helminths.^[26] In the present study, there was a high

245 prevalence of eosinophilia in children infected by parasites, about 90%, although some
246 children also presented eosinophilia without being infected by parasites. This could be
247 explained by the multifunctional role of these cells in response to asthma, inflammatory
248 processes, allergic reactions and gastric disorders.^[29]

249 Many studies demonstrated a strict relation between the infestation by and
250 transmission of parasites and social/economic conditions and sanitation conditions, defining
251 a challenge to provide to these communities adequate sanitation, information and access to
252 healthcare services.^[7,10,23]

253 Concerning the family income factor, 54.16% of the families would receive less than
254 or one minimum wage, exposing a disparity between these results and Silva *et al.* (2014),
255 which displayed 72.5% of the analyzed population in Igarapé-Miri, state of Pará, within those
256 income limits.^[23]

257 Regarding the sanitation criteria, the existence of septic tanks, despite being low,
258 still is very higher than the numbers from Igarapé-Miri (2.4%) and similar results to the study
259 developed by Santos *et al.* (2010) in Coari (15.06%).^[7,23] Even though most communities use
260 water from the river, the treatment given to it is different. Santos *et al.* (2010) points 92.17%
261 of the analyzed families applying no treatment to the water. Although the present study
262 observed 42.7% of the families applying some treatment to the water before its consumption.
263 In this context, amazon riverside groups are more vulnerable to enteroparasitosis on its
264 different gravities, producing disease and worsening of other scenarios, due to their low
265 social and economic level, bad sanitation conditions and water quality.^[7,23]

266 According to Osório (2002) low income groups are more prone to a monotonous
267 diet, rich in cereals and grains such as beans and poor in meat and vitamin C sources (citric
268 fruits). Because of this, associated with a low iron intake, there is a lower consumption of
269 bioavailable iron.¹⁵ On both communities targeted by the present study a trend on the other
270 hand was observed. Families would likely feed on animal meat and less likely on vegetables
271 and grains. Then, it is suggested that the reasoning behind the iron deficiency anemia on

amazon riverside children is that the described feeding patterns do not match their own or that the mentioned foods are not always available at the families' houses.

274

275 **4. CONCLUSION**

276 The present study demonstrated that the incidence of anemia on the observed
277 riverside children population, despite being lower than other results from other studies, still
278 persists as a public health issue. Caused by difficulties in accessing healthcare services by
279 these populations, the clinic and laboratorial investigations become very limited. Therefore,
280 identifying risk factors, such as the parasite infections, in causing or worsening anemia
281 displays as a very relevant matter.

282 The obtained results may contribute to leading actions aiming preventing and
283 treating anemia on infant population from these communities. The location of coastal
284 communities of the state of Pará found along river banks makes it difficult access to health
285 services located in urban centers. It is suggested developing public policies regarding
286 infrastructure, adequate sanitation, correct water treatment, nutritional followe-ups, basic
287 healthcare and educational programs, respecting the social and cultural aspects of these
288 communities and aiming to stop the cycles of transmitting-infection of these enteroparasites.

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290

291 **CONSENT**

292 All authors declare that 'written informed consent was obtained from the patient (or other
293 approved parties) for publication of this case report and accompanying images. A copy of
294 the written consent is available for review by the Editorial office/Chief Editor/Editorial Board
295 members of this journal.

296

297 **ETHICAL APPROVAL**

298 All authors hereby declare that all experiments have been examined and approved by the
299 appropriate ethics committee. The research protocol was analyzed and approved by Ethics
300 Committee for Human Research of the Institute of Health Sciences of Federal University of
301 Pará, in november 09th, 2014, according to the number of protocol 156/08 CEP-ICS/UFGA.

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