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Socioenvironmental and nutritional factors associated with *Schistosoma mansoni* infection among schoolchildren in a public-school at south of Espírito Santo, Brazil

Factores socioambientais e nutricionais associados à infecção por Schistosoma mansoni entre crianças em idade escolar numa escola pública do sul do Espírito Santo, Brasil

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ABSTRACT
Introduction: Schistosomiasis mansoni is a neglected tropical disease that still needs adequate efforts for its control. This study investigated the factors that may been corroborating to *Schistosoma mansoni* infection amongst scholar children living in Alegre, Brazil. Methods: A school-based transversal study was conducted with 55 schoolchildren aged 6-10 years enrolled in one full-time municipal school at Alegre-ES. All participants were evaluated by food quality consumed classified according to School Child Diet Index - Ales Index and by anthropometric parameters of nutritional status. A parasitological survey was performed in stool samples from children that accepted to bring them to the school. Results: Ales Index revealed 70.91% (39/55) low-quality feeding, 10.91% (06/55) intermediate-quality feeding and 18.18% (10/55) good-quality feeding. An overall of 3.64% (02/55) malnutrition, 3.64% (02/55) obesity, 9.09% (05/55) overweight and 83.64% (46/55) normal weight were verified by body mass index (BMI)/age. Height/age revealed 5.45% (03/55) short stature-for-age and 94.55% (52/55) adequate stature-for-age. Parasitological survey showed 4.0% (01/25) of children infected with both *S. mansoni* and *Ancylostoma duodenale* and another child (01/25) positive only to *A. duodenale*. There were associations between BMI/age and food quality ($P < 0.05$); intestinal polyparasitism and schistosomiasis mansoni ($P < 0.05$) and between the absence of sewage network with the occurrence of *S. mansoni* infection ($P < 0.05$). Conclusion: *S. mansoni* infection still needs to be controlled by efforts that improve environmental safety and may include the access to good-quality feeding and adequate hygienic sanitary conditions, even in areas considered as low endemicity to schistosomiasis mansoni in Brazil.

Keywords: *Schistosoma mansoni*, nutritional status, food quality, intestinal polyparasitism, schoolchildren.

RESUMO
Introdução: A esquistossomose mansônica é uma doença tropical negligenciada que ainda necessita de esforços adequados para o seu controlo. Este estudo investigou os factores que

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podem estar a corroborar a infecção por Schistosoma mansoni entre as crianças académicas que vivem em Alegre, Brasil. Métodos: Foi realizado um estudo transversal com 55 crianças com idades compreendidas entre os 6-10 anos matriculadas numa escola municipal a tempo inteiro em Alegre-ES. Todos os participantes foram avaliados pela qualidade dos alimentos consumidos classificados de acordo com o School Child Diet Index - Ales Index e por parâmetros antropométricos do estado nutricional. Foi realizado um levantamento parasitológico em amostras de fezes de crianças que aceitaram trazê-las para a escola. Resultados: O Índice de Ales revelou 70,91% (39/55) de alimentação de baixa qualidade, 10,91% (06/55) de alimentação de qualidade intermédia e 18,18% (10/55) de alimentação de boa qualidade. Um total de 3,64% (02/55) de subnutrição, 3,64% (02/55) de obesidade, 9,09% (05/55) de excesso de peso e 83,64% (46/55) de peso normal foram verificados por índice de massa corporal (IMC)/idade. Altura/idade revelou 5,45% (03/55) de baixa estatura por idade e 94,55% (52/55) de estatura por idade adequada. O inquérito parasitológico revelou 4,0% (01/25) de crianças infectadas com S. mansoni e Ancylostoma duodenale e outra criança (01/25) positiva apenas para A. duodenale. Houve associações entre IMC/idade e qualidade alimentar ($P < 0,05$); poliparasitismo intestinal e esquistossomose mansoni ($P < 0,05$) e entre a ausência de rede de esgotos com a ocorrência da infecção por S. mansoni ($P < 0,05$). Conclusão: A infecção por S. mansoni ainda precisa de ser controlada por esforços que melhorem a segurança ambiental e podem incluir o acesso a uma alimentação de boa qualidade e condições higiénicas adequadas, mesmo em áreas consideradas de baixa endemicidade à esquistossomose mansoni no Brasil.

Palavras-chave: esquistossoma mansoni, estado nutricional, qualidade alimentar, poliparasitismo intestinal, crianças em idade escolar.

1 INTRODUCTION

Schistosomiasis (Schistosoma spp) is a waterborne parasitic worm infection that affects over 200 million people worldwide, and more than 700 million people live at risk of acquiring the disease in tropical and sub-tropical endemic areas[1,2]. Approximately more than 90% of the cases occur in the poorest regions of Africa and this percentage also includes the cases of Asian Schistosomiasis in China, the Philippines, and Southeast Asia[3]. An additional 25 million cases occur in the Americas, primarily in Brazil, which has the largest endemic area and accounts for 95% cases of schistosomiasis mansoni from this continent[4,5]. Unlike the soil-transmitted helminths, which are nematodes, the schistosomes are a type of flatworm, also known as a trematode or fluke. As adult worms, schistosomes live in the bloodstream (and are known as blood flukes), where they release eggs armed with a spine that produces serious disease in either the urinary tract or in the intestine and liver, depending on the particular species of parasite[3]. There are mainly three species that can infect humans and *Schistosoma mansoni* (*S. mansoni*) is the specie present in the America continent among human infections[6,7]. Humans acquire schistosomiasis by direct contact with the larval stages (known as cercariae) that swim in freshwater. Prior to becoming

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cercariae, the immature developing and reproducing forms of these parasites spend a part of their life history living in various species of aquatic snails[3]. In Brazil, 10 species and one subspecie of *Biomphalaria* are recognized, out of them *B. glabrata, B. tenaghophila* and *B. straminea* are found naturally infected with *S. mansoni*[8]. Particularly at south of Espírito Santo state, where is geographically located the city of Alegre, the Schistosomiasis Control Program (PCE) has been notifying the snail host specie *B. tenagophila* infected by *S. mansoni*[9]. According to Almeida et al.[10] *B. tenagophila* was found infected with *S. mansoni* in an average infection rate of 7.7% in the district of Anutiba, Alegre municipality.

Considering that human beings acquire schistosomiasis through freshwater contact with free-swimming cercariae, poor rural populations whose everyday activities involve fishing, bathing, or swimming in schistosome-contaminated waters are at the highest risk of infection[3,11]. Thereby, several countries worldwide have also been extensively studied the socio-economical status and its correlation with schistosomiasis[12]. The knowledge on specific, local features of water contact that determine schistosomiasis infection, as well as the habits and characteristics of local populations have regarding the disease, are essential to provide support on elaborating control strategies involving local communities[7,13]. Since schistosomiasis (*Schistosoma* spp.) is an intestinal parasitic infection that also causes anaemia, stunted growth, impaired cognition and decreased physical fitness[7], the evaluation of nutritional status and feeding quality together with the stool survey, besides recognition of local people social behavior, are important to improve the control strategies in areas monitored by Schistosomiasis Control Program (PCE).

In order to improve the control of schistosomiasis mansoni incidence, the present study aimed to evaluate the risk factors associated with *S. mansoni* infection amongst school-age children enrolled in one municipal school located in a low endemicity area monitored by Schistosomiasis Control Program (PCE) at south of Espírito Santo, Brazil.

2 METHODS

2.1 STUDY AREA

This study was carried out in the municipality of Alegre, at south of Espírito Santo state located in the southeast region of Brazil. The municipality of Alegre is characterized by a hot and rainy climate in the summer and dry in the winter, with average annual temperature of 22.2 degrees Celsius, varying between 16.9 to 29.0 degrees Celsius. Alegre presents a very rugged and elevated territory, and shallow mineral soils can be found. The

municipality is endowed with a vast and dense hydrographic network, having as predominant biome the Atlantic Forest and its main river is the River Itapemirim. Local economy is based on agriculture and according to the most recent national census by the Brazilian Institute of Geography and Statistics[14], the municipality had a population of 30,768 in 2010, of whom 16,179 (52.6%) lived in the urban area of the host city. The Schistosomiasis Control Program is active in the region and has already notified the *B. tenagophila* as the main host snail specie for *S. mansoni* in the municipality[9].

2.2 STUDY DESIGN AND TARGET GROUP

The current study was a descriptive and exploratory cross-sectional survey, carried out at 2012-2013 to evaluate the nutritional and health conditions of children from one public-school setting. All schoolchildren enrolled in one full-time public school of fundamental education (primary + lower secondary) located in an urban area of Alegre, Espírito Santo, Brazil, were considered for the study. All schoolchildren aged 6-10 years who agreed to participate and whose parents gave written informed consent were eligible for inclusion into the study. A parasitological survey was also conducted in those schoolchildren that accepted to provide their stool samples.

2.3 SOCIOECONOMIC AND HYGIENIC-SANITARY EVALUATION

Socioeconomic and hygienic-sanitary data were obtained through a structured questionnaire answered by parents or guardians during parents' meetings at the school. The occupational activity of parents or guardians of the schoolchildren, the existence of sewage network, treated water and water filter inside household were evaluated, besides the occurrence of diarrhea in the month prior to the study and the existence of previous treatment for anaemia and intestinal parasites (worms) in the last year prior to the study.

2.4 FOOD CONSUMPTION ASSESSMENT

The food consumption assessment was performed applying a food frequency questionnaire to the parents or guardians of the schoolchildren. Food information was obtained from a food frequency questionnaire (FFQ) with 18 food items, based on studies conducted in Brazil with children or adolescents[15,16]. The intake of the main nutrient-rich foods related to the low infant development was verified through an index entitled School Child Diet Index (ALES Index), which was previously described to assess diet quality

taking in consideration the nutritional recommendations for the brazilian population and the habit of having breakfast[17].

2.5 NUTRITIONAL ASSESSMENT

The anthropometric parameters weight and height were measured to analyze the nutritional status of all school-age children included in the study. The weight was measured only once by means of a Tanita® digital scale. Weight was computed in kilograms for the calculation of Body Mass Index (BMI). Height was measured to the nearest 0.1cm using a stadiometer (Altura Exata®). The BMI of each schoolchild was acquired according to the calculus: BMI = Weight / Height². The nutritional status was classified through the indicators body mass index by age (BMI-for-age) and height by age (stature-for-age), according to the curves of World Health Organization[18].

2.6 STOOL SURVEY

Parasitological diagnosis was carried out through the quantitative method Kato-Katz[19] and by the qualitative method of Hoffman spontaneous sedimentation[20]. The stool diagnosis was performed mainly for *S. mansoni*, but also to identify eggs from the others soil-transmitted helminths *Ascaris lumbricoides*, *Trichuris trichiura*, *Necator americanus*, *Ancylostoma duodenale* and for eggs from the protozoan *Giardia lamblia*. The survey involved the distribution of stool containers at schools and sample collection on the next day. Stool samples were prepared by qualitative method of Hoffman spontaneous sedimentation and immediately followed for the glass blades exams. The blades prepared for the Kato-Katz test were left at room temperature for 24 hours and examined the next day under an optical microscope. For quality control purposes, all slides prepared by Kato-Katz were also examined by two experienced microscopists which were working at PCE from the municipality of Alegre-ES and discussed in the event of discrepancy[21].

2.7 DATA MANAGEMENT AND ANALYSIS

Categorical variables were expressed as frequencies and percentages with 95% CI, such as the presence of more than one specie of intestinal parasites (intestinal polyparasitism), the presence of eggs from *S. mansoni*, diet quality (low, intermediate and good-quality feeding), nutritional status (low BMI-for-age or malnutrition, eutrophy or normal weight, overweight, obesity, short stature-for-age and adequate stature-for-age), the

level of parents' education, the existence of sewage network, treated water and water filter inside household, as well as the occurrence of diarrhea in the month prior to the study and the existence of previous treatment for anaemia and intestinal parasites (worms) in the last year prior to the study. Data analysis was based on Qui-square test to assess the existence of association between either food quality and *S. mansoni* infection with the categorical variables evaluated. Data were analyzed by *GraphPad Prism* with the assumption that *P*-values below 5% indicate statistical significance.

2.8 ETHICAL CONSIDERATIONS

The research project including all study protocol was approved by the Ethics Committee of North University Center of Espírito Santo from the Federal University of Espírito Santo− CEUNES/UFES (protocol Nº. 41/2012). All experiments were performed in accordance with the human experimental guidelines of the Brazilian Ministry of Health and the Declaration of Helsinki.

Before the study began, parents and guardians of the children were invited to attend a meeting at school, where they were informed about the goals and procedures of the study and how it would benefit their children, as well as the freedom to withdraw from the study at any time without detriment. Once informed and satisfied as to the terms of the study, they were asked to sign a declaration of free and informed consent to their child's inclusion in the study. It was made certain that the participants understood this information and gave their assent freely. The parents or guardians were also informed that, in case of any concern or doubt, they could contact the principal investigator, or the Ethics Committee, whose addresses and phone numbers were provided in the declaration of informed consent.

3 RESULTS

3.1 STUDY ADHERENCE, SOCIOECONOMIC AND HYGIENIC-SANITARY CONDITIONS

There were 89 schoolchildren (mean age: 8.2 years; 95% CI: 7.9 years–8.6 years) enrolled at October of 2012 in the municipality full-time school of fundamental education evaluated in this study; 48.3% (95% CI: 41.1%-62.3%) were females and all of them aged 6 to 10 years. From the overall enrolled schoolchildren, 55 (61.8%; 95CI: 51.5%–72.1%) were analyzed by anthropometric nutritional status, feeding consumption quality, socioeconomic and hygienic-sanitary conditions. Amongst these 55 children, 25 (28.1%;

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95CI: 18.6%–37.6%) also adhered for the parasitological survey; the remaining refused to be tested or were absent during stool collection.

Table 1 shows the frequencies, percentages and respective confidence intervals of occupational activity from parents and/or guardians and the water hygienic-sanitary conditions available inside household. It was observed that the majority of parents' occupational activity required low school levels, such as 40% of jobs like housekeepers amongst the mothers, 18.2% of bricklayers and 23.6% of jobs not surely lifelong or even the others 23.6% not reported by fathers who hadn't been living together with the family. The present study also verified the existence of precarious conditions of basic sanitation and hygiene in the life environment from children evaluated, since it was reported 23.6% of household with the absence of water filter inside them and others 10.9% without sewage network (Table 1).

3.2 FOOD CONSUMPTION AND NUTRITIONAL STATUS

An intake of foods related to infant development was verified through an index entitled ALES – School Child Diet Index, followed by the stratification of feeding as low-quality, intermediate-quality or good-quality. There was 70.91% (39/55) of the schoolchildren presenting low-quality feeding, 10.91% (06/55) with intermediate-quality feeding and 18.18% (10/55) demonstrated a good-quality feeding (Fig. 1). According to these results, the majority of schoolchildren presented a low-quality feeding characterized by an absence of daily consume of vegetables, fruits, beans, milk and natural juice, besides the constant consumption of sweets, industrialized biscuits and soft drinks.

To verify if the feeding quality could interfere with nutritional aspects and health conditions of schoolchildren, anthropometric parameters were measured, as well as the collection of data about the previous occurrence of treatment for anaemia and intestinal parasites (worms). The anthropometric parameter body mass index (BMI)/age revealed 3.64% (02/55) of malnutrition, 3.64% (02/55) of obesity, 9.09% (05/55) of overweight and 83.64% (46/55) of normal weight. Moreover, the parameter height/age verified an overall of 5.45% (03/55) of short stature-for-age and 94.55% (52/55) of adequate stature-for-age. Regard to the existence of previous treatment for anaemia and intestinal parasites (worms) in the last year prior to the study, it was verified that 29.09% (16 of the 55 schoolchildren) performed the treatment for anaemia and 67.27% (37/55) of the schoolchildren fulfilled the

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treatment for intestinal parasites. The occurrence of diarrhea in the month prior to the study was reported by 9.09%, or 5 of the 55 schoolchildren.

Table 2 shows the results of analysis between the association of Ales Index with the anthropometric parameters of nutritional status and health basic conditions, like as diarrhea occurrence and previous treatment for anaemia or worm infections. A significant association between BMI/age and Ales Index was verified ($P < 0.05$), implying that the quality of feeding interfered with the nutritional status of schoolchildren measured by BMI/age. However, there were not associations amongst Ales Index with height/age and either with diarrhea occurrence and previous treatment for anaemia or worm infections, even though most of the children presented poor quality of food (70.91%) due to inadequate intakes of foods rich in micronutrients necessary for growth and immunological development during school-age.

3.3 STOOL SURVEY

Diagnosis for schistosomiasis mansoni and polyparasitism were performed in stool samples from 25 of 55 schoolchildren whose nutritional status and feeding quality were previous evaluated. Figure 2A shows the results of stool exams performed by Hoffman technique and Figure 2B shows the results of diagnosis realized by Kato-Katz. Hoffman method revealed the presence of schistosomiasis mansoni in 4.0% (01/25) of children (Fig. 2A) and Kato-Katz showed that 8.0% (2/25) of school-age children presented ancylostomiasis (Fig. 2B). Moreover, one schoolchild (01/25) showed the occurrence of polyparasitism by either eggs of *S. mansoni* and *A. duodenale*, whereas another child (01/25) revealed positive stool sample only to *A. duodenale* (Fig. 2C).

In order to analyze the nutritional and socioenvironmental factors probably related to the occurrence of *S. mansoni* in the area evaluated, analysis of associations was tested between schistosomiasis mansoni and nutritional status as well as food quality, intestinal polyparasitism and hygienic-sanitary conditions measured by sewage network, treated water and water filter inside household (Table 3). Although both schoolchildren with stool positive samples to intestinal parasites including *S. mansoni* had also presented low-quality food verified by Ales Index, schistosomiasis mansoni was not associated with the quality of food. Additionally, the same two schoolchildren positive for intestinal parasites presented normal nutritional status evaluated by anthropometric parameters, corroborating with the inexistence of associations between schistosomiasis mansoni with either BMI-for-age and

height-for-age (Table 3). In turn, there was an association ($P < 0.05$) between schistosomiasis mansoni and co-infection with the hookworm *A. duodenale*, or intestinal polyparasitism. Another association ($P < 0.05$) was verified amongst the *S. mansoni* infection and the absence of sewage network (Table 3).

4 DISCUSSION

Socioenvironmental and host factors studies are important for elucidating the dynamics of *S. mansoni* transmission foci, since even low endemic areas have biological, ecological, social, and economic characteristics that may affect the natural rates of disease incidence [22]. Notwithstanding the present study was conducted in an urban area considered as low endemicity to schistosomiasis mansoni and revealed considerable positive surveys either for *S. mansoni* and *A. duodenale*. The area studied includes a social and environmental scenario that is conducive to the formation/maintenance of potential schistosomiasis transmission foci and it was no surprise that one schoolchild with positive stool sample for *S. mansoni* presented no access to sewage network inside home. Additionally, both two children positive to ancylostomiasis did not present water filter inside household confirming that the precarious nature of basic sanitation are essential for understanding these results.

Adequate education of parents or guardians are also important to the development of health education for the overall family and to improve the hygienic-sanitary conditions. The low adherence of schoolchildren to the stool survey verified in this study may be due to the embarrassment at having to hand over stool samples in the presence of classmates. Moreover, the high absenteeism on the day of stool collection sometimes reflects the precarious knowledge of their parents about the importance of conducting health exams. Previous studies showed that child development is influenced by the environmental and socioeconomic conditions during childhood[23-25]. Precarious conditions of basic sanitation and hygiene amongst schoolchildren have unleashed a greater risk to the development of chronic malnutrition, mainly due to the greater propensity to acquire infectious diseases and other serious clinical disorders[26].

The relative influence of the occupational activity of parents and family income are socioeconomic factors important to understand the access to education and adequate hygienic-sanitary conditions as well as good quality of food during scholar-age life. Income has been a determining factor for the purchase of foods rich in nutrients essential to the development and growth of brazilian children. In general, families with low-incomes

consume more food with sources of energy that are low in protein and micronutrients, influencing children nutritional status and leading them to greater vulnerability of infections[27]. Our data confirmed these findings since parents or guardians presented occupational activity commonly attributed to low incomes and most of the children had evidenced consume of foods classified as low-quality according Ales Index.

The poor quality of food may be due to either low quality as its frequency of consumption, leading to impairments in child development and more susceptibility to infections. Similarly, the consume of low-quality food was also more verified amongst schoolchildren from São Luiz-MA, Brazil, which them presented high consumption of sugars and fats, more consumption of soft drinks instead of natural juices and low intake of vegetables and fruits that are rich sources of vitamins and minerals[28].

An anthropometric analysis conducted with children aged 6 to 10 years from a municipal school in Belo Horizonte-MG, Brazil, showed a significant association between eutrophic nutritional status and good-quality feeding, since among the 72.4% of eutrophic children evaluated, 93.5% of them had a habit of consuming fruits and vegetables normally[29]. The authors also observed a small prevalence of low height-for-age according to expected limits for adequate conditions of feeding, health and nutrition[29]. These data differ from the highest prevalence of low-quality food observed in the present study, although more than 80.0% of school-age children were also eutrophic according anthropometric parameters. In turn, Neves et al.[30] verified similar levels of nutritional status amongst primary schoolchildren of a school in Belém-PA, Brazil, with 7.8% of short stature-for-age and 83.3% of adequate stature-for-age. In addition, the parameter weight-for-age also detected a higher proportion of eutrophic (88%) than malnourished (0.9%), overweight (3%) and obesity (4.4%)[30].

In the present study, there was not evidenced association between food quality and occurrence of anaemia, as well as to clinical occurrence of diarrhea, even in the presence of a high daily consumption of foods generally attributed to diarrhea, such as sweets and cookies. Meanwhile, a study carried out with children from public day care centers in Campina Grande-PB, Brazil, showed that high daily consume of vegetables and fruits was attributed to lower occurrence of diarrhea[31]. In the present study, the occurrence of diarrhea in the month prior to the study was not associated to the poor-quality food, suggesting that others factors might be attributed to the etiology of the 9.1% of diarrhea described, like as the infection by some intestinal parasites. According to Muhsen & Levine[32], enteroparasites,

mainly *G. lamblia*, are abler to develop diarrhea than the daily consumption of foods with high amounts of sugar and fat.

The low occurrence of diarrhea in the present study, as reported by only 9.1% of the schoolchildren, together with the high report of previous treatment for anaemia (29.1%) and worms (67.3%) is suggestive to the concept that the most likely intestinal parasite infections found in the schoolchildren evaluated may be more related to anaemia due to the exfoliative character of many helminths, such as *S. mansoni*, when compared to diarrhea commonly seen in intestinal infections by the protozoan *G. lamblia*. According to Brito et al.[33] the occurrence of anaemia was associated with both iron deficiency and intestinal helminths infections amongst schoolchildren from Jequié-BA, Brazil.

In the present study, the diagnosis of only 4.0% (1/25) shistosomiasis mansoni was not associated to nutritional status evaluated by BMI-for-age and height-for-age. Similarly, Munisi et al.[34] verified the absence of associations between schistosomiasis mansoni and anthropometric nutritional status among schoolchildren in Northwestern Tanzania, since *S. mansoni* infection was not found to be associated with either undernutrition or anaemia ($P > 0.05$). In turn, Tsuyuoka et al.[35] showed that amongst 360 children from public schools of Aracaju-SE, Brazil, 26.7% had anaemia and 42.0% presented intestinal parasitic infections. Additionally, although there were not significant associations between these variables, the children with intestinal parasitic infections presented a lower growth rate, suggesting that parasitic infections may cause deficits in the nutritional status of these children[35]. Interestingly, Ferreira et al.[36] verified that amongst 280 hospitalized children from Guarapuava-PR, Brazil, 32.1% (90/280) presented infection by intestinal parasites and 64 of the 90 infected children (71.1%) revealed concomitant nutritional deficiencies. The parasite loads were highest in malnourished children, which also showed that poor nutritional status had a higher possibility of worsening the intestinal parasitic infections[36].

An important evidence of the involvement of socioenvironmental conditions with the occurrence of schistosomiais mansoni was showed in the present study, since the child with positive stool sample for *S. mansoni* infection did not have sewage network neither water filter inside home and was also diagnosed with ancylostomiasis. Polyparasitism by different geohelminth species was a significant risk factor for *S. mansoni* infection in a population of schoolchildren from Jequié, Bahia, Brazil, and about 20% of the strength of this association was contributed by socioeconomic status or environmental conditions[37]. Another study in northeastern Brazil showed that schistosomiasis mansoni was still with alarming incidence

numbers in the State of Alagoas during 2013 to 2016 years, highlighting the persistence of lack sanitation and continuing education for the community[38].

An overall analysis of our data revealed that even in an area considered as low endemicity to *S. mansoni* infection, the control of shistosomiasis mansoni needs of strategies to socio-environmentally improve the conditions of health, including good quality of food, hygienic-sanitary education and safer conditions of residence.

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ANEXOS

Figure 1 - Food quality classified according to the School Child Diet Index (Ales Index) measured in school-age children enrolled in one public-school from Alegre, Espírito Santo state, Brazil.

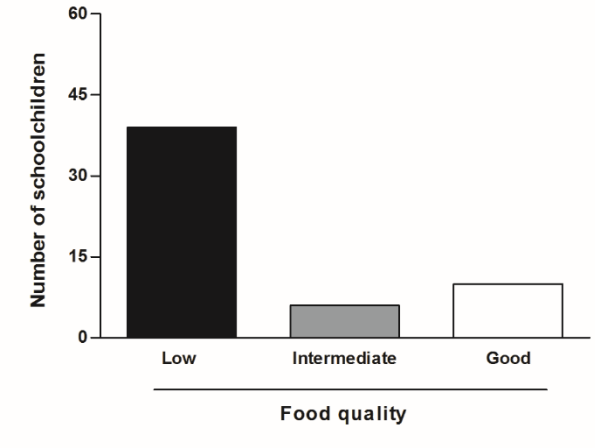

Figure 2 - Stool sample survey carried out through: **(A)** the qualitative method of Hoffman spontaneous sedimentation and **(B)** the quantitative method of Kato-Katz; **(C)** total of positive stool samples analyzed by either Hoffman and Kato-Katz techniques applied in children from one public-school from Alegre, Espírito Santo state, Brazil.

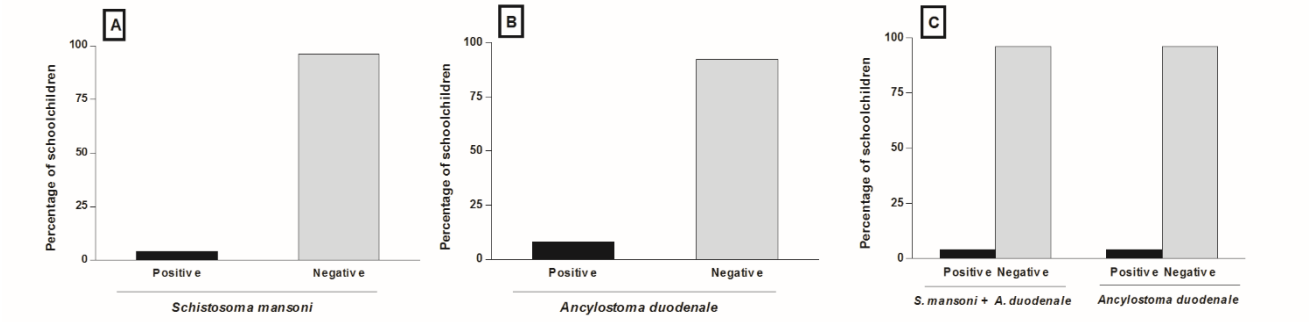

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Table 1 – Socioeconomic and hygienic-sanitary characteristics of schoolchildren in a public full-time school from Alegre, Espírito Santo state, Brazil. N, number of individuals; CI, confidence interval.

Characteristics		Value	95% CI
Mother occupational activity, N (%)			
	Housewife	17 (30.9)	18.3-43.5
	Housekeeper	22 (40.0)	26.6-53.4
	Own business	2 (3.6)	-1.5-8.7
	Rural worker	1 (1.8)	-1.8-5.5
	Craftswoman	1 (1.8)	-1.8-5.5
	Unemployed	12 (21.8)	10.6-33.1
Father occupational activity, N (%)			
	Employee	13 (23.6)	12.1-35.2
	Bricklayer	10 (18.2)	7.7-28.7
	Own business	2 (3.6)	-1.5-8.7
	Rural worker	4 (7.3)	0.2-14.4
	Truck driver	1 (1.8)	-1.8-5.5
	Fisherman	1 (1.8)	-1.8-5.5
	Mechanic	1 (1.8)	-1.8-5.5
	Woodworker	1 (1.8)	-1.8-5.5
	Chef	1 (1.8)	-1.8-5.5
	Retired	4 (7.3)	0.2-14.4
	Unemployed	4 (7.3)	0.2-14.4
	Uninformed	13 (23.6)	12.1-35.2
Sewage network, N (%)			
	Yes	49 (89.1)	80.6-97.6
	No	6 (10.9)	2.4-19.4
Treated water, N (%)			
	Yes	53 (96.4)	91.3-101.5
	No	2 (3.6)	-1.5-8.7
Water filter inside household, N (%)			
	Yes	40 (72.7)	60.6-84.9
	No	15 (27.3)	15.1-39.4

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Table 2 – School Child Diet Index assessed by Qui-square test to verify the existence of link-up with the nutritional status and previous health conditions of anaemia, worm infections and diarrhea occurrence of schoolchildren in a public full-time school from Alegre, Espírito Santo state, Brazil.

Variables		Value*	*p*
Height-for-age, N (%)			
	Short	3 (5.4)	0.5216
	Adequate	52(94.5)	
BMI-for-age, N (%)			
	Malnutrition	2 (3.6)	0,0316**
	Obesity	2 (3.6)	
	Overweight	5 (9.1)	
	Normal weight	46 (83.6)	
Worm treatment, N (%)			
	Yes	37 (67.3)	0.3511
	No	17 (30.9)	
	Not remembered	1 (1.8)	
Anaemia treatment, N (%)			
	Yes	16 (29.1)	0.3114
	No	34 (61.8)	
	Not remembered	5 (9.1)	
Diarrhea occurrence, N (%)			
	Yes	5 (9.1)	0.8987
	No	48 (87.3)	
	Not remembered	2 (3.6)	

* Percentage established from N = 55

** Significant differences based on the Qui-square test ($p < 0.05$)

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Table 3 – *Schistosoma mansoni* infection assessed by Qui-square test to verify the existence of link-up with the nutritional status, food quality, intestinal polyparasitism and the hygienic-sanitary conditions of schoolchildren in a public full-time school from Alegre, Espírito Santo state, Brazil.

Variables		Value*	p
Height-for-age, N (%)			
	Short	2 (8.0)	0.7634
	Adequate	23 (92.0)	
BMI-for-age, N (%)			
	Malnutrition	1 (4.0)	0.9056
	Obesity	0 (0)	
	Overweight	2 (8.0)	
	Normal weight	22 (88.0)	
Quality of food, N (%)			0.6755
	Low	21 (21/25)	
	Intermediate	2 (8.0)	
	Good	2 (84.0)	
Intestinal polyparasitism, N (%)			
	Yes	1 (4.0)	0.0005**
	No	24 (96.0)	
Sewage network, N (%)			
	Yes	22 (88.0)	0.0057**
	No	3 (12.0)	
Treated water, N (%)			
	Yes	23 (92.0)	0.7634
	No	2 (8.0)	
Water filter inside household, N (%)			
	Yes	16 (64.0)	0.6037
	No	9 (36.0)	

* Percentage established from N = 25

** Significant differences based on the Qui-square test ($p < 0.05$)