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Low prevalence of soil transmitted helminths among children in rural areas in Senegal: A cross sectional survey

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Soil transmitted helminthiasis (STH) represents a major public health problem in tropical regions. In many countries including Senegal, STH control strategies usually involve mass deworming campaigns. This study was carried out to assess the prevalence and distribution of intestinal parasites among children, several years after the initiation of mass deworming campaigns with mebendazole in Senegal. A cross sectional survey was conducted in 8 villages located in the Southeastern part of Senegal. Children younger than 10 years old were sampled using a two level random sampling technique. Stool samples were collected from each participant after clinical assessment. Parasites detection was done by light microscopy using a modified Ritchie technique. Among the 1,163 surveyed children, 353 were found with at least one intestinal parasite species representing an overall prevalence of 30.4% (IC95%: 27.3 to 33.7). Proportion of children with protozoan infections was 29.6% (95%CI: 26.9 to 32.3); a small fraction of children were found with helminthic infestations (0.8%) (95%CI: 0.3 to 1.4). The identified parasites were represented by *Giardia intestinalis* (17.7%), *Entameoba coli* (14%), *Endolimax nana* (0.86%), Hookworm (0.52%), *Ascaris lumbricoides* (0.17%), and *Hymenolepis nana* (0.34%). This study revealed a low prevalence of helminthic infestations while protozoan infections remained high. This changing profile in the epidemiology of intestinal parasitic infections among children may require revision of the current deworming policy programme. However, extensive data at the national level are needed to support modification of strategy.

Key words: Helminths, protozoan, children, Senegal.

INTRODUCTION

Intestinal parasitic infections are still a public health concern despite reported declines in Sub-Saharan and Asian countries (de Silva et al., 2003; Pullan and Brooker, 2012). Globally 1.45 billion people are infected

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worldwide with at least one species of a nematode (Pullan et al., 2014). In sub-Saharan countries, 866 million individuals are infected by Soil Transmitted Helminth (STH), with the majority of these infections occurring among pre-school and school children (Pullan et al., 2014). These paediatric infections can lead to adverse effects on nutrition, growth and cognition and contribute to the global burden of childhood anaemia (Moore et al., 2012; Balarajan et al., 2011; Bethony et al., 2006).

The control strategies of STH in many endemic countries usually involve mass drug administration (MDA) programmes with single oral dose of Mebendazole or Albendazole periodically administered to pre-school and school children (Levecke et al., 2014; Gabrielli et al., 2011; WHO, 2012). The word health organisation (WHO) has advocated for countries to roll out anti-helminthic drugs with a long term goal of eliminating STH as a public health problem by 2020 (WHO, 2015). Consequently, in the last 10 years, there has been increased scientific and financial support for the control of STH, with a strong focus on mass deworming campaigns targeting pre-school and school children (Bundy, 2011; WHO, 2015).

In Senegal, mass deworming programmes have being implemented since 2005 as a national initiative to reduce morbidity related to STH. The national deworming initiative implemented by the Ministry of Health in Senegal consists of administering a single dose of mebendazole (500 mg) twice yearly to pre-school children (6 to 59 months). In 2010, a study conducted by the Department of Parasitology, University of Dakar, revealed a high coverage of MDA (95%) with mebendazole and a low prevalence of STH (1.5%) among children living in rural areas in the central part of the country (Tine et al., 2013). However, more epidemiological and parasitological data are required to confirm reported findings as well as assess the situation in other places such as the southern part of the country, where STH have been considered in the past years, as major public health problem (Diouf et al., 2000). Such a data will contribute to further guide the existing STH control programs. The present study aimed at assessing the prevalence and distribution of intestinal parasites species in children under the age of 10 years living in southern rural areas of Senegal, several years after the implementation of mass deworming initiatives.

METHODOLOGY

Study area

The study was conducted at the Bonconto health post, located in the Velingara health district in the south-eastern region of Senegal, 500 km from the capital city of Dakar. The area is predominately rural and most residents live in villages as agriculturists and farmers. Mass deworming that was initiated in 2006 covers this area. A single oral dose of 500 mg mebendazole is administered in June and December each year. Drug delivery is done by community health workers under the supervision of district health staff.

Study design and population

A cross sectional survey was conducted within the 8 villages covered by the Bonconto health post. In each village, prior to the study, a census was done to enumerate all under 10-year-old children living in the study area. Children less than 10 years of age were sampled using a two level random sampling technique. At the first level, participating villages were randomly selected from the list of the 16 villages covered by the Bonconto health post. Study subjects were then randomly selected from the sampled villages using the list of enumerated children.

Sample size calculation

With 1163 children sampled, the study was powered at 90% to detect 5% variation of intestinal parasite prevalence, assuming a current prevalence of intestinal parasite carriage at 25% based on previous studies (Tine et al., 2013) with alpha at 0.05 (two sided).

Data collection methods and specimen examination

Data were collected using a structured questionnaire followed by a biological assessment. An initial physical examination was first conducted by a physician and all data obtained from physical examination and interviews were assigned on a case report form (CRF). A code was given to every child after parents' informed consent. For each enrolled child, the mother was interviewed directly concerning the child's symptoms as well as sociodemographic characteristics, history of mebendazole uptake using a standard questionnaire. Fresh stools samples were collected into wide mouth screw-cap clean containers. Faecal samples were examined for the intestinal parasite using direct microscopic examination and a modified Ritchie technique. Intestinal parasite was recorded as positive in the presence of helminthes and/or protozoans in the faeces.

Data management and data analysis

Data were double entered in Excel software and all analyses were conducted using Stata package (StataCorp, Texas). For categorical data, percentage was used to assess the frequency of each outcome with a 95% confidence interval. Characteristics of all children included in the study were tabulated. Proportions were compared using chi square test (univariate analysis). To assess the main factors associated with intestinal parasitic infections, a multivariate logistic regression was done with adjustment on covariates such as exposure to mebendazole in the previous 6 months, age group, gender, mother or care taker level of instruction. From the final model, adjusted odds ratios were derived with their 95% confidence interval. Model validity was tested using the Hosmer-Lemeshow goodness of fit test. The performance of the final model was assessed by the area under the curve and Akaike and Bayesian information criterion; in addition a test for multicolinearity between variables was done using the variance inflation factor. Significance level of the different tests was 0.05 (two sided).

Ethical considerations

The study protocol was approved by the Conseil National de Recherche en Santé in Senegal (N° 027/MSP/DS/CNRS). Prior to the study, a community sensitization was undertaken in villages surrounding the Bonconto health post and community consent was obtained from community leaders (religious guide, village head).

Table 1. Study participant's characteristics at enrolment (N=1163).

Parameter	Number	Percentage	95%CI
Age group (years)			
under 5	604	51.9	49.1 - 54.8
5 to 10	559	48.1	45.1 - 50.9
Sex			
Female	571	49.1	46.2 - 52.0
Male	592	50.9	47.9 - 53.8
Care taker's level of instruction			
Non educated	917	78.8	76.4 - 81.2
Primary school	152	13.1	11.2 - 15.1
Secondary school	33	2.8	1.9 - 3.9
Coranic instruction	16	1.4	0.8 - 2.2
Family size			
Less than 5 members	848	72.9	70.3 - 75.4
5 to 10 members	301	25.9	23.4 - 28.5
More than 10 members	14	1.2	0.6 - 2.0
Symptoms at enrollement			
Nausea	20	1.7	1.1 - 2.6
Vomiting	70	6.0	4.7 - 7.5
Anorexia	79	6.8	5.4 - 8.4
Palor	257	22.1	19.5 - 24.3
Diarrhea	110	9.5	7.8 - 11.3
Exposure to antihelminthic treatment within previous 6 months			
Under 5 years	479 / 604	79.3	75.8 - 82.4
5 to 10 years	173 / 559	30.9	27.1 - 34.9

On the day of survey, informed consent was obtained from mothers or children's care takers prior to their enrollement. The study was conducted in collaboration with the Velingara health district.

RESULTS

Study participant's characteristics

Overall, 1163 eligible children participated in the study. Children under 5 years of age represented 51.9%; proportion of female children was 49.1%. The majority of interviewed mothers or caretakers were illiterate (78.8%). The main symptoms presented by study participants on the day of survey were pallor (22.1%), diarrhoea (9.5%), anorexia (6.8%), vomiting (6%) and nausea (1.7%). Table 1 summarises study participants characteristics at enrolment.

Prevalence and distribution of intestinal parasitic infections among study participants

Overall, 353 children were found with at least one intestinal parasite species. The prevalence of intestinal parasites was 30.4%. Intestinal parasitic infections were predominantly caused by protozoas (29.6%), (95%CI: 26.9 to 32.3) relative to helminthics infections (0.8%) (95%CI: 0.3 to 1.4). Intestinal parasitic infections were mainly caused by *Giardia intestinalis* (14%), *Entamoeba coli* (17.7%), *Endolimax nana* (0.9%), Hookworm (0.5%), *Ascaris lumbricoides* (0.2%), and *Hymenolepis nana* (0.3%) (Table 2).

Intestinal parasitic infections were higher among children aged between 5 to 10 years (34.5%), as compared to children less than 5 years (26.5%) with a prevalence ratio of 1.3 (95%CI (1.1 to 1.6), p = 0.003). Protozoan infections were more frequent among children aged above 5 years (33.4%) compared to the youngest age group (25.9%) (prevalence ratio 1.3; 95%CI (1.1 to 1.6), p = 0.005)). No statistical difference was found in terms of helminthic infections between the two age categories (prevalence ratio: 2.2 95%CI (0.5 - 8.6); p=0.26)). Parasitic infections distributions by age groups are summarised in Table 3.

Among patients with protozoan infections, the most frequently reported symptoms were pallor (18.5%) and

Table 2. Overall prevalence of intestinal parasitic infections among study participants (N=1163).

Parameter	Number of positive	Prevalence (%)	95%CI
Overall intestinal parasite carriage	353	30.4	[27.7 - 33.1]
Overall protozoan infections	344	29.6	[26.9 - 32.3]
Overall helminthic infestation	09	0.8	[0.3 - 1.4]
Parasites especies			
Giardia intestinalis	163	14.0	[12.2 - 16.1]
Entameaba coli	206	17.7	[15.5 - 20.0]
Endolimax nana	10	0.9	[0.4 -1 .6]
Hookworm	06	0.5	[0.2 - 1.1]
Ascaris lumbricoides	02	0.2	[0.02 - 0.6]
Hymenolepis nana	04	0.3	[0.09 - 0.8]

Table 3. Prevalence of intestinal parasitic infections by age group and gender.

Parameter	Under 5 years (N=604) [n(%), (95%CI)]	5 to 10 years (N=559) [n(%), (95%CI)]	Prevalence ratio 95%CI	p value
Overall intestinal parasite carriage	[160(26.5), 23.0 - 30.2]	[193(34.5), 30.6 - 38.6]	1.3(1.1 - 1.6)	0.003
Overall protozoan infections	157(25.9), 22.5 - 29.7]	[187(33.4), 29.5 - 37.5]	1.3(1.1 - 1.5)	0.005
Overall helminthic infestations	[03(0.5), 0.1 - 1.4]	[06(1.1), 0.4 - 2.3]	2.2(0.5 - 8.6)	0.26
Parasites especies				
Giardia intestinalis	[87(14.4), 11.7 - 17.5]	[76(13.6), 10.8 - 16.7]	0.94(0.7 - 1.3)	0.69
Entameaba coli	[87(14.4), 11.7-17.5]	[119(21.3), 17.9 - 24.9]	1.5(1.1 - 1.9)	0.002
Endolimax nana	00	[10 (1.8), 0.8-3.3]	--	0.001
Hookworm	[01 (0.2), 0.00 - 0.9]	[05(0.9), 0.3 - 2.1]	5.4(0.6 - 46.1)	0.08
Ascaris lumbricoides	00	[2(0.4), 0.04 - 1.3]	--	0.14
Hymenolepis nana	[02 (0.3), 0.04 - 1 .2]	[02(0.4), 0.04 - 1.3]	1.1(0.1 - 7.6)	0.93
	Female (N=532) (n, %, 95%CI)	**Male (N=592) (n, %, 95%CI)**	**Prevalence ratio 95%CI**	**p value**
Overall intestinal parasite carriage	[177(33.3), 29.3 - 37.4]	[171(28.9), 25.3 - 32.7]	0.9 (0.7 - 1.0)	0.11
Overall protozoan infections	[175(32.9), 28.9 - 37.1]	[164(27.7), 24.1 - 31.5]	0.8 (0.7 - 1.0)	0.06
Overall helminthic infestations	[05(0.9), 0.3 - 2.2]	[04(0.7), 0.2 - 1.7]	0.7 (0.2 - 2.6)	0.62
Parasites especies				
Giardia intestinalis	[97(18.2), 15.0 - 21.8]	[64(10.8), 8.4 - 13.6]	0.6 (0.4 - 0.8)	0.0004
Entameaba coli	[92(17.3), 14.2 - 20.8]	[110(18.6), 15.5 - 21.9]	1.1 (0.8 - 1.4)	0.57
Endolimax nana	[05(0.9), 0.3 - 2.1]	[05(0.8), 0.3 - 1.9]	0.9 (0.3 - 3.1)	0.86
Hookworm	[04(0.7), 0.2 - 1.9]	[02(0.3), 0.04 - 1.2]	0.4 (0.1 - 2.4)	0.34
Ascaris lumbricoides	[02(0.4), 0.04 - 1.3]	00	00	0.14
Hymenolepis nana	[01(0.2), 0.00 - 1.0]	[03(0.5), 0.1 - 1.4]	2.7 (0.3 - 25.8)	0.37

diarrhoea (13.8%); other observed symptoms were anorexia (7.9%), vomiting (6.5%) and nausea (2.4%). Only one patient with helminthic infection was found with pallor. No other symptoms were described in patients with helminthic parasites. Episodes of diarrhoea was more frequently reported among patients with protozoan infections (13.8%) compared to patients with helminthic infections (0%) and non-infected participants (7.7%) p = 0.003. The frequency of reported symptoms by type of infection is presented in Table 4.

Factors associated with intestinal parasitic infections among study participants

Participants who had received mebendazole during the previous 6 months prior to the survey were less likely to carry intestinal parasites compared to those who did not

Table 4. Distribution of reported symptoms among study participants

Parameter	Non infected (N=814)	Helminthic infestation (N=9)	Protozoan infections (N=340)	p value
Nausea	12 (1.5%)	00	08 (2.4%)	0.53
Vomiting	48 (5.9%)	00	22 (6.5%)	0.70
Anorexia	52 (6.4%)	00	27 (7.9%)	0.45
Palor	193 (23.7%)	01 (11.1%)	63 (18.5%)	0.11
Diarrhea	63 (7.7%)	00	47 (13.8%)	0.003

Table 5. Adjusted analysis of intestinal parasitic infections among study participants.

Parameter	Intestinal parasites prevalence (95%CI)	Unadjusted prevalence ratio (95%CI)	Adjusted prevalence ratio (95%CI)	p value
Received mebendazole in previous 6 months				
No	37.4 (30.7 - 38.8)	1	1	
Yes	24.9 (21.6 - 28.3)	0.55 (0.43 - 0.71)	0.65 (0.48 - 0.92)	0.01
Gender				
Girls	31.9 (28.1 - 35.9)	1	1	
Boys	28.9 (25.3 - 32.7)	0.87 (0.68 - 1.11)	0.77 (0.59 - 0.97)	0.04
Mother's education level				
No formal education	31.6 (28.1 - 35.5)	1	1	
Coranic education	18.7 (3.9 - 54.8)	0.49 (0.14 - 1.76)	0.74 (0.20 - 2.69)	0.65
Primary school	30.9 (22.7 - 41.1)	0.97 (0.67 - 1.40)	1.01 (0.69 - 1.49)	0.95
Secondary school	18.2 (6.7 - 39.6)	0.48 (0.20 - 1.18)	0.35 (0.14 - 0.88)	0.02
Age group (years)				
Under 5	26.5 (23.0 - 30.2)	1	1	
5 to 10	34.5 (30.6 - 38.6)	1.46 (1.14 - 1.88)	1.10 (0.79 - 1.52)	0.57

Goodness of fit test: Hosmer-Lemeshow Chi (7df) =4.01; p=0.78. Area under the curve (AUC)=68.3%; Akaike Information Criterion (AIC): 1339; Bayesian Information Criterion (BIC): 1365; variance inflation factor: 1.17.

received any anti-parasite treatment during the previous 6 months: adjusted odds ratio at 0.65; 95%CI (0.48 to 0.92). Other factors significantly associated with intestinal parasitic infections were represented by: (i) gender: male children were less likely to be infected compared to female children (adjusted odds ratio: 0.77 ; 95%CI (0.59 to 0.97) ; p=0.04); (ii) education level of mothers or care takers: children whose mothers or care takers instruction level was equivalent to secondary school, were less likely to carry intestinal parasites compared to others (adjusted odds ratio: 0.35 ; 95%CI (0.14 - 0.88), p=0.02) (Table 5).

DISCUSSION

As part of a long-term goal of eliminating STH as public health problem by 2020, WHO recommended MDA with single oral dose of mebendazole or albendazole periodically administered to pre-school and school age children (Gabrielli et al., 2011; Levecke et al., 2014; WHO, 2012). This strategy is currently implemented in many countries including Senegal in order to control morbidity related to STH. Our study investigated the prevalence and distribution of intestinal parasitic infections among children less than 10 years of age in rural areas in Senegal, several years after the implementation of MDA campaigns.

One third of the study participants were infected with at least one intestinal parasite species and protozoan infections were predominant (29.9% of infected children) compared to the small fraction of children carrying helminthic parasites (0.8%). Contrary to previous studies conducted in Senegal, helminthic infections have become very rare, while protozoan infections are more common, with *Giardia* being the predominant pathogenic protozoa. Indeed, previous studies demonstrated a prevalence of helminthic infections of 42 to 56% (Faye et al., 2008; Faye et al., 1998a) with *A. lumbricoides* being the most

prevalent STH (22 to 34%) (Faye et al., 1998b), followed by *Trichuris trichiura* (15 to 20%) (Faye et al., 1998c). Protozoan infections ranged from 15 to 22.5% (Diouf et al., 2000).

The low prevalence of helminthic infections among children observed in this study is in line with recent findings from other rural areas in Senegal (Tine et al., 2013) and other sub-Saharan countries (Moser et al., 2017). Several years after the initiation of mass deworming campaigns, helminthic infections among children in this area of Senegal have significantly decreased to a point where they can no longer be regarded as a significant public health treat. Consequently a substantial modification in the spectrum of intestinal parasites is noted, with protozoan parasites predominating.

While helminthic infections remained at a low level, one third of the study participants were infected with protozoan species in which *Giardia* was the predominant pathogen. Single dose of mebendazole given during deworming campaigns has limited effect on Giardiasis (Olsen, 2003; Keiser and Utzinger, 2008), and may have induced a “replacement effect” on parasite species as described in other settings (Moore et al., 2012). Observed frequency of Giardia is however consistent with other findings (Tine et al., 2013; Azazy, 2002). The deleterious effect of *Giardia intestinalis* on growth and health of children has been shown by several studies (Al-Mekhlafi et al., 2005; Rosenthal, 1999). This parasite is known for its ability to induce diarrhoea (Polis et al., 1986) and mal-absorption syndrome. It can lead to protein energy malnutrition, vitamin A deficiency, iron deficiency anaemia and vitamin B12 deficiency (Gendrel et al., 2003).

Although, *Giardia* prevalence remained high, the potential source of contamination for children with regard to this parasite remained unclear. Distributions of Giardiasis and other intestinal parasites are often linked to lack of sanitation, lack of access to safe water and improper hygiene (Abossie and Seid, 2014). The study did not investigated the distribution of these known risk factors, but its was noted that children whose mothers or caretakers instruction level was equivalent to secondary school were less likely to carry intestinal parasites which is in line with findings from other studies (Okyay et al., 2004). Improving population awareness on Giardiasis risk factors and its modes of transmission could contribute to further reduce morbidity related to this parasite. Additional data for a better understanding of the epidemiology of *Giardia* and its determinants will be needed to optimise Giardiasis control strategies (Savioli et al., 2006).

Conclusion

This study revealed a low prevalence of helminthic infections while protozoan infections remained high. This changing profile in the epidemiology of intestinal parasitic infections among children may require revision of the current deworming policy programme. However, extensive data at the national level are needed to support modification of strategy.

CONFLICT OF INTERESTS

The authors have no conflicts of interests concerning the work reported in this paper.

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