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Research Article

Prevalence of Intestinal Parasite Infections in Stool Samples of Patients in Le Dantec University Hospital of Dakar, Senegal, from 2011 to 2020

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ABSTRACT

Background: In Senegal, intestinal parasites are common due to poverty, poor personal hygiene, poor environmental sanitation, overcrowding, a lack of safe drinking water, and a lack of knowledge. To identify the parasites responsible for intestinal parasitic infections diagnosed at Le Dantec University Hospital of Dakar, distribution of parasites detected in stool samples of patients was studied from 2011 to 2020.

Methodology: This was a cross-sectional, descriptive, retrospective study of 3515 samples from patients aged four months to 91 years. A direct examination and Ritchie technique were performed as parasite search techniques. The effect of intestinal parasitic infections was assessed using a multivariate logistic regression with adjustment on covariates such as study period, age, sex, season and service. From the final model, adjusted odds ratios were derived with their 95% CI.

Results: Of these 751 parasites, 661(18.81%), were identified in monoparasitism by decreasing order: *Entamoeba coli*, 6.43% (226/3515), *Blastocystis hominis* (5.60%), *Entamoeba histolytica/dispar* (2.22%), *Giardia intestinalis* (1.22%), *Ascaris lumbricoïdes* (1.05%), *Trichuris trichiura* (0.68%), *Trichomonas intestinalis* (0.51%), *Taenia saginata/solium* (0.37%), *Cystoisospora. belli, Dicroecelium dendriticum*, *Endolimax nana*, *Schistosoma mansoni* and *Strongyloïdes stercolaris* respectively (0.11%), *Hymenolepis nana* (0.08 %), *Ancylostoma spp* (0.06%), *Cryptosporidium spp* and *Enterobius vermicularis* respectively (0.03%). In biparasitism (2.48%), 174 parasites (87 associations) were identified. The most common associations were dominated by *B. hominis-E. coli* with 26 cases, *E. coli-E. histolytica/dispar* with 16 cases, *A. lumbricoides-T. trichiura* 10 cases, *E. coli-G. intestinalis* 9 cases, *B. hominis/E. histolytica/dispar* 7 cases, *A. lumbricoïdes- E. coli* 6 cases. Three triparasitism cases (0.09%) were observed with *E. histolytica/dispar/ Ascaris lumbricoïdes/Trichuris trichiura, E. histolytica/dispar-Blastocystis hominis-Entamoeba coli, E. histolytica/dispar-Blastocystis hominis-Chilomastix mesnili.* Multivariate analysis using a logistic regression model showed intestinal parasitic infections was significantly frequent in years 2013 (OR 0.48CI 95% (0.33-0.69)) and 2020 (OR 0.51 CI 95% (0.34-0.78)). Intestinal parasite infections were significantly associated with all age range (p=0.0001). There is no statistically significant association between isolated intestinal parasite such as gender, season and service. There was statistically significant association between age ranges and *Giardia intestinalis, Blastocysts hominis* ($p<0.05$).

Conclusions: This prevalence of intestinal parasite might be due to differences in hygiene practices, water supplies, latrine coverage, economic and educational status, and climatic conditions. Multiple intervention strategies could reduce the morbidity of acute diarrhea in populations such as health education, access to a safe water supply and improvement in hygiene.

Keywords: Simple Parasitic Index (SPI); Intestinal parasitic infection; Prevalence; Mass Drug Administration (MDA)

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INTRODUCTION

Intestinal parasites are the organisms that inhabit intestine and lives on the expense of their host. The factors like social customs, religious affairs, and environmental factors, availability of the intermediate hosts, notorious habits and personal cleanliness of the individuals are affected on the distribution of parasites [1]. Over 3 billion people worldwide are infected with different intestinal parasites, causing morbidity in 450 million individuals [2]. The prevalence of these infections is governed by geographical, behavioral, biological and socioeconomic factors. They are closely associated with the humid tropical climate, limited access to clean water, poor environmental sanitation, overcrowding and low family income. All these conditions favour and facilitate the growth, transmission and exposure to intestinal parasites [3]. Ingestion of contaminated food and water is the commonest route for transmitting different intestinal parasites. Infection can also be acquired after active skin penetration by infective larval stages in polluted soil [4]. Intestinal helminths and protozoan infections have both been identified as major causes of illness and mortality worldwide [5]. The most prevalent helminth parasites are *Ascaris lumbricoides A. lumbricoides, Trichuris trichiura* (*T. trichiura*), and hookworm, which affect about one-sixth of the world's population [6]. Protozoa parasites such as *Giardia lamblia* (*G. lamblia*) and *Entamoeba histolytica* (*E. histolytica*) are also significant causes of morbidity worldwide [7]. The intestinal parasite infection has a major effect on an individual's physical and mental development. It causes malnutrition, anemia, stunting, and cognitive impairment, and is thus a major public health issue throughout the world [8]. As part of a long-term goal to eliminate intestinal parasitic infections as a public health problem by 2020, WHO has recommended Mass Drug Administration (MDA) with a single oral dose of mebendazole or albendazole given periodically to children preschool and school age [9,10]. This strategy is currently being implemented in many countries including Senegal. In Senegal, Intestinal Parasitic Infections (IPIs) are widely distributed due to the low level of environmental and personal hygiene and contamination of food and water due to improper disposal of human and animal excreta [11-13]. In our study, it was aimed to show the frequency of intestinal parasites detected in patients who applied to the parasitology laboratory of our hospital between January 2011 and December 2020 and the relationship of this distribution with variables such as age, gender, season and hospitalized or nonhospitalized status.

METHODOLOGY

Study area and population survey

We carried out a retrospective and descriptive study at the Parasitology and Mycology laboratory of Le Dantec University Hospital of Dakar. Between 2011 and 2020, all patients received in the laboratory were included in the study for parasitological examination of stools with symptoms suggestive of intestinal protozoan infections. Over the ten-year period, all intestinal protozoan suspected patients in the study area were included, and any data lacking sociodemographic characteristics and the year of stool examination performed, as well as data lacking species and stage of intestinal parasite, were excluded. The main collection tool was the bench registries specially designed for parasitological examination of stools. These registries collected information on age, sex, season, hospitalized or nonhospitalized status of the patients, and the year (months) and the results of the examinations. The dry season is from January to June and from October to December. The rainy season corresponds to the months of July, August and September. The age was defined in four categories: Age was defined in four categories: children (0-15 years), (16-30 years), (31-60 years) and (>60 years).

Stool specimen analysis

Stool specimens were sent to the laboratory promptly after collection, in a plastic jar, for hospitalized patients; they were collected, in the laboratory itself, for the nonhospitalized patients. Stool specimens were examined for intestinal parasites using the standard routine methods used by hospitals and microbiological laboratories for diagnosing parasites [14]. First, they were analyzed macroscopically by recording the consistency, colour and the presence of blood, mucous or adult intestinal worms. A direct saline (0.9%) smear preparation and Lugol's iodine were made and examined by light microscopy with 10x and 40x objectives. Several slides were prepared from each single sample. For each slide, about 2 mg (the size of a match-stick head) of stool was obtained from both the surface and the inside of the specimen to increase the rate of detection of different parasites. Wet mount preparations were used for detecting helminth ova and protozoan cysts. Samples which did not show any intestinal parasites by direct smear were examined using Ritchie concentration technique (Formalin-Ether Concentration). A formalin-ether concentration technique was adopted. About 1 g to 1.5 g of stool specimen was mixed in a centrifuge tube containing 10 ml formalin mixture and stirred until a suspension formed. Then, 3 ml of ether was added to the suspension and thoroughly mixed by putting a rubber stopper in the tube and then shaken for ten seconds. The tube was placed in a centrifuge for 2 minutes-3minutes at 2000 revolutions per minute. Then, the tube was removed from the centrifuge, where 4 layers have been observed from the top to the bottom (top layer ether, 2nd layer fat debris, 3rd layer formalin, and bottom layer sediment). The first three layers were discarded. A small amount of residual fluid was flown back to the sediment, properly mixed with the sediment, and a drop of suspension was transferred to a clean slide and covered with a cover slip. Finally, the slide was examined at 10x and 40x objectives for the presence of intestinal parasites.

Data analysis

Data were entered in Excel software and analyzed using STATA 10 software. For descriptive data, percentage was used to assess the prevalence of each outcome. Proportions were compared using chi-square test or the Fisher exact test (univariate analysis); significance level of the different tests was 0.05 two-sided. A stepwise logistic regression was done for the determination of relationship of this distribution with variables such as age, gender, season and hospitalized or nonhospitalized status. The validity of the final models was tested using the Hosmer-Lemeshow goodness of fit test.

The following formulas have made it possible to calculate the parasitic indices:

1. Simple Parasitic Index (SPI), which corresponds to the prevalence here, is equal to the percentage of parasitized subjects relative to the total parasitological examinations of stools carried out.

2. Corrected Parasitic Index (CPI) is equal to the ratio of the number of parasites recorded on the number of total examinations multiplied by 100.

3. Polyparasitism Index (PPI) is the coexistence in the same individual of two or more parasitic species. The PPI is deduced from the difference between the CPI and the SPI.

RESULTS

Characteristics of the study population

The demographic data of all participants are presented in Table 1. A total of 3515 patients were included in the study with a sex ratio of 1.04. Patient's age ranged from four months to 91 years with a mean age of 35.6 years. The distribution of patients by age group was as follows: 0-15 years, 302 (8.86% (95% CI: 07.95-09.87)); 15-30 years, 1,139 (33.43% (95% CI: 31.87-35.03)); 31-60 years, 1,562 (45.85 % (95% CI: 44.18-47.52)) and >60 years, 404 (5.52% (95% CI: 10.81-12.99)). It was observed that 50.95% of the patients were male and 50.95% were female. When the distribution of the patients according to season was examined, the dry season presented highest rate of 84.41% compared with rainy season (15.59%). According the service, nonhospitalized (73.80%) were more represented than hospitalized (26.20%).

Table 1: Socio-demographic characteristics of participants.

	Number	Percentage	CI 95%
Years			
2011	424	12.06	(11.03-13.18)
2012	454	12.92	(11.85-14.07)
2013	354	10.07	(09.12-11.11)
2014	314	8.93	(08.03-9.92)
2015	310	8.82	(07.93-9.80)
2016	424	12.06	(11.03-13.18)
2017	421	11.98	(10.94-13.09)
2018	357	10.16	(09.2-11.20)
2019	263	7.48	(06.66-8.40)
2020	194	5.52	(04.81-6.32)
Age group			
<15 years	311	8.85	(07.95-9.83)
15-30 years	1178	33.51	(31.97-35.09)
31-60 years	1612	45.86	(44.22-47.51)
>60 years	414	11.78	(10.75-12.89)
Gender			
Male	1791	50.95	(49.3-52.6)
Female	1724	49.05	(47.4-50.7)
Service			
Hospitalized	921	26.2	(24.77-27.68)
Nonhospitalized	2594	73.8	(72.32-75.23)
Seasons			
Dry	2967	84.41	(83.17-85.57)
Rainy	548	15.59	(14.43-16.83)
Intestinal parasites			
Negative	2764	78.63	(77.25-79.96)
Positive	751	21.37	(20.04-22.75)

Parasitic indices and evolution of prevalence according to age and years of study

Of the 3515 stool samples examined, 751 showed the presence of intestinal parasites in monoparasitism 661(18.81%), biparasitism 87(2.48%), or triparasitism 9 (0.09%), corresponding to a Simple parasitic index (SPI) or prevalence of 21.37% (95% CI: 20.04-22.75). Of these confirmed intestinal parasite infections, 844 strains belonging to nine species of intestinal parasite, were counted as a Corrected Parasitic Index (CPI) of 24.01%. The Polyparasitism Index (PPI) is derived from the difference between the CPI and the SPI. The PPI in our study is 2.64%. When the distribution of parasite detection rates by years is examined, it is seen that the highest value belongs to 2019 and the lowest value belongs to 2011. The evolution of prevalence over the years showed a significantly increasing trend from 3.92% in 2011 to 16.02% in 2012. However, between 2012 and 2013, it decreased from 16.02 to 10.17%. Following the positive cases from 2013 to 2020, there is a sawtooth evolution (Figure 1). When the distribution of the patients according to age was examined, the highest rate of parasites was 27.01% between the ages of 0-15 years, 21.77% in the individuals aged 31-60 years, 20.37% in age group 15-30 years and 18.36% in the individuals aged 60 years and above (Figure 2).

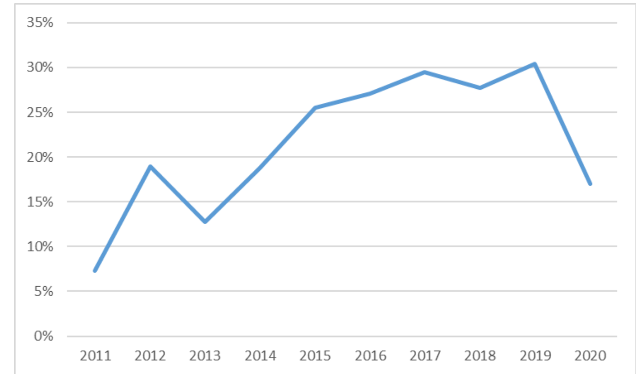

Figure 1: Evolution of the intestinal parasitic infection's prevalence by years.

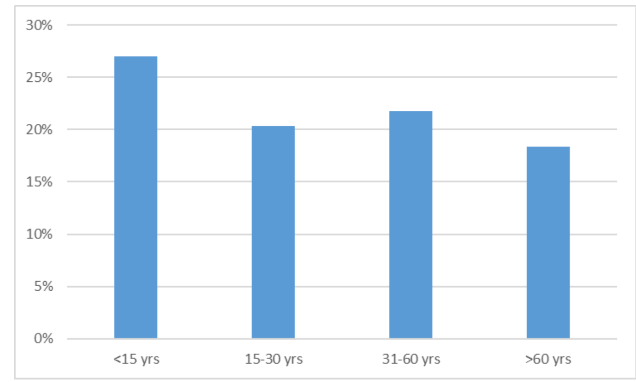

Figure 2: Intestinal parasitic infection's prevalence by age group.

Distribution of identified species

Of these 751 parasites, 661(18.81%), were identified in monoparasitism by decreasing order: *Entamoeba coli*, 6.43% (226/3515), *Blastocystis hominis* (5.50%), *Entamoeba histolytica/dispar* (2.22%), *Giardia intestinalis* (1.22%), *Ascaris lumbricoïdes* (1.05%), *Trichuris trichiura* (0.68%), *Trichomonas intestinalis* (0.51%), *Taenia saginata/solium* (0.37%), *Cystoisospora. belli*, *Dicroecelium dendriticum*, *Endolimax nana*, *Schistosoma mansoni* and *Strongyloïdes stercolaris* respectively (0.11%), *Hymenolepis nana* (0.08 %), *Ancylostoma spp* (0.06%), *Cryptosporidium spp* and *Enterobius vermicularis* respectively (0.03%) (Table 2a).

Table 2a: Species distribution in monoparasitism.

Species	Numbers	%
Entamoeba coli	226	6.43
Blastocystis hominis	196	5.6
Entamoeba histolytica/dispar	77	2.22
Giardia intestinalis	43	1.22
Ascaris lumbricoïdes	37	1.05
Trichuris trichiura	24	0.68
Trichomonas intestinalis	18	0.51
Taenia saginata/solium	13	0.37
Cystoisospora. belli	4	0.11
Dicroecelium dendriticum	4	0.11
Endolimax nana	4	0.11
Schistosoma mansoni	4	0.11
Strongyloïdes stercolaris	4	0.11
Hymenolepis nana	3	0.08
Ancylostoma spp	2	0.06
Cryptosporidium spp	1	0.03
Enterobius vermicularis	1	0.03
Total in monoparasitism	661	18.81

In biparasitism (2.48%), 174 parasites (87 associations) were identified. The most common associations were dominated by *B. hominis-E. coli* with 26 cases, *E. coli-E. histolytica/dispar* with 16 cases, *A. lumbricoides-T. trichiura* 10 cases, *E. coli-G intestinalis* 9 cases, *B. hominis/E. histolytica/dispar* 7 cases, *A. lumbricoïdes-E. coli* 6 cases (Table 2b).

Table 2b: Species distribution in biparasitism.

Biparasitism	Species	Associated species	Number of isolations	Total no. of Species	%
Between helminths	*Ascaris lumbricoides*	*Trichuris trichiura*	10	20	0.28
	Ascaris lumbricoides	*Strongyloides stercoralis*	1	2	0.028
Between protozoa	*Blastocystis Hominis*	*Entamoeba coli*	26	52	0.74
	Blastocystis Hominis	*Entamoeba histolytica/dispar*	7	14	0.2
	Blastocystis Hominis	*Giardia intestinalis*	1	2	0.03
	Blastocystis Hominis	*Trichomonas intestinalis*	1	2	0.03
	Blastocystis Hominis	*Endolimax nana*	1	2	0.03
	Entamoeba coli	*Entamoeba histolytica/dispar*	16	32	0.45
	Entamoeba coli	*Giardia intestinalis*	9	18	0.27
	Entamoeba coli	*Trichomonas intestinalis*	1	2	0.03
	Entamoeba histolytica/dispar	*Trichomonas intestinalis*	1	2	0.03
Between protozoa and helminths	*Ascaris lumbricoides*	*Entamoeba coli*	6	12	0.17
	Blastocystis Hominis	*Cystoisospora belli*	1	2	0.03
	Entamoeba coli	*Trichuris trichiura*	1	2	0.03
	Entamoeba coli	*Hymenolepis nana*	1	2	0.03
	Entamoeba histolytica/dispar	*Trichuris trichiura*	1	2	0.03
	Entamoeba coli	*Trichuris trichiura*	1	2	0.03
	Giardia intestinalis	*Trichuris trichiura*	1	2	0.03
	Giardia intestinalis	*Strongyloides stercoralis*	1	2	0.03
Total in biparasitism			87	174	2.48

Three triparasitism cases (0.09%) were observed with *E. histolytica/dispar-Ascaris lumbricoïdes-Trichuris trichiura*, *E. histolytica/dispar-Blastocystis hominis-Entamoeba coli*, *E. histolytica/dispar-Blastocystis hominis-Chilomastix mesnili* (Table 2c).

Table 2c: Species distribution in polyparasitism.

Species	Number of isolations	Total no. of species	%
Triparasitism			
E. histolytica/A. lumbricoïdes/T. trichiura	1	3	0.03
E. histolytica/B. hominis/E. coli	1	3	0.03
E. histolytica/B. hominis/ Chilomastix mesnili	1	3	0.03
Total in polyparasitism	3	9	0.09

Factors associated with intestinal protozoan infections

Multivariate analysis using a logistic regression model showed intestinal parasitic infections was significantly frequent in years 2013 (OR 0.48CI 95% (0.33-0.69)) and 2020 (OR 0.51 CI 95% (.34-0.78)). Intestinal parasite infections were significantly associated with all age range (p=0.0001). There was no statistically significant association between isolated intestinal parasite such as gender, season and service (Table 3). We compared the most frequently species with age, sex, season, service and years of study There was statistically significant association between age ranges and *Giardia intestinalis, Blastocysts hominis* (p<0.05). There was no association between species and gender. However, *Entamoeba coli* and *Blastocystis hominis* were more isolated in non-hospitalized patients (Table 4). According the season *B. hominis* and *Intestinalis* were more isolated in dry season. *G. intestinalis*, *E. coli*, *B. hominis* and *E. histolytica/dispar* were more identified between 2011 and 2020 (Table 5).

Table 3: Associated factors with intestinal parasite infections.

	Number (%)	OR (95% CI)	P-value
	Years		
2011	31 (07.31)	1	
2012	86 (18.94)	0.78 (0.58-1.06)	0.109
2013	45 (12.71)	0.48 (0.33-0.69)	0
2014	59 (18.79)	0.77 (0.55-1.07)	0.119
2015	79 (25.48)	1.13 (0.82-1.56)	0.46
2016	115 (27.12)	0.96 (0.73-1.27)	0.793
2017	124 (29.45)	1.08 (0.82-1.43)	0.592
2018	99 (27.73)	0.94 (0.70-1.27)	0.705
2019	80 (30.42)	1.14 (0.83-1.57)	0.415
2020	33 (17.01)	0.51 (0.34-0.78)	0.002
	Age group		
<15 years	84 (27.01)	1	
15-30 years	240 (20.37)	0.30 (0.24-0.38)	0
31-60 years	351 (21.77)	0.33 (0.27-0.41)	0
>60 years	76 (18.36)	0.27 (0.20-0.36)	0
	Gender		
Male	365 (20.38)	1	
Female	386 (22.39)	0.90 (0.77-1.05)	0.188
	Service		
Hospitalized	138 (14.98)	1	
Nonhospitalized	613 (23.63)	1.00 (0.83-1.20)	0.998
	Season		
Dry	608 (20.49)	1	
Rainy	143 (26.09)	1.12 (0.89-1.42)	0.319

Note: *Adjusted odds ratio. Goodness of fit: Hosmer-Lemeshow χ^2(8df)=50.63, P=0.0000

Table 4: Prevalence of different intestinal parasites in relation to age groups, gender and service.

Species	Age group (years)					Gender			Service		
	<15 years (N=302)	13-30 years (N=1139)	31-60 years (N=1562)	>60 years (N=404)	P-value	Male (N=1735)	Female (N=1672)	P-value	Hospitalized (N=896)	Nonhospitalized (N=2511)	P-value
Entamoeba coli	29 (9.32%)	86 (7.30%)	140 (8.68%)	31 (7.49%)	0.463	138 (7.71%)	148 (8.58%)	0.34	47 (5.10%)	239 (9.21%)	0
Blastocystis hominis	32 (10.29%)	80 (6.79%)	101 (6.27%)	23 (5.56%)	0.051	117 (6.53%)	119 (6.90%)	0.661	29 (3.15%)	207 (7.98%)	0
Entamoeba histolytica/ dispar	8 (2.57%)	34 (2.89%)	50 (3.10%)	13 (3.14%)	0.954	52 (2.90%)	53 (3.07%)	0.766	22 (2.39%)	83 (3.20%)	0.214
Giardia intestinalis	18 (5.79%)	12 (1.02%)	21 (1.30%)	4 (0.97%)	0	27 (1.51%)	28 (1.62%)	0	14 (1.52%)	41 (1.58%)	0.899
Ascaris lombricoïdes	4 (1.29%)	24 (2.04%)	26 (1.61%)	1 (0.24%)	0.086	31 (1.73%)	24 (1.39%)	0.419	11 (1.19%)	44 (1.70%)	0.292
Trichuris trichiura	2 (0.64%)	11 (0.93%)	23 (1.43%)	2 (0.48%)	0.263	16 (0.89%)	22 (1.28%)	0.273	9 (0.98%)	29 (1.12%)	0.723
Trichomonas intestinalis	2 (0.64%)	4 (0.34%)	12 (0.74%)	3 (0.72%)	0.566	9 (0.50%)	12 (0.70%)	0.457	8 (0.87%)	13 (0.50%)	0.214
Tænia saginata/ solium	2 (0.64%)	8 (0.68%)	2 (0.12%)	1 (0.24%)	0.089	4 (0.22%)	9 (0.52%)	0.145	1 (0.11%)	12 (0.46%)	0.128

Table 5: Prevalence of different intestinal parasites in relation to season and year of occurrence.

Species	Age group (years)					Gender			Service		
	<15 years (N=302)	13-30 years (N=1139)	31-60 years (N=1562)	>60 years (N=404)	P-value	Male (N=1735)	Female (N=1672)	P-value	Hospitalized (N=896)	Nonhospitalized (N=2511)	P-value
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Ascaris lombricoïdes	4 (1.29%)	24 (2.04%)	26 (1.61%)	1 (0.24%)	0.086	31 (1.73%)	24 (1.39%)	0.419	11 (1.19%)	44 (1.70%)	0.292
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Trichomonas intestinalis	2 (0.64%)	4 (0.34%)	12 (0.74%)	3 (0.72%)	0.566	9 (0.50%)	12 (0.70%)	0.457	8 (0.87%)	13 (0.50%)	0.214
Tænia saginata/solium	2 (0.64%)	8 (0.68%)	2 (0.12%)	1 (0.24%)	0.089	4 (0.22%)	9 (0.52%)	0.145	1 (0.11%)	12 (0.46%)	0.128

DISCUSSION

Intestinal parasite infections are still public health problems in tropical and subtropical countries including Senegal, which motivated this study in the laboratory of parasitology-mycology of the CHU Le Dantec of Dakar during the period from January 2011 to December 2020. An overall prevalence of 21.37% was found. This prevalence can be considered as high compared to the one found by same laboratory during the period from January 2011 to December 2015. An overall prevalence of 15.8 % was found [12].

This prevalence may be considered low compared to not only that found in another Dakar University Hospital laboratory where Sylla et al. found prevalence of 26.8% between 2006 and 2010 at the Fann hospital but also that found in a study of slaughterhouse workers in Dakar with 49.56% even if the latter may be classified among subjects at risk [15,16]. Recently in 2022, Wale and Solomon were found in Ethiopia a prevalence of 65% [17]. Elsewhere, but still in Asia, a study among schoolchildren was found a prevalence of protozoan and helminth intestinal parasitism was 82.0% [18].

These values are very high above ours. However, these differences could be put into perspective, given that these cross-sectional studies had been carried out in a population aged between 5 years and 15 years, where hygiene conditions remained much more precarious, especially with promiscuity. On the contrary, in Turkey, the prevalence found (3.7%) by a study carried out between 2012 and 2014 was four times lower than ours. This low prevalence may be justified by the fact that intestinal parasitic infections are more frequent in developing countries (30% to 60%) than in developed ones (≤ 2%) [19]. Disparity in prevalence between our study and others could be attributed to sociodemographic factors such as the study subjects educational status, occupation, or age. Geographic factors such as sanitation and climatic factors may also play a role in the variation. According to the results of this study, females (22.39%) had slightly higher infection rate than male (20.38%). In Ethiopia, regarding the intestinal parasite cases between the genders, males (28.6%) were more infected with IP infection than females (26.2%), this undoubtedly shows that gender does not necessarily influence infestation by intestinal parasites [20]. Multivariate analysis using a logistic regression model showed that intestinal parasitic infections were less frequent in 2013 and 2020 versus 2011. Regarding hospitalized or nonhospitalized status, intestinal protozoan infections were significantly more frequent in nonhospitalized patients with 23.63% than in hospitalized patients with 14.98%. This same observation was made studying the epidemiological aspects of intestinal parasitic infections diagnosed at the Fann hospital in Dakar [15]. This same observation was supported by Marwa Omar et al. [21]. Their study has reported the highest prevalence rates of the infection during the summer months (66.9%) and the lowest infection rates in winter (35.8%). Additionally, Amer et al. have denoted the relationship between seasonality and intestinal parasitic infections [3]. This observation can be explained on one hand by the fact that very often patients considered nonhospitalized (outpatients) are, for the majority, hospitalized in other structures without a laboratory of parasitology. So they are actually hospitalized patients. On the other hand, the aim of the parasitological examination in outpatients, in general, is to confirm intestinal parasitic infection before treatment unlike in hospitalized patients (inpatients) in whom, very often, the parasitological examination of stools could aim to rule out the hypothesis of intestinal parasitic infection.

According to the result of this study, the distribution of infestation according to age group was significant in our series. The prevalence of intestinal protozoa parasite's infection observed could be due to low immunity in individual, less awareness of washing hands and other personal hygiene measures within these age groups. Akimbo et al., as well as Hailu and Ayele, reported age as a potential risk factor for intestinal parasitism [22,23]. On the other hand, Hussein et al. and Abbaszadeh Afshar et al. denied any correlation between either age or gender and intestinal parasitism. Protozoal infection was more prevalent than helminthic infection in our sample [24,25]. Similar to the present study, protozoan parasites were more common in studies from Senegal [12,15,16]. However, in Ethiopia, helminth infection was more prevalent than protozoan infection [26]. The higher prevalence of protozoan parasites may be linked to poor personal and environmental hygiene, as protozoan parasites are transmitted mostly by the feco-oral route, which is transmitted indirectly through the intake of contaminated food and drink [27]. The lower helminth prevalence could be due to a deworming program against helminths particularly soil-transmitted helminths and schistosomiasis in Senegal [6,11,13]. Furthermore, because low temperatures are not conducive to helminth infection, the climatic conditions of our study area (high altitude and low temperature) may reduce the prevalence of helminth infection [28]. The most common protozoan found were *E. coli* (6.43%), *B. hominis* (5.60%), *E. histolytica/dispar* (2.22%), *G. intestinalis* (1.22%), and *T. intestinalis* (0.51%) were the most found species in our series. These same species have already been found among the predominant species by El Guamri et al. and Baba et al., respectively, in Morocco in 2009 and Mauritania in 2012 [29,30]. However, the order of distribution could be different. *E. coli* was the most frequent parasite found. This may be justified by the commensal nature of this amoeba considered to be little or no pathogenic [17]. However, it has been identified as an indicator of environmental pollution due to the poor sanitation and the low hygiene level of the residents [31]. *E. coli* is a common commensal parasite found in the intestinal tract but does not cause clinical symptoms. It is only found in the lumen of the intestinal tract but not in the epithelial cells. Furthermore, *E. coli* infection does not spread to other organs compared to *E. histolytica/dispar*. However, the examination of one child in the study showed the presence of *E. histolytica/dispar* therefore, the discovery of *E. coli* in the water needs special consideration since the examination using lugol dyeing technique has its limitation in differentiating Entamoeba species [32]. The second protozoan isolated in our study was *B. hominis* (5.60%). In Algeria, the most common species in the symptomatic subjects were *Blastocystis spp.* (43.8%), *E. histolytica/dispar* (25.4%) and *Giardia intestinalis* (14.6%) [33]. The authors of this study explained he high prevalence of *Blastocystis spp.* in symptomatic population confirms the results of a previous survey in Libya in which a prevalence of 35.3% was recorded in symptomatic patients compared to a prevalence of 13.2% in asymptomatic subjects [34]. However, multifactorial analysis of prevalence of Blastocystis infection and risk factors showed that in symptomatic population male subjects experienced significantly higher prevalence with Blastocystis than females. The higher prevalence in male subjects might be due to their greater everyday participation in outdoor activities than females, as for example in the raising and husbandry of animals, which make them more vulnerable to parasitic infections. Moreover, in asymptomatic population, significantly higher values for prevalence of Blastocystis infection were recorded in each year of the study among those who owned animals. It is pertinent that a high prevalence of Blastocystis infections, and subtypes of this species, have been previously reported amongst subject with close contact with animals and animal handlers, providing supporting evidence that transmission of the parasite between humans and animals may be frequent in pastoral communities [35,36]. In Indonesia, the predominant species found were *Blastocystis hominis* (34.5%), *Giardia lamblia* (19.0%), and *Entamoeba coli* (15.5%). The authors was showed that several residents do not get adequate nutritional intake, this condition exacerbates the pathogenicity of *B. hominis* infections and might even lead to clinical symptoms such as malnutrition and stunting [37]. From the species of intestinal protozoan, the leading pathogenic one was *E. histolytica/dispar* with a 2.22% prevalence rate, following G. *intestinalis* (1.22%). In Ethiopia, the overall prevalence of intestinal protozoa infections (*E. histolytica/dispar* and G. *lamblia*) was 44% [17]. Hajissa Khalid et al. reported in their meta-analysis, nine types of protozoan parasites. *Giardia spp.* (38/46 (82.6%)) and *E. histolytica/dispar* (33/46 (71.7%)) were the most frequently identified parasites [38]. The variations in prevalence rates of *E. histolytica/dispar* and *Giardia spp.* might be attributed to low sanitation level, contamination of drinking water source, poor hand washing practices and consumption of raw vegetables. In our study G. *intestinalis* was significantly associated with age. The observed prevalence of *Giardia* in this study is consistent with those described in other countries [11,39]. The deleterious effect of *Giardia intestinalis* on growth and health of children has been shown by several studies [40]. This parasite is known for its ability to induce diarrhoea and malabsorption syndrome, and it can lead to protein energy malnutrition, vitamin A deficiency, iron deficiency anaemia, and vitamin B12 deficiency anaemia [41].

As part of a long-term goal to eliminate intestinal parasitic infections as a public health problem, WHO has recommended Mass Drug Administration (MDA) with a single oral dose of mebendazole or albendazole given periodically to children preschool and school age [42-44]. Albendazole can have an effective action against both protozoan and helminthic infections and can be a suitable molecule in mass deworming programs, particularly in areas where *Giardia* is frequent. Thus, replacing mebendazole by albendazole during a mass deworming programme could further reduce the frequency of helminthic infections as well as protozoan infections and, consequently, the occurrence of diarrheal disease and malabsorption syndrome [11].

Among different helminth species detected during this study, A. lumbricoides was the most frequently recovered parasite (1.05%), which is comparable with study conducted in Senegal [12,15,16]. The prevalence of *T. trichiura* (0.68%) and *Taenia saginata/solium* (0.37%) and others helminths were lower. This variation might be due to the difference in the distribution of helminth species in different geographical areas and method differences that might underestimate the detection of helminth infection [44]. The associations of protozoa which we found were dominated by *B. hominis-E. coli* (26 cases), *E. coli-E. histolytica/dispar* (16 cases) and *E. coli-G. intestinalis* (9 cases) by biparasitism. Concerning helminths, a most association between helminths was found at 10 cases with *A. lumbricoides* associated with *T. trichiura.* Three polyparasitism were found *E.histolytica/dispar-A.lumbricoïdes-T. trichiura*, *E.histolytica/dispar-B.hominis-Chilomaxtix mesnili* and and *E. histolytica/dispar- B. hominis-E. coli.* In Indonesia, Sri Wahdini et al. were observed the same mixed infections, B. hominis- *E. coli* (13.8%), *B. hominis-G. intestinalis*, (8.6%), *E. coli-G. intestinalis* (1.7%) and *E. histolytica/dispar- B. hominis-E. coli* (1.7%) [45]. The associations found in our study showed very often the species considered as little or no pathogenic as *B. hominis*, *E. coli* or *T. intestinalis*, which confirms the opportunistic and frequent character of these protozoan species which, in the presence of favorable factors, can increase in number and determine digestive disorders.

Our study presents some limitations mainly due to the fact that these data are derived from a retrospective evaluation of intestinal parasites. For this reason, important data, such as possible risk factors for parasitic infection (hand hygiene, food safety training, medical check-up, educational status, monthly income, hand and vegetable washing, domestic animals and livestock, type of house material, source of drinking water, use of water treatment-chlorine or boiling, latrine use and rural/urban residence. A stool examination diagnostic technique that is carried out in Senegal in general is direct wet mount, which could underestimate the prevalence of intestinal parasite in this retrospective study.

CONCLUSION

The prevention and control of intestinal parasitic infections are now more possible than ever before, owing to the discovery of safe and effective drugs, the improvement and simplification of some diagnostic procedures. In recent years, general health care strategies have emphasized preventive medicine and community cooperation in the control of endemic disease and have created a favourable environment for the design and implementation of control measures against intestinal parasitic infections. The evaluation of the results of our laboratory, which is one of the centers that can screen many patients, will contribute to the epidemiological data of our country. In the light of the results obtained from different regions of our country, it will be possible to properly direct the necessary strategies for the diagnosis, treatment of parasitic infections and the implementation of preventive measures. This highlights the fact that parasitic infections are still an important public health problem.

AUTHORS CONTRIBUTION

Conceptualization, MN; Formal analysis, MN: Methodology, MN: Writing-original draft, MN: Writing-review and editing. MAD; DN; ASB; MCS; and EK.

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STATEMENTS

Institutional review board statement

Individual names were deleted from the data acquired from the laboratory to maintain confidentiality, and only unique identification numbers were used to identify individuals. We certify that the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

Informed consent statement

It's a retrospective study.

Data availability statement

Not applicable.

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CONFLICTS OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and the writing of this paper.

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