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PREVALENCE OF GASTROINTESTINAL PARASITES AND ITS PREDICTORS AMONG RURAL EGYPTIAN SCHOOL CHILDREN

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Abstract

The development of suitable control measures for various intestinal parasitic infections (IPIs) requests essential epidemiological information on their prevalence. The present study was conducted to determine the prevalence of IPIs among school children living in a rural setting in Upper Egypt and to identify the associated risk factors to these infections**.** A Descriptive cross-sectional study included 630 randomly selected students enrolled in primary and preparatory schools aged from 6 to 17 years old from rural Assiut Governorate. The data were collected using a structured questionnaire. A laboratory stool examination was performed. The overall prevalence of IPIs was 56.3 %. The parasites were *Ascaris lumbricoides* (11.4%), *Giardia lamblia* (10.0%), *Entamoeba coli* (9.7%), *Ancylostoma duodenal* (8.7%), *Entamoeba histolytica/dispar* (8.1%), *Cryptosporidium parvum* (3.3%), *Blastocystis hominis* (2.4%), *Enterobius vermicularis* (1.7%) and *Hymenolepis nana* (1.1%). A single parasite was in 64.8% of children. 23.1% & 12.1% had double and multiple parasites respectively.

Keywords: Intestinal parasites, Predictors, School children, Rural, Upper Egypt.

Introduction

Despite the great development in socio-economic status which has occurred recently in many parts of the world, particularly in developing countries, intestinal parasitic infections (IPIs) are still a common public health problem in school-age children (Bayoumy *et al*, 2018). The prevalence of these parasites differs from one Arabian country to another. In the Middle East, for instance, reports on intestinal parasites have shown variable prevalence rates of 42.5% in Syria, 33.9% in Qatar, 31.4-32.2% in Saudi Arabia, 28.7% in Yemen, 28.5% in Jordan, 19.3-27.3% in Iran, 27% in Egypt, 16.6-74.6% in Palestine, 17-90.4% in Sudan, and 12.4% in Lebanon (Bdir and Adwan, 2010). In Egypt, IPIs are an important health problem in children (Monib *et al*, 2016). There are many causes for difference in infections prevalence between countries as geographic, socio-economic aspects, climate, poverty, malnutrition, personal and community hygiene, population density, no clean water and poor sanitary facilities (Amer *et al*, 2018).
Un-development of the hygienic habits of children gets them more vulnerable to intestinal parasitic infections (Macchioni *et al*, 2015). Crowding among children in schools was reported to be the cause of environmental contamination with these parasites (Mbae *et al*, 2013). About 600 million school-age children worldwide suffered from intestinal parasitic infections (Tefera *et al*, 2015)

Child nutritional status and physical development impairment are commonly affected by IPIs, which will have negative consequences on cognitive function and learning ability (Nematian *et al*, 2008). Children are in a dynamic state of growth with their rapidly multiplying cells and developing organ systems which make them more vulnerable to the environmental risks (WHO, 2003).

The IPIs consume nutrients from children-infection, thus retarding their physical development. IPIs cause many health problems because they destroy tissues and organs leading to abdominal pain, diarrhea, intestinal obstruction, anemia, ulcers, especially when hookworms infection was present (Adeyeba and Akinlabi, 2002; Ahmed *et al*, 2003). Parasitic sicknesses might be a reason for other medical issues, for example, a ruptured appendix, cholecystitis, and intestinal obstacle (Radwan *et al*, 2019). The scaling up action to confront environmental risks including IPIs is a real prospect for improving child health and generating a better future for the coming generations (Adeyeba and Akinlabi, 2002; Ukpai and Ugwu, 2003; WHO 2003). Several studies reported varied prevalence of IPIs, due to its importance for public health, and showed its high prevalence in developing countries especially in children (Ulukanligil and Seyrek, 2003; Graczyk *et al*, 2005; Banke *et al*, 2006; Jiraamonninit *et al*, 2006; Cauyan *et al*, 2008; Aly and Mostafa, 2010). For identification of the potential factors associated with IPIs risks few studies had been conducted (Nematian *et al*, 2004; Awolaju and Morenikeji, 2009; Sah *et al*, 2013).

The present study aimed to determine the prevalence of intestinal parasitic infections among 6 to 17 years old school children from rural Upper Egypt and to identify the socio-demographic, environmental and behavioral predictors related to the detected infections.

Materials and Methods

Study area: The study was performed on two primary and two preparatory schools in Koom Abousheel; a randomly selected village at Abnoub District located in north As siut. Assiut Governorate is one of the Upper Egyptian Governorates 375km South to Cairo.

Study design and sampling: A cross-sectional study was carried out during the academic year 2017-2018, on students aged 6 to 17 years. The sample size was calculated using the following equation: n= (Z2*p* "p)/ D2 (Lwanga and Lemeshow, 1991). Actual number of randomly selected classes was 684 of whom 630 (92%) completed the questionnaires and sampling. A dropout rate of 8% (n= 54) due to absenteeism.

Data collection and specimen analysis: A semi-structured questionnaire gathered infomation concerning: socio-demographic characteristics including personal data, work in agricultural or other duties, educational level of the parents, parents occupation, number of individuals in the household and number of the house rooms of the studied students.

Data regarding hygienic behavior of the studied students were also collected in the questionnaire including habit of washing hands before meals, and after defecations, availability of soap for hand-washing, habit of eating raw and/or unwashed vegetables, water source for drinking, presence of animals inside home and fingernail condition (observed during questionnaire). A field pretesting of the questionnaire was carried out on a sample of 30 students who were not in the sample; the necessary modification in the sheets was done.

A total of 630 stool samples were collected from children after procuring informed permission from the school and parental authorities. Students were instructed about what they must do. Stool samples were collected at schools in dry, clean, leak-proof plastic disposable cups with lids labeled with name, age, date, class, and sex of the student. All samples were transported within half an hour to parasitology Laboratory, Department of Medical Parasitology, Faculty of Medicine, Assiut University. Stool specimens were examined macroscopically and microscopically. Stool consistency was reported. Each stool sample after macroscopic examination was well mixed and stored in10% formalin at 4°C, (one portion stool with three portion preservative) using suitable containers labeled with the same information. Each stool specimen was concentrated using formalin-ethyl acetate sedimentation and zinc sulfate floatation concentration methods. Direct microscopic examination of saline, iodine and lacto-phenol cotton blue (LPCB) wet mount preparations of stool specimens were prepared to screen for parasitic stages. The smears from each stool sample were stained using a modified Kinyoun acid-fast staining technique for coccidian parasites detection (Parija *et al*, 2003).

Statistical analysis: Data were entered and analyzed using SPSS (statistical package for social science) software version 16. The frequencies and percentages were computed. A chi-squared test was used to measure the association of risk factors with parasitic infections. The confidence level was set at 5%. The bivariate analysis used contingency table analysis with the chi-square test. The multiple logistic regression models, odds ratios and the corresponding 95% confidence level were calculated. Multivariate analysis was performed on all the variables with a P-value of less than 0.05. To eliminate confounding variables, the significance level was settled at $P<0.05$.

Ethical consideration: The study was approved by the committee of the Faculty of Medicine, Assiut University. Formal administrative approvals and informed permission from the school and parental or guardian authorities were obtained before the start of the fieldwork. Students were briefed about the study. The authors stressed on the issue of confidentiality and all students were requested to fill out the questionnaires anonymously. To overcome variations in reading, the questionnaire was read aloud to students. As regards the young students aged 6- 8 years, home visits were done to complete the questionnaires by personal interviews. Parasitological reports were sent to the school administers and school health teams including the names of the positive students and the detected parasites for proper treatment.

Results

Out of 630 examined school children, nine species of intestinal parasites were encountered with an overall prevalence of 56.3% (355). Various intestinal parasites including protozoans, nematodes, and cestodes were detected. The gastrointestinal parasites were *Ascaris lumbricoides* eggs (11.4%), *Giardia lamblia* cysts and trophozoites (10.0%), *Entamoeba coli* cysts and trophozoites (9.7%), *Ancylostoma duodenale* eggs (8.7%), *Entamoeba histolytica* cysts (8.1%), *Cryptosporidium parvum* oocysts (3.3%), *Blastocystis hominis* cysts (2.4%), *Enterobius vermicularis* eggs (1.7%) and *Hymenolepis nana* eggs (1.1%) in order of frequencies.

For both sexes, the infections were higher for protozoa compared to helminthes. The later was detected in 144 students (22.9) while protozoan infections were in 211 students (33.5). Single infection was detected in 65% of positive cases, while 23% showed double infection and 12% showed multiple infections. Double infection was common between *G. lamblia* and *C. parvum* and multiple infections between *A. lumbricoides*, *G. lamblia* and *E. histolytica*.

The distribution of parasitosis concerning age groups showed that in all ages, the predominant intestinal parasite was *G. lamblia* and *E. coli* followed by *A. lumbricoides* and *A. duodenale*. Protozoan infections were among younger school children (6-13 years old) than older ones (14-17years). But, helminths were common in the middle age group (10-13 years). Helminthic infections were more predominant in males (32.6) than in females (16.9) the difference was significant, while protozoan infections were nearly equal in both sexes (33.2 in males and 32.5 in females) the difference was not statistically significant. The commonest parasites in males were *A. lumbricoides* (15.4%), *G. lamblia* (11.7%), *A. duodenale* (11.4%) and *E. histolytica* (9.7%) in order of frequency.

The age was ranged from 6 to 17 years with a mean of 11.5. The age groups 6-14 years had a high proportion of parasitic infections compared to the older age group ($P=0.003$). Details mentioned above. Out of 630 randomly selected pupils, 298 (47.3%) were males and the rest 332 (52.7%) were females. Gastrointestinal parasitic infections were more widespread in male children (62.8%) than in female ones (50.6%) with significant difference ($P=0.004$).

As regards working in agricultural duties; 230/332 working children were infected by different parasites while 102 students were free of parasites. At the same time, 173 out of 298, not working children were free and

125 were infected. These differences were statistically significant.

The occurrence of IPIs among school children was not affected by both the father's education and parent's occupation, without significant difference between parasitic infection and these factors (P=0.294, P=0.883 & P=0.080 respectively). The majority of pupils' mothers were illiterate and children showed higher frequencies of parasitosis in this group than in other maternal educational levels and with significantly increased risk for parasitosis (P=0.030). The IPIs increased when the number of persons in household was from 6-9 persons and decreased when they were 2-5 or more than ten. The difference was statistically significant (P>0.05). Parasites' prevalence was increased with a decrease in the number of house rooms (1-3) (67.7%) and decreased when there were more than 4 rooms at homes. (P=0.041).

As to hygienic behavior, a high percentage of parasitic infections were significantly associated with an absence of the habit of washing hands before meals and after defecation (P=0.011 & 0.033 respectively).

There were IPIs increased among school children when no availability of soap for hand-washing was present and the reverse occurred, with insignificant (P>0.05). Concerning the practices of eating raw and/or unwashed vegetables, a high risk of infection was significantly associated with the presence of these habits (P<0.05). Tap water was main source, but without significant effect on IPIs prevalence (P > 0.05). Intestinal parasitosis rates were higher among children having pets than those without, but insignificant difference (P=0.079). The prevalence of IPIs among school children having the bad figure nails (long, unclean) was higher (65.8%) than those who had short and clean figure nails (36.5%)(P=0.031). The multiple logistic regression analysis in table 5 investigated which factors dah significant independent contributions to IPI risk. ten factors were identified as the most predictors of parasitic infections among them including: age (P= 0.003, OR= 3.9), sex (P= 0.004, OR= 4.7) of respondent children, working in agricultural duties (P= 0.001, OR= 3.3), mother's education (P= 0.030, OR= 10.4), increased number of individuals in the household (P= 0.020, OR= 3.9), decreased number of house rooms (P= 0.030, OR= 3.7), unwashed hands before meals (P= 0.010, OR= 3.6), unwashed hands after defecation (P= 0.030, OR= 3.7), Habit of eating raw/ unwashed vegetables (P= 0.044, OR= 2.9) and children with dirty fingernails (P= 0.031, OR= 13.8). Details were given in tables (1, 2, 3, 4 & 5) and figures (1 & 2).

Table 1: Number and percent distribution of IPIs by species (n=630)

Detected parasites	Positive Number	Positive Percent %
Helminthes	144	22.9
Ascaris lumbricoides	72	11.4
Ancylostoma duodenale	55	8.7
Enterobius vermicularis	11	1.7
Hymenolepis nana	6	1.1
Protozoans	211	33.5
Giardia lamblia	63	10.0
Entamoeba coli	61	9.7
Entamoeba histolytica	51	8.1
Cryptosporidium parvum	21	3.3
Blastocystis hominis	15	2.4
Total positive children	355	56.3

NB: Columns, sum more than total due to some co-infections.

Table 2: Distribution of IPIs by Age groups among children at Koom Abousheel School

Parasites	6- (n = 203)	10- (n =258)	14-17 (n = 169)
	No (%)	No (%)	No (%)
Helminthes	36(17.7)	92 (35.7)	28 (16.6)
Ascaris lumbricoides	14 (6.9)	53 (20.5)	5 (3.0)
Ancylostoma doudenale	9 (4.4)	29 (11,2)	17 (10.1)
Enterobius vermicularis	5 (2.5)	4 (1.6)	2 (1.2)
Hymenolepis nana	3 (1.5)	2 (0.8)	1 (0.6)
Protozoans	99 (48.8)	72 (27.9)	58 (34.3)
Giardia lamblia	34 (16.7)	18 (7.0)	11 (6.5)
Entamoeba coli	29 (14.3)	23 (8.9)	9 (5.3)
Entamoeba histolytica	9 (4.4)	20 (7.8)	22 (13.0)
Cryptosporidium parvum	12 (5.9)	4 (1.6)	5 (3.0)
Blastocystis hominis	8 (3.9)	3 (1.2)	4 (2.4)
Total	123 (60.6)	156 (60.5)	76 (45.0)

NB: Columns' sum more than total due to some co-infections.

Table 3: Univariate analysis of relationship between IPI and socio-demographic characteristics of students (P<0.05)

Characteristics	Total (n= 630)	Positive (n=355)		Negative (n=275)		P-value
		No.	%	No.	%	
Age in years 6- 10- 14- 17 Range (6-17) (11.4± 2.5)	203 258 169	123 156 76	60.6 60.5 45.0	80 106 93	39.4 40.0 55.0	0.003
Male Female	298 332	187 168	62.8 50.6	111 164	37.2 49.4	0.004
Working in agricultural duties: Yes No	332 298	230 125	69.3 41.9	102 173	30.7 58.1	0.001
Father education: Illiterate :Read and write :Basic education (Primary or Preparatory) : Secondary school (General/Technical) : Higher education :Do not know and died fathers	167 91 99 110 65 98	87 51 52 61 39 65	52.1 56/0 52.5 55.5 60.0 66.3	80 40 47 49 26 33	47.9 44.0 47.5 44.5 40.0 33.7	0.294
Mother's education: Illiterate :Read and write: Basic education (primary or preparatory) :Secondary school (general/technical) :Higher education :Do not know and died mothers	270 136 68 44 38 74	155 80 33 23 20 44	57.4 58.8 48.5 52.3 52.6 59.5	115 56 35 21 18 30	42.6 41.2 51.5 47.7 47.4 40.5	0.030
Father's occupation: Farmer :Employer :Workers :Free business :Does not work and died father	258 70 180 93 29	145 42 98 55 15	56.2 60.0 54.4 59.1 51.7	113 28 82 38 14	43.8 40.0 45.6 40.9 48.3	0.883
Mother's occupation: Housewife :Employer :Do not know and died mother	431 93 106	233 53 69	54,1 57.0 65.1	198 40 37	45.9 43.0 34.9	0.080
Number of individuals indoors: 2-5 :6-9 :10+	82 425 123	22 266 67	26.8 62.6 54.5	60 159 56	73.2 37.4 45.5	0.039
Number of rooms: 1-3 :4-6 :7+ Crowding index (2.4±1.3)	319 241 70	216 113 26	67.7 46.9 37.1	93 128 44	32,3 53.1 62.9	0.041

Table 3: Univariate analysis of relationship between IPI and socio-demographic characteristics of students (Level of significance P<0.05).

Characteristics	Total (n= 630)	Positive (n=355)		Negative (n=275)		P-value
		No.	%	No.	%	
Age in years: 6-	203	123	60.6	80	39.4	0.003
:10-	258	156	60.5	106	40.0	
:14- 17	169	76	45.0	93	55.0	
:Range (6-17) (11.4± 2.5)						
Male	298	187	62.8	111	37.2	0.004
Female	332	168	50.6	164	49.4	
Working in agriculture; Yes	332	230	69.3	102	30.7	0.001
No	298	125	41.9	173	58.1	
Father's education: Illiterate	167	87	52.1	80	47.9	0.294
:Read and write	91	51	56.0	40	44.0	
:Basic education (Primary + Preparatory)	99	52	52.5	47	47.5	
:Secondary school (general/technical)	110	61	55.5	49	44.5	
:Higher education	65	39	60.0	26	40.0	
: Do not know and died father	98	65	66.3	33	33.7	
Mother‘s education: Illiterate	270	155	57.4	115	42.6	0.030
:Read and write	136	80	58.8	56	41.2	
:Basic education (primary or preparatory)	68	33	48.5	35	51.5	
:Secondary school (general/technical)	44	23	52.3	21	47.7	
:Higher education	38	20	52.6	18	47.4	
: Do not know and died mother	74	44	59.5	30	40.5	
Father‘s occupation: Farmer	258	145	56.2	113	43.8	0.883
:Employer	70	42	60.0	28	40.0	
:Workers	180	98	54.4	82	45.6	
:Free business	93	55	59.1	38	40.9	
:Does not work and died father	29	15	51.7	14	48.3	
Mother‘s occupation: Housewife	431	233	54,1	198	45.9	0.080
:Employer	93	53	57.0	40	43.0	
:Do not know and died mother	106	69	65.1	37	34.9	
Number of individuals indoors: 2-5	82	22	26.8	60	73.2	0.039
:6-9	425	266	62.6	159	37.4	
:10+	123	67	54.5	56	45.5	
Number of rooms: 1-3	319	216	67.7	93	32,3	0.041
:4-6	241	113	46.9	128	53.1	
:7+	70	26	37.1	44	62.9	
Crowding index (2.4±1.3)						

Table 4: Univariate analysis of relationship between IPI and hygienic behavior of respondent students

Characteristics	Total examined (n=630)	Positive (n=355)		Negative (n=275)		P-value
		No.	%	No.	%	
Washing hands before meals Yes	398	168	42.2	230	57.8	0.011
No	232	187	80.6	45	19.4	
Washing hands after defecation Yes	240	92	38.3	148	61.7	0.033
No	390	263	67.4	127	32.6	
Availability of soap :Yes	415	210	50.6	205	43.4	0.069
:No	215	145	67.4	70	32.6	
Eating raw/unwashed vegetables :Yes	375	223	59.5	152	40.4	0.044
:No	255	132	51.8	123	48.2	
Water source for consumption						0.073
:Waterworks system	510	278	54.5	232	45.5	
:Other	120	77	64.2	43	35.8	
Presence of pets indoors :Yes	363	210	57.9	153	42.1	0.079
:No	267	145	54.3	122	45.7	
Fingernail condition: Short, clean	203	174	36.5	129	63.5	0.031
:Long, unclean	427	281	65.8	146	34.2	

Level of significance P<0.05

Table 5: Multiple logistic regression analysis of predisposing factors associated with for intestinal parasitic risk.

Predictors	P-value	Odds ratio	OR 95 % confidence interval	
			Upper Limit	Lower Limit
Age in years	0.003	3.9	15.8	4.3
Sex	0.004	4.7	22.9	7.8
Working in agricultural duties	0.001	3.3	12.4	2.3
Mother's education	0.030	10.4	57.2	1.9
Increased number of individuals in the household	0.039	3.9	48.6	8.0
Decreased number of the house’ rooms	0.041	2.3	22.1	2.3
Unwashed hands before meals	0.011	3.6	12.3	2.6
Unwashed hands after defecation	0.033	3.7	14.6	2.3
Habit of eating raw/ unwashed vegetables	0.044	2.9	12.1	1.3
Dirty fingernail condition	0.031	13.8	49.5	4.2

Discussion

Identification of high-risk communities and formulation of appropriate interventions was the primary objective of epidemiological studies on the prevalence of IPIs in different localities (Gelaw *et al*, 2013; Teklemariam *et al*, 2014; Mengistu *et al*, 2014). IPIs are public health problem in many countries, including Egypt accompanied by high morbidity rates among schoolchildren (Al-Delaimy *et al*, 2014). The present results showed the occurrence of several intestinal parasites of public health importance among school children. The prevalence of intestinal parasites (56.3%) was higher than studies in rural Egyptian Governorates e.g. Minia Governorate (53.8%), Sohag Governorate (38.5%) Upper Egypt, Damanhur villages (57.3%), rural Beheira Governorate (38.3%), rural Menoufia Governorate (27%) Lower Egypt, Damietta (30.7%) and Aswan (31%) respectively (Ibrahium, 2011; El-Masry *et al*, 2007; Radwan *et al*, 2019; Bayoumy *et al*, 2018; Abou El-Soud *et al*, 2009; Mohammad *et al*, 2012; Dyab *et al*, 2016).
Abroad, Mekonnen and Ekubagewargies (2019) reported that the prevalence of intestinal parasites was (18.7%) in Northwest Ethiopia in younger children, Ismail (2018) in Saudi Arabia, Taif reported a prevalence of (12%) in school children. But, El-Nadi *et al*. (2017) found a higher (63.5%) prevalence among school children. The present prevalence was lower than studies done in different developing and undeveloped countries (Ulukanligil and Seyrek, 2003; Jiraamonninit *et al*, 2006; Awolaju and Morenikeji, 2009; Aly and Mostafa, 2010; Ayalew *et al*, 2011; Gelaw *et al*, 2013; Sah *et al*, 2013). The lower intestinal parasitosis could be due to differences in urbanization, improved knowledge of personal hygiene, and improved environmental sanitation, for example, clean and safe water supply, and effective human and animal waste disposal (Kamel *et al*, 2014).

There are various factors that could affect the prevalence variations between different countries or even within the same country including; economic and educational status of parents and study subjects, environmental sanitation, differences in climatic conditions, and previous control efforts and low socioeconomic circumstances communities were more subjected to parasitic diseases (Luong, 2003).. Improved environmental and socioeconomic factors may account for the decreased prevalence of intestinal parasites (Punsawad *et al*, 2018).

Other factors affected the distribution and prevalence of various intestinal parasites species included methodology, sample size, seasonal variation and/or lack of school deworming activity (Teklemariam *et al*, 2014).

The gastro-intestinal parasites included: *A. lumbricoides* (11.4%), *G. lamblia* (10%), *E. coli* (9.7%), *A. duodenale* (8.7%), *E. histolytica* (8.1%), *C. parvum* (3.3%), *B. hominis* (2.4%), *E. vermicularis* (1.7%) and *H. nana* (1.1%). Similar parasites were detected in Minia and Sohag Governorates with variable rates (El-Masry *et al*, 2007; Ibrahium, 2011; El-Nadi *et al*, 2017). Also, data were in line with studies conducted in Nigeria and Ethiopia (Adeyeba and Akinlabi, 2002; Ukpai and Ugwu, 2003; Banke *et al*, 2006; Awolaju and Morenikeji, 2009; Ayalew *et al*, 2011; Gelaw *et al*, 2013; Mengistu *et al*, 2014; Teklemariam *et al*, 2014).

In this study, protozoa (33.5%) were more prevalent in school children than helminths (22.9%). This could be due to the slow development of immunity in children to protozoan parasites and different evasion mechanisms to helminthes' immunity. Radwan *et al*. (2019) found that protozoa diseases were more common than helminthes, which might be credited to the distinction in their transmission, as the majority of sore or growths are transmitted legitimately by one individual then onto the next (Ukpai and Ugwu, 2003). The prevalence of protozoan and helminthic infections may be attributed to many reasons comprising: poor environmental conditions and personal hygiene, an inadequate supply of drinking water, and a waste disposal system which did not correspond with the approved standards (Ayalew *et al*, 2011). The rural residence had a significant difference regarding the intestinal parasitic infection due to bad environmental sanitation and low personal hygiene or usage of human feces as an agricultural fertilizer and due to central sewage disposal system absence (Dyab *et al*, 2016; El-Nadi *et al*, 2017; Maru, 2017).

In this study, multiple infections (polyparasitism) occurred in 12% of the total positive subjects. Double infections were detected in 23% of study subjects with intestinal parasites. The prevalence of multiple infections was very low compared to previous studies conducted on various localities including Ethiopia (Ayalew *et al*, 2011), Plateau Central and Centre-Ouest locales, Burkina Faso (Erismann *et al*, 2017). Difference in parasites detections may be attributed to sample size, population and/or methodology (Awolaju and Morenikeji, 2009; Gelaw *et al*, 2013).

There was a highly statistical association between pupil's sex, and parasitic infection in the present study. Authors recorded higher infection rates in males than females, especially helminthic infection. This result agreed with Ayalew *et al*. (2011). These differences could be attributed to that boys spent most of their time playing outside the home, especially in the rural communities, due to their high activity in this age group (Cauyan *et al*, 2008; Sah *et al*, 2013). But, Monib *et al*, (2016) reported a slightly higher prevalence rate among females (29.4%) compared with males (24.7%) explained by the smaller sample size of females. Radwan *et al*. (2019) did not recognize factually huge distinction among sexes.

Infection was higher in the age group less than 15 years old than 15 years old or more. This could be due to better awareness of washing hands and other personal hygiene measures in the elder group. This agreed with Radwan *et al*. (2019) who found that the high level of parasites was among patients less than 10 years ascribed to their terrible clean practices.

In the present study, working school children in agricultures were more exposed to parasitosis (69.3%) than others (41.9%). Kishk *et al*. (2004) found high parasitosis among working children due to frequent contact with contaminated environment.

There was a strong significant relationship between mothers' education and the prevalence of IPIs. Maternal education levels were inversely correlated with the risk of infections in children in this study. Radwan *et al.* (2019) reported that parasitic diseases level was higher among kids whose moms were of lower and medium classifications of training than advanced educated ones. This agreed with others. Nematian *et al*. (2004) detected a lower parasitic infection rates in children when the educational level of the mothers was elevated in Iran. Curtale *et al*. (1998) declared that one of the instrumental in designing and implementing an effective community based intestinal helminth control program in Egypt was the mother's educational level including; knowledge, perception, and behavior of mothers. Wamani *et al*. (2004) found that the best predictor of health and nutrition inequalities among children in rural Uganda was the mother's education.

There were no significance between the prevalence of protozoa or helminths with socio-economic factors; including father's education and parents' occupation (P>0.5). The reverse was observed for house materials and crowding index. An increase in the number of individuals in the household had a positive impact on the occurrence of parasitic diseases of school children in comparison to those lives with a little number of individuals in the household. Also, decreased numbers of house rooms caused more chances to acquire infections reflected on increased numbers of parasitically infected children in the present study who lived in a few rooms in their houses with a significant difference. This agreed with Abou El-Soud *et al*. (2009) who found that crowded houses caused owners to be more exposed several infections including parasites. Low financial standard additionally influences their wholesome status and thusly lessens protection from contamination with crafty pathogens (Radwan *et al*, 2019).

Talukder (2002) reported those habits and behaviors that contribute to individual cleanliness which include washing face and hands; regular bathing, nail cutting and wearing clean to be the definition of personal hygiene. This was in agreement with the study results where high association was detected between IPIs in children and improper personal hygiene such as lack of hand washing before meals (80.6%) and after defecation (67.4%) and under-nails (65.8%). Proper hand-washing before and after meals and after using toilet minimize chances of contracting diseases (Ulshen, 2000; FNRI, 2002). FDA stated that the foods are borne-diseases (Abou El-Soud *et al*, 2009). The improper food safety practices among school children were associated significant intestinal parasitism. Cleanliness of household utensils, drinking water, toilets and proper management of human and animal excreta around households were referred to household sanitation (Greshoff, 2002). A significant health beneficial impact on households and across communities especially among young children was obtained through improving sanitation (Rao, 2002).

In the present study, children in households with pets had near rates for IPIs similar to those without pets with no significant difference (P= 0.079). Many pets as dogs, cats, chickens, cattle, and horses were possiand others are reservoirs for IPIs (Sackey *et al*, 2003). Pets were an important factor of exposure to contamination (Puteri, 2007). The availability of the soap and water source did not affect IPIs prevalence (P> 0.5).

Ten main risk factors were identified as the most important predictors of parasitic infections among school children in a rural area included age, sex, working in agricultural duties, mother's education, increased number of individuals in the household, decreased number of house rooms, lake of hand washing before meals and after defecation, the habit of eating raw/ unwashed vegetables and dirty fingernails. The results agreed with others indicated that hygienic behavior and environment caused the risk of IPIs (Bartlett, 2003). Parasites were significant in poor houses, low or no mothers' education and sanitation lack (Culha, 2007).

Conclusion

Intestinal parasites were prevalent in varying magnitude among the school children. Protozoa were higher than helminthes. *Giardia lamblia* was commonest protozoa and *Ascaris lumbricoides* was commonest helminthes. Ten factors were identified as the most important predictors of parasitic infections including age, sex, working in agricultural duties, mother's education, increased number of individuals in the household, decreased number of house rooms, lack of hand-washing before meals and after defecation, habit of eating raw/ unwashed vegetables and dirty fingernails. Continuous health education campaigns and increase families' awareness about proper sanitation and hygienic behavior in and outdoors for these target population.

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Explanation of figures

Fig. 1: Types of IPIs among school children

Fig. 2: Percent distribution of IPIs among school children by sex