Research Article

Current Status of Intestinal Parasites among Elementary School children in Sohag, Egypt

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Abstract | Intestinal parasitic infections (IPIs) are of the maximum generic of human infections international, causing extensive morbidity and mortality particularly in children. Our aim was to estimate the situation of IPIs in stool and fingernails samples among elementary schoolchildren in Sohag, Egypt. In this cross-sectional research stool specimens from 200 schoolchildren were inspected macroscopically and microscopically by formol-ether sedimentation, after that staining with Kinyoun's modified acid-fast stain. Fingernails cuts of the children were gathered, put in tubes including 10% KOH before examination by light microscope for detection of parasites. A detailed questionnaire about clinical symptoms was done. Univariate also multivariable logistic relapse models were calculated for interpretation of the danger figures for parasitic infection. 63.5% of children harbored at least one type of intestinal parasite. There were significant differences regarding infections in contrast to residence and family size. Monoparasitized children constituted 40% while 23.5% were polyparasitized. Protozoa were more frequent than helminths parasitizing (53.5% vs 4%) of the studied children. *Cryptosporidium* sp., *G. duodenalis* and *E. histolytica/ dispar* were the majority regular parasites found, with prevalence rates of 34%, 14.5% and 13% respectively. The predominant helminthic infection was *H. nana* (5%). Polyparasitzed children were more frequently symptomatized than monoparasitized children. A significant difference was detected between diarrhea and polyparasitzed children. *E. vermicularis* and *H. nana* eggs were found in 2% of the fingernail clippings. Age, gender, residence, also family size were not danger figures to polyparasitism after calculation of univariate what's more multivariable logistic relapse models. IPIs were very common among Sohag schoolchildren. Hence, there is an insistent requirement to execute an integrated project to decrease the predominance and intensity of these infections.

Keywords | Intestinal parasitic infections, School children, Polyparasitized, Monoparasitized

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INTRODUCTION

Gastrointestinal illnesses created toward pathogenic protozoa and helminths are related to an elevated degree of morbidity and mortality worldwide, particularly in children. In developing nations, protozoal infections were registered every year in 58 million children (Calderaro et al., 2014). Intestinal worms reached up to 12% of the total disease burden in children aging 5–14 years in low-income countries (Reji et al., 2011). The World Health Organization detected that 600 million of school children living in tropical and subtropical localities had intestinal parasitic infections (Tefera et al., 2015). The difficulty to acquire safe water, hygiene and sanitation are the key factors for the high intensity of intestinal parasites that, children frequently have the clinical manifestations of gastrointestinal morbidity and malabsorption syndrome (Macchioni et al., 2015). Crowding among children in schools was reported to increase the opportunity for person-to-person transmission or environmental contamination with these parasites (Mbae et al., 2013).

The oro-fecal course has a gigantic role in the transmission of IPIs to individuals. Intestinal parasites stick to fin-

gers, fruits, vegetables, instruments, and others can do the trick. Adherence of parasites to fingernails is considered a salient source of infection. Hence, their vicinity clinched alongside fingernails will be an implication of an animated contamination (Moses et al., 2013). In Egypt, IPIs are a common health trouble in children. Almost 27% of the know youngsters would endure from intestinal parasites. To realize good preventive measures, epidemiological studies are important methods for determining the occurrence of these parasitic infections (Monib et al., 2016).

The available research was to recognize intestinal parasites, both helminth and protozoa in schoolchildren through copro-microscopic techniques.

MATERIALS AND METHODS

Study Area

This study was evaluated in Sohag Governorate, Upper Egypt. Sohag is located in the southern part of the country, toward 467 km to the south of Cairo. It covers an extent of the Nile Valley with a total area of 1547 km^2, with estimated 4,603,861 people.

Ethics statement and study design

Evaluation of this cross sectional research started from January 2015 to December 2016 in Sohag, Egypt after being authorized by the scientific ethics committee of our institute. Investment for schoolchildren was voluntary taking after demonstrating the intent of the study. Distinct agreements were obtained from selected children' guardians before data and sample collection with a short illustration of the methodology and the target of this study.

Inclusion Criteria

200 school-aged children between 6 and 12 years (Age Mean ± SD = 8.9±1.9) had participated in this study and randomly recruited from four elementary schools (2 urban and 2 rural) in our governorate to be included in the study. 119 (59.5%) were <10 years , while 81 (40.5%) were ≥10 years. 103 (51.5%) of them were boys and 97 (48.5%) were girls. As regards residence they were evenly divided between rural and urban areas. As for family size <5 members were 42 (21%) of the studied group and ≥ 5 members were 158 (79%) of the studied group .

Parasitological Methods

Fecal Samples: Stool specimens were gathered in dry, clean and labeled containers. Macroscopic and microscopic examination of the safeguarded specimens (formalin 10%) were completed then focus toward formol-ether sedimentation (Garcia, 2016) emulated by staining with Kinyoun's modified acid-fast stain (Garcia, 2016).

Nail Clippings Examination: Fingernails of the selected kids were curtailed and gathered in little plastic bags after that converted to centrifuge tubes and 10% KOH might have been included (Alo et al., 2013).

Diagnosis: Children were considered as positive for a particular infection if one of the diagnostic methods revealed a positive result.

STATISTICAL ANALYSIS

Information was organized, tabulated, and statistically analyzed utilizing SPSS version (22). Chi-Square test (χ^2) and Fisher's Exact test were utilizing when appropriate for comparison between qualitative variables. Univariate also Multivariate logistic regression tests were dissected for identification of certain danger figures for polyparasitism. $P < 0.05$ indicates significant values.

RESULTS

Among 200 children registered in this research, 127 (63.5%) were found to be positive for at least one intestinal parasitic species. There were significant differences regarding infection related to residence and family size. No statistically significant differences regarding gender or age were observed (Table 1).

Table 1: Demographic features of the studied children in relation to infection.

	Infected children (n=127)	Non-infected children (n=73)	P-value
Age			
< 10 years	76 (63.9%)	43 (36.1%)	0.425
≥ 10 years	51 (63%)	30 (37%)	
Gender			
Boys	68 (66%)	35 (34%)	0.446
Girls	59 (60.8%)	38 (39.2%)	
Residence			
Urban	56 (56%)	44 (44%)	0.028*
Rural	71 (71%)	29 (29%)	
Family size			
< 5 members	19 (45.2%)	23 (54.8%)	0.006*
≥ 5 members	108 (68.4%)	50 (31.6%)	

* Statistically significant

Monoparasitic children (80 child= 40%) were more frequent than polyparasitic children (47 children = 23.5%). Protozoan infections were more frequent than helminths, (107 children 53.5% vs 8 children 4%) of the studied group. 36 child (12%) were harboring both protozoa and helminths, while, pure polyhelmithic infection was not recorded in our research.

The predominant pathogenic protozoan was Cryptosporidium with a prevalence (34%). The prevalence of other detected parasitic infections is illustrated in (Table 2). Using the modified Z-N (Kinyoun) stain, intestinal coccidian parasites prevalence are illustrated in (Table 3).

Table 2: Parasite frequencies and percentages in descending manner

	n (%)
Protozoa	
Pathogenic	
Cryptosporidium	68(34.0)
G. intestinalis	29(14.5)
E. histolytica/ dispar	26(13.0)
Blastocystis	21(10.5)
C. caytanensis	13(6.5)
Non-pathogenic	18(9.0)
Helminths	
H. nana	10 (5.0)
A. lumbricoides	4 (2.0)
E. vermicularis	4 (2.0)
A. duodenale	3 (1.5)

Table 3: Frequencies of intestinal coccidian oocysts detected by the Kinyoun stain

Cryptosporidium	63 (31.5%)
Cyclospora	8 (4.0%)
Cryptosporidium and Cyclospora	5 (2.5%)

Results showed that children exhibited various forms of polyparasitism (Table 4). Polyparasitism with two protozoan parasites were revealed in (17.3%) of the children. Cases of protozoan polyparasitism are illustrated in (Table 5).

Table 4: Frequencies of different forms of polyparasitism (mixed protozoal & helminth infections)

	n(47)	%
Double infection	31	24.4
Triple infection	10	7.9
Quadruple infection	5	3.9
Pentaple infection	1	**0.8**

To define the performance of the nail clipping inspection in expression of sensitivity and specificity, stool examination was considered the confirmatory test. Fingernail clip pings examination was performed for all enrolled children. *E. vermicularis* and *H. nana* eggs were detected. Gathering stool and fingernail examinations, a total of 4 children were infected with *E. vermicularis* eggs, 3 of them were positive in both stool and fingernail specimens and only one child

Table 5: Protozoal co-infections among parasitized children (n = 127)

	n (%)
Double infection	
E. histolytica/ dispar, Blastocystis	4 (3.1)
Giardia, Blastocystis	3 (2.4)
E. histolytica/ dispar, Giardia	5 (3.9)
Giardia, C. mesnilli	1 (0.8)
Giardia, E. coli	5 (3.9)
Blastocystis, I. butscilli	2 (1.6)
E. histolytica/ dispar, I. butscilli	2 (1.6)
Total	22(17.3)
Triple infection	
E. histolytica/ dispar , Giardia, Blastocystis	3 (2.4)

was positive in the stool sample. Results showed that nail clipping examination 75% sensitive and 100% specific (Table 6, 7). For *H. nana* infection, 10 children were positive. Of them, 4 were positive using both examinations and 6 were positive using stool examination only (Table 8). This stands for a sensitivity of 40% and a specificity of 100% (Table 9).

Table 6: Results of stool and nail clipping examinations for diagnosis of *Enterobius* infection (n=200)

Nail examination	**Stool examination**		**Total**
	Positive	**Negative**	
Positive	3	0	3
Negative	1	196	197
Total	**4**	**196**	**200**

Table 7: Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) of nail clipping examination for the screening of *Enterobius* infection

	Value %
Sensitivity	75%
Specificity	100 %
Positive predictive value (PPV)	100 %
Negative predictive value (NPV)	99.4 %

Results revealed that the type of polyparasitzed children was more frequently symptomatized than monoparasitized children. A statistical significance was exposed between diarrhea and the type of parasitism. Other symptoms showed no statistical significance. Statistical significant difference was found regarding *Blastocystis*, *Cryptosporidium*, *A. lumbricoides* and *E. vermicularis* in relation to symptoms. (Table 11).

Table 8: Results of stool and nail clipping examination for diagnosis of *H. nana* infection (n=200)

Nail examination	Stool examination		Total
	Positive	Negative	
Positive	4	0	4
Negative	6	190	196
Total	**10**	**190**	**200**

Table 9: Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) of nail clipping examination for the screening of *H. nana* infection

	Value %
Sensitivity	40%
Specificity	100 %
Positive predictive value (PPV)	100 %
Negative predictive value (NPV)	96.9 %

Table 10: Relation between symptoms and type of parasitism amongst parasitized children (n=127)

	Monoparasitism (N=80)	Polyparasitism (N=47)	P-value
Diarrhea			
Yes	12 (42.9%)	16 (57.1%)	0.012*
No	68 (68.7%)	31 (31.3%)	
Pain			
Yes	6 (42.9%)	8 (57.1%)	0.098
No	74 (65.5%)	39 (34.5%)	
Dysentery			
Yes	0 (0.0%)	2 (100%)	0.135
No	80 (64%)	45 (36 %)	
Perianal itching			
Yes	2 (66.7%)	1 (33.3%)	0.894
No	78 (62.9%)	46 (37.1%)	

*Statistically significant

Infection rates with *G. intestinalis*, *E. histolytica/ dispar, Cryptosporidium, C. caytanensis and A. duodenale* were more popular in children <10 years. However, no statistical significance was found. On the other hand, children ≥10 years were more infected with, *Blastocystis*, *H.nana*, *A.lumbricoides*. Moreover, *E.vermicularis* was equally distributed between the two age groups.

Univariate also multivariable logistic regression tests were analyzed to identify danger figures that were expected to be significantly correlated with intestinal polyparasitism. According to our data, none of the age, gender, residence or family size were danger figures for polyparasitism. (Tables 12, 13).

DISCUSSION

IPIs are still a public health issue in many communities, especially in the developing countries including Egypt and are accompanied with elevated morbidity among schoolchildren (Al-Delaimy et al., 2014).

The data of the actual study directed over four haphazardly decided governmental primary schools in urban and rural Sohag, Egypt demonstrated that (63.5%) of the sharing children infected at least by one parasite.

The almost non-changing situation of IPIs in Sohag is evident from the agreement of the actual feedback with those of Hamed et al. (2013) who reported the infection in (63.31%) among Sohag rural children aged less than 12 years. Over contrast, a lower predominance rate about (38.5%) has been formerly accounted for IPIs among elementary schoolchildren in Sohag by El-Masry et al. (2007); they didn't perform any special concentration or staining procedures for diagnosis.

Several other studies have reported lower rates of IPIs among schoolchildren from other governorates, for instance, (30.7%), and (31%) in Damietta, and Aswan by Mohammad et al. (2012) and Dyab et al. (2016). Changes in these proportions were correlated to the variance in sample size and methods for examination.

In our research, a predominance of protozoa compared to helminthic infections (53.5% vs. 4%) among school children was found. Such high predominance rate is depended on the solitary stool test per child, as contrary to the perfect three sequential tests.

Monoparasitism had the majority predominant sort for infection, being common around (40%) from claiming schoolchildren, while (23.5%) were harboring various infections. Our outcomes are consistent with the outcomes of a cross-sectional overview carried out earlier by Matthys et al. (2011) in Western Tajikistan who detected that (40.9%) of all children participated in their evaluation had a solitary species of infection, whereas (17.3%) had a double species of infection. Meanwhile, co-infections were common, influencing (32.5%) for schoolchildren in the Plateau Central and Centre-Ouest locales of Burkina Faso as reported by Erismann et al. (2017). This indicates that these environments are extremely contaminated.

Cryptosporidium was the most predominant parasite in this study (34%). The significant danger variable to *crypto sporidium* contamination may be drinking water that is defiled for oocysts. Moreover, oocysts can survive in chlorine

Table 11: Symptoms of pathogenic parasites among all infected children

	Symptoms				No symptoms	P-value
	Diarrhea	Pain	Dysentery	Perianal itching		
Protozoa						
E. histolytica/ dispar	7 (26.9%)	2 (7.7%)	2 (7.7%)	0 (0.0%)	15 (57.7%)	0.053
Blastocystis	7 (33.3%)	8 (38.1%)	0 (0.0%)	0 (0.0%)	6 (28.6%)	0.000*
G. intestinalis	11 (37.9%)	2 (6.9%)	0 (0.0%)	0 (0.0%)	16 (55.2%)	0.151
Cryptosporidium spp.	16 (23.6%)	3 (4.4%)	0 (0.0%)	0 (0.0%)	49 (72.1%)	0.033*
C. caytanensis	4 (30.8%)	2 (15.4%)	0 (0.0%)	0 (0.0%)	7 (53.8%)	0.825
Helminths						
H. nana	1 (10%)	2 (20%)	0 (0.0%)	0 (0.0%)	7 (70%)	0.732
A. lumbricoides	1 (25.0%)	3 (75%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.001*
A. duodenale	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (100%)	0.772
E. vermicularis	0 (0.0%)	1 (25%)	0 (0.0%)	3 (75%)	0 (0.0%)	0.000*

*Statistically significant

Table 12: Univariate logistic regression test of factors associated with polyparasitism

	OR ($CI_{95\%}$)	P - value
Age	0.7 (0.4 – 1.5)	0.426
Sex	0.7 (0.3 – 1.5)	0.425
Residence	0.9 (0.5– 1.9)	0.919
Family size	1.8 (0.6 – 5.3)	0.3

OR, Odds ratio. CI, Confidence interval.

Table 13: Multivariate logistic regression test of factors associated with polyparasitism

	Adjusted OR ($CI_{95\%}$)	P - value
Age	0.8 (0.4 – 1.7)	0.579
Sex	0.8 (0.4 – 1.6)	0.456
Residence	1.03 (0.5– 2.2)	0.936
Family size	1.7 (0. 5 – 5.1)	0.374

OR, Odds ratio. CI, Confidence interval.

utilized for water treatment (Latif and Rossle, 2015). This is higher than the study evaluated in Triopli, Lebanon by Osman et al. (2016), where *Cryptosporidium* was (10.4%) despite using molecular methods. One illustration to this might be that the project performed in an urban zone.

G. intestinalis was the second predominant intestinal parasite in our research (14.5%) which was slightly less than the prevalence reported earlier in rural schoolchildren of our governorate by El-Masry et al. (2007) (15.2%). *G. intestinalis* infection reached (28.1%) among Burkina Faso school children (Erismann et al., 2017), they used the same diagnostic techniques for intestinal protozoa detection as ours.

In the existing project, (13%) of children had *E. histolytica/ dispar* infection. This is a high prevalence denoting that the diagnosis was based on a solitary stool test rather than the perfect three sequential tests. *E. histolytica* was the most prevalent (20.4%) as reported by El-Masry et al. (2007). Significantly higher prevalence (66.5%) was reported among Burkina Faso schoolchildren (Erismann et al., 2016). This may confirm the fact that both *G. intestinalis* and *E. histolytica/ dispar* are still endemic in this region.

Blastocystis sp. is considered an under-reported parasite around the world, It has a prevalence far exceeding that of other intestinal parasites in the mankind's populace. Indeed, its predominance can arrive 100% in developing nations and between 1.5% and 20% in industrialized nations (Osman et al., 2016). In the existing study, (10.5%) of children were infected with *Blastocystis* sp. It was also discovered in 10.6% among Peninsular Malaysia schoolchildren (Nithyamathi et al., 2016).

C. cayetanensis showed a prevalence of (6.5%) in the sitting evaluation, while, it was detected in (3.9%) in schoolchildren from Kathmandu, Nepal (Bhandari et al., 2015).

Only 4 species of intestinal helminths were noted with prevalence lower than expected in this highly susceptible age group.

The exhibited study revealed *H.nana* in (5%) of the sample. The researcher expected that formol-ether concentration (FEC) method designated for identification of the low-intensity infections was expected to expose higher rates of infection. Comparable prevalence (6.5%) was reported in Burkina Faso (Erismann et al., 2017). Meanwhile, *H. nana* prevalence was (14.9%) among rural schoolchildren in Sohag, Egypt (El-Masry et al., 2007). They did not report us-

ing FEC techniques which point to a promising decrease in infection prevalence in our governorate.

About STHs, only *A. lumbricoides* and *A. duodenale* were detected (2% and 1.5% respectively). This is a very minimal prevalence than expected in this age group. This decrease is multifactorial. First of all, we did not perform further FEC methods such the Kato-Katz techniques to assess infection intensity and detect light infections. *A. lumbricoides* (6.5%), *A. duodenale* (5.1%) and *T. trichiura* (2.1%) were reported by El-Masry et al. (2007). In contrast, (27.9%) of STH was reported by Al-Delaimy et al. (2014) in rural Malaysia. The authors reported using the Kato-Katz and the Harada Mori methods.

E. vermicularis eggs were revealed in (2%) only of the studied children and this was partly expected as the scotch adhesive tape swab, being the gold standard method for diagnosis, was not performed because of compliance issues. According to El-Masry et al. (2007), *E. vermicularis* prevalence was (16.6%); they reported using the scotch adhesive swab. Mohammad et al. (2012) and Yazgan et al. (2015) reported higher prevalence (5.2%) and (10.4%) among Damietta, Egypt, and the town of Kayseri Turkey schoolchildren respectively. They also reported using the cellophane tape method.

The rural residence had a significant difference regarding infection (P-value 0.028). This might be due to poor environmental sanitation and lack of personal hygiene. The present results are in agreement with that recently detected by Dyab et al. (2016) and Maru (2017). They found that Intestinal parasitic infection was strongly associated with residence in rural localities in schoolchildren of Aswan, Egypt, and Northern Ethiopia. This may be due to that the human feces are usually utilized as agricultural fertilizer. Also, absence of the central sewage disposal system.

For *Cryptosporidium*, a statistical significance was found in relation to symptoms. (72.1%) of *Cryptosporidium*-infected children were asymptomatic, while (23.6%) complained of diarrhea and (4.4%) had an achy tummy. Consistently, an investigation around Spanish children attending day care facilities indicated that *Cryptosporidium* sp. infections were asymptomatic in 82% of cases (Mateo et al., 2014).

Blastocystis infected children complained of diarrhea (33.3%), abdominal pain (38.1%) while (28.6%) were asymptomatic. This revealed a statistically significant relationship. This finding highlights the potential pathogenicity of the infection.

Nevertheless, a positive combination regarding *Blastocystis* sp. and abdominal pain suggests a pathogenic impact for this parasite of questionable clinical significance (Osman et al., 2016).

Regarding Helminths, a significant difference was found between *A. lumbricoides* and *E.vermicularis* in relation to symptoms. (75%) of children harbored *A. lumbricoides* had abdominal pain while (75%) of children harbored *E.vermicularis* had perianal itching.

Shrestha et al. (2012) achieved a cross-sectional survey to appreciate the severity of intestinal parasites among Western Nepal schoolchildren. Results explored that children who reported gastrointestinal complaints were found to have an elevated rate of infection by intestinal parasites (23.45%).

In the exhibit study, (23.5%) of selected children were polyparasitized. Out of them, (17.5%) had pure protozoal polyparasitism and (6%) were parasitized by protozoa and helminths simultaneously.

22 (17.3%) of the parasitized children had two species infections. The most popular double infection was with *E. histolytica/dispar* and *Blastocystis* sp. with a prevalence of (3.1%). In addition, (2.4%) of children presented triple infections with *E.histolytica, G.intestinalis* and *Blastocystis*. Univariate What's more multivariate logistic relapse models revealed that age, gender, residence also family size were not danger figures to polyparasitism. This is consistent with Al-Delaimy et al. (2014).

Lack of Nail hygiene undoubtedly is highly accompanied with intestinal parasitosis. Only *E. vermicularis* (2.36%) and *H. nana* (3.15%) eggs were detected by fingernail examination. Meanwhile, Moses et al. (2013) accounted for an extensive variety of parasitic helminth eggs with fundamentally higher pervasiveness (57.2%). The parasites disconnected from those primary schoolchildren fingernails were; *A. lumbricoides, E.vermicularis, T.trichiuria,* and *A. duodenale* with predominance rates of (20.0%), (17.8%), (12.9%) and (6.5%) respectively.

Untrimmed and filthy fingernails were watched throughout information collection, and it is being likewise an autonomous danger element for the procuration of IPIs correlates with those of former studies from the developing countries.

Therefore, promoting school hygiene practices through inspection of schoolchildren for cleanliness and trimming of fingernails could have a positive impact on decreasing the burden of infections with parasites that have direct life cycles.

CONCLUSION

IPIs are very common among schoolchildren in Sohag, Egypt. Hence, there is a pressing need to attain a modernistic control program to constrict the predominance and intensity of these infections significantly and to save these children from their negative impacts.

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CONFLICT OF INTEREST

There are no conflicts of interest.

AUTHORS CONTRIBUTION

Idea by Nada AF El-Nadi, Eman F Fadel performed the laboratory works and collected data, Noha S Ahmed helped with the laboratory analysis of samples, collection of papers, data analysis and writing the manuscript and Nada AF El-Nadi, Eman K Omran revised the manuscript.

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