Ahmed and Abu-Sheishaa
Egyptian Pediatric Association Gazette (2022) 70:6
https://doi.org/10.1186/s43054-021-00093-9

Egyptian Pediatric Association Gazette

RESEARCH
Open Access

Intestinal parasitic infection among school children in Dakahlia governorate, Egypt: a cross-sectional study

Haytham Mahmoud Ahmed[1*] and Gamal Ali Abu-Sheishaa[2]

Abstract

Background: Intestinal parasitic infections are still representing a significant health problem in developing countries including Egypt. School children are highly vulnerable to this type of infection, and they suffered many health consequences. This study was conducted to identify the prevalence of intestinal parasitic infection among school children and its related factors.

Results: This is a school-based cross-sectional study conducted on 726 school children selected from primary, preparatory, and secondary schools located at Aga district, Dakahlia governorate. A questionnaire sheet including data on the socio-demographic characters of students and their families, environmental and behavioral variables, and gastro-intestinal symptoms was filled. Also, fresh stool samples were collected from each child for microscopic examination to detect eggs, cysts, and trophozoites of intestinal parasites. There were 239 of 726 children with IPIs representing an overall prevalence of 32.9%. The most prevalent parasitic species were *E. histolytica* (12.3%), *G. lamblia* (8.5%), *H. nana* (7.7%), and *A. lumbricoides* (5.7%). There were significant differences between infected and non-infected children regarding age, educational stage, residence, monthly family income, and maternal education levels. Also, there were highly significant differences between infected and non-infected children regarding all environmental and behavioral variables and the occurrence of GIT symptoms.

Conclusion: High prevalence of IPIs among school children indicates little personal hygiene and poor environmental sanitation. Much more efforts are needed for the application of proper prevention and control strategy.

Keywords: Aga district, Dakahlia governorate, Intestinal parasitic infection, School children

Background

Intestinal parasitosis is a group of diseases caused by infection by one or more cestodes, trematodes, nematodes, and protozoa [1, 2]. Health services have achieved significant improvement in the diagnosis and treatment of the parasitic disease; however, it still represents a challenge for health staff and facilities in many developing countries and IPIs infection is one of the major public health problems and affecting primarily school children [3]. The problem of IPIs is greater in poor countries with limited resources [4].

Parasitic infection is much more prevalent among poor individuals of the population. This is due to the associated poor housing conditions, poor personal hygiene and unsanitary environmental conditions, overcrowding, higher contact with contaminated soil and water, and lack of accessible health services [5]. It is also affected by behavioral, environmental, biological, socio-economic, and health service factors. Family income, educational and employment status, and quality of civil infrastructures have a role in disease transmission and the associated morbidity and even mortality [6, 7].

*Correspondence: drhaytham1972@gmail.com
[1] Department of Public Health and Community Medicine, Faculty of Medicine, Al-Azhar University, Cairo, Egypt
Full list of author information is available at the end of the article

Most of the intestinal parasites are transmitted to their susceptible host by ingestion of contaminated foods and drinks or by getting in contact with contaminated soil and water where infection occurs through skin penetration by the infective larva stage. Sometimes, the infection may be acquired by close personal contact especially between school children [8].

Parasitic infection is associated with intestinal bleeding, nutritional deficiency, cell and tissue damage, anemia, and delayed physical and mental development. This leads to high rates of school absenteeism and poor academic performance [9–11].

Children are at high risk of infection due to their little awareness, immature immune system, and high nutritional requirements [12]. Children's IPIs are significantly associated with wasting and stunted growth [13]. Therefore, World Health Organization (WHO) recommends periodic treatment of school children with anti-helmentic drugs especially in highly infected localities, and to improve the children's nutritional status, hemoglobin, cognition, and overall health status [10].

In the last few years, the prevalence of IPIs and their associated risk factors among Egyptian school children were assessed through studies conducted in different governorates which revealed IPIs still representing a public health problem as it affects a considerable proportion of children. Therefore, periodic assessment of IPIs prevalence and identification of the associated risk factors is necessary for proper planning and implementation of effective prevention and control measures.

Therefore, the present study was performed to assess the prevalence of IPIs and identification of the possible related factors among school children in the Aga district of Dakahlia governorate.

Methods

Study design and setting

This is a school-based cross-sectional study that was conducted on primary, preparatory, and secondary school children in Aga district, Dakahlia governorate during the studying year 2020-2021from October 2020 to January 2021 to assess the prevalence of IPIs among school children. Dakhalia governorate is located in the northeast of the Delta region with an estimated population number 6.577 million. The capital of the governorate is Mansoura city which lies at a distance of 130 km of Cairo. Aga district lies 15 km south of Mansoura city at latitude 30.91° N and longitude 31.29° E with a population number 538.484 in July 2017 [14].

Sampling technique and sample size

A cluster sampling technique was used in the study where a school list in the Aga district was obtained from the local educational directorate. Schools were categorized according to their localities into urban and rural schools and from each category we selected randomly one school from each educational stage (primary, preparatory, and secondary). In the end, we have six schools; three urban (primary, preparatory, and secondary) and three rural (primary, preparatory, and secondary schools). A representative random sample of children was selected from each school which ranges from 10 to 15% of the total number of children in the school.

The calculated sample size required to perform the study was 367 children based on estimated IPIs prevalence 39.5% [15], 95% confidence interval, and 5% marginal errors. In order to increase the power of the study, we decided to double the calculated number, so the planned sample size was 734 children. During the data collection phase, 8 children failed to give stool samples, so we have complete data of 726 children who were included in the final analysis.

Study questionnaire

Data were collected using a structured questionnaire which was designed after reviewing the literature of similar objectives. It was prepared first in the English language and then translated to the Arabic language. Two staff members from parasitological and community medicine departments, Al-Azhar faculty of medicine assessed the quality of the questionnaire where some modifications were performed. Also, a pilot study was performed on 30 school children to assess its applicability. These students would not be included in the study. The questionnaire includes data on the socio-demographic characters (age, gender, educational stage, residence, monthly family income, and father and mother education) of the participants, environmental and behavioral risk factors (home environment, finger hygiene, handwash habit, washing vegetables and fruits well before consumption, domestic animal and water contact, and walking bare footed), and GIT symptoms (anorexia, nausea or vomiting, abdominal pain, bloating, constipation or diarrhea and bloody stool).

Data collection

Data collection was performed by three interviewers who were trained by the authors on the procedures of data collection and the method of stool sample collection and preservation. The selected children were interviewed to obtain information about their address and the mobile of their parents. Also, children received dry, clean, leak-proof, and labeled plastic disposable containers for stool sample collection. The questionnaire was filled out through home visiting of the selected children and interviewing their parents. During the interview, the home environment and fingernails hygiene of children were observed by the interviewers. At the end of the visit, a stool sample was collected.

Stool examination

In the laboratory, each collected sample was examined using a direct wet mount and the formal ether concentration technique. Stool specimens were examined macroscopically and microscopically. Stool samples were examined macroscopically and microscopically by (i) direct wet smear method [16], (ii) concentration methods by simple floatation and formol ether sedimentation techniques [17], and (iii) Kato-Katz technique [18]. The cellophane tape adhered to a glass slide was used by children to investigate the infection status of *Enterobius vermicularis*.

Data analysis was performed using the SPSS software version 20. Descriptive statistics in the form of frequencies and percentages were performed and the differences between the studied variables were analyzed using chi-square and Fisher's exact tests. *P* value < 0.05 was considered a sign of significance.

The study was approved by the Ethics Committee of the Faculty of Medicine, Al-Azhar University. All the study participants and their parents were informed about the aim and the procedures of the study. Also, written informed consents were obtained from the parents before data collection. Permission from the responsible authorities to perform the study was obtained.

Table 1 Prevalence of intestinal parasitic infection among studied school children

	No.	%
Type of intestinal parasite[a]		
Protozoa		
E. histolytica/dispar	89	12.3
G. lambilia	62	8.5
Helminthes		
A. lumbricoides	41	5.7
A. duodenale	6	0.8
E. vermicularis	49	6.8
H. nana	56	7.7
S. mansoni	2	0.3
Number of parasites		
No infection	487	67.1
Mono infection	143	19.7
Double infection	71	9.8
Triple infection	25	3.4
Total	726	100

[a] Sum is greater than the total due to co-infections of some students

Results

There were 239 students infected with intestinal parasites of 726 studied students representing a prevalence rate of 32.9%. Of those infected students, there were 143 students mono-infected, 71 double-infected, and 25 triple-infected. The most prevalent parasites were *E. histolytica/dispar* (12.3%), *G. lambilia* (8.5%), *H. nana* (7.7%), and *E. vermicularis* (6.8%) (Table 1).

The studied sample consisted of 385 (53.0%) male and 341 (47.0%) female children. There were 256 (35.3%) children with an age range between 6 and 10 years, 271 (37.3%) with age range 11–14 years, and 199 (27.4%) with age range between 15 and 18 years. Also, there were 336 children (46.3%) from rural areas whereas 390 (53.7%) were from urban areas. There were 151 (20.8%) children with family income less than 2000 L. E, 364 (50.1%) with family income between 2000 and 4000 L. E and 211 (29.1%) with family income more than 4000 L.E. Most of the children's parents were of secondary level education (36.9% of fathers and 38.8% of mothers). Also, most of the infected children were male (53.0%), between 6 and 10 years old (35.3%), at primary school (40.1%), rural residents (53.7%), with family income between 2000 and 4000 L. E (50.1%), and secondary educated fathers and mothers (36.9% and 38.8%, respectively). There were significant differences between infected and non-infected children regarding gender, residence, family income, and mother's educational level (Table 2).

Most children have a clean home environment (66.4%), good hygiene of the fingernails (68.5%), wash their hands before and after meals (55.0%) and after bathroom use (57.3%), and wash vegetables and fruits well before consumption (61.0). On the other side, the minority of children has contact with domestic animals (32.6%), water contact activities (24.4%), and walks barefooted (25.5%). Also, most of the infected children have a dirty home environment (57.7%), bad fingernails hygiene (50.7%), not wash their hands before after meals (56.1%), not wash their hands after bathroom use (51.0%), not wash vegetables and fruits well before consumption (64.0%), in contact with domestic animals (65.7%), have water contact activities (60.0%), and walk barefooted (54.8%). There were highly significant differences between infected and non-infected children regarding all behavioral and environmental risk factors (Table 3).

The most-reported GIT symptoms among infected children were abdominal pain (60.7%), constipation or diarrhea (42.7%), bloating (38.5%), anorexia (30.1%), and nausea or vomiting (24.7%) whereas the presence of blood in stool was the least reported symptom (13.0%). These symptoms were much less prevalent in non-infected children. Also, highly significant differences were observed between infected and non-infected children (Table 4).

Table 2 Socio-demographic risk factors of parasitic infection among studied school children

	Total No. (%)	**Infected No. (%)**	**Non-infected No.(%)**	***P* value**
Gender				
Male	385 (53.0)	131 (54.8)	254 (52.1)	0.5
Female	341 (47.0)	108 (45.2)	233 (47.9)	
Age				
6–10	256 (35.3)	109 (45.6)	147 (30.2)	0.00001*
11–14	271 (37.3)	87 (36.4)	184 (37.8)	
15–18	199 (27.4)	43 (18.0)	156 (32.0)	
Educational stage				
Primary	291 (40.1)	133 (55.7%)	158 (32.4)	< 0.00001*
Preparatory	245 (33.7)	67 (28.0)	178 (36.6)	
Secondary	190 (26.2)	39 (16.3%)	151 (31.0)	
Residence				
Urban	336 (46.3)	93 (38.9)	243 (49.9)	0.005*
Rural	390 (53.7)	146 (61.1)	244 (50.1)	
Monthly family income				
< 2000 L,E	151 (20.8)	36 (15.1)	115 (23.6)	0.003*
2000–4000 L. E	364 (50.1)	140 (58.6)	224 (46.0)	
>4000 L. E	211 (29.1)	63 (26.3)	148 (30.4)	
Fathers' education				
Illiterate	173 (23.8)	61 (25.5)	112 (23.0)	0.54
Primary and preparatory	125 (17.2)	35 (14.6)	90 (18.5)	
Secondary	268 (36.9)	87 (36.4)	181 (37.2)	
University or higher	160 (22.1)	56 (23.5)	104 (21.3)	
Mothers' education				
Illiterate	227 (31.3)	81 (33.9)	146 (30.0)	0.02*
Primary and preparatory	100 (13.8)	28 (11.7)	72 (14.8)	
Secondary	282 (38.8)	104 (43.5)	178 (36.5)	
University or higher	117 (16.1)	26 (10.9)	91 (18.7)	
Total	726 (100)	239 (100)	487 (100)	

*statistically significant difference

Discussion

This study was conducted to identify the prevalence of different parasite species and the related factors among the most vulnerable group in the community; school children. This will aid to identify the hot infection areas and proper application of control measures.

There were 239 school children have positive results for parasitic stool analysis representing an overall prevalence of 32.9%. Of those infected children, there were 143 (19.7%) mono-infected children, 71 (9.8%) double infected, and 25 (2.3%) triple infected. This indicates parasitic infections still represent a public health problem among school children who are forming a considerable proportion of the population. This can be attributed to the unsanitary environmental conditions and low level of public awareness [19]. Egyptian studies conducted on school children revealed marked variability regarding the prevalence of IPIs with an infection range from 22.4 to 63.8% [15, 20–31].

The most prevalent parasitic species were *E. histolytica* (12.3%) and *G. lamblia* (8.5%). *E. histolytica* infection is strongly associated with drinking water sources contamination, poor personal hygiene, and lack of regular handwash habits [19]. Also, *G. lamblia* was associated with open field defecation, poor hand washing, raw vegetables, and unwashed fruit consumption [32]. This finding agreed with the findings of some Egyptian studies [20, 21, 24, 30] where *E. histolytica* was the most prevalent parasitic species with variable prevalence rates. However, other studies have shown variability regarding the most prevalent parasite where it was *G. lambilia* [15, 29], *A. lumbricoides* [25], and *E.vermicularis* [22, 26]. This variability regarding the overall prevalence of IPIs, type of infection, and parasite species can be attributed

Table 3 Environmental and behavioral risk factors of parasitic infection among studied children

	Total No. (%)	Infected No. (%)	Non-infected No.(%)	*P* value
Clean home environment				
Yes	482 (66.4)	101 (42.3)	381 (78.2)	<0.00001*
No	244 (33.6)	138 (57.7)	106 (21.8)	
Good hygiene of the finger nails				
Yes	497 (68.5)	118 (49.3)	379 (77.8)	<0.00001*
No	229 (31.5)	121 (50.7)	108 (22.2)	
Hand wash before and after meals				
Yes	399 (55.0)	105 (43.9)	294 (60.4)	<0.00001*
No	327 (45.0)	134 (56.1)	193 (39.6)	
Hand wash after bathroom use				
Yes	416 (57.3)	117 (49.0)	299 (61.4)	0.0014*
No	310 (42.7)	122 (51.0)	188 (38.6)	
Washing vegetables and fruits well before consumption				
Yes	443 (61.0)	86 (36.0)	357 (73.3)	<0.00001*
No	283 (39.0)	153 (64.0)	130 (26.7)	
Domestic animals contact				
Yes	237 (32.6)	157 (65.7)	80 (16.4)	<0.00001*
No	489 (67.4)	82 (34.3)	407 (83.6)	
Water contact activities				
Yes	177 (24.4)	96 (40.0)	81 (16.7)	<0.00001*
No	549 (75.6)	144 (60.0)	405 (83.3)	
Walking bare footed				
Yes	185 (25.5)	131(54.8)	54 (11.1)	<0.00001*
No	541 (74.5)	108 (45.2)	433 (88.9)	
Total	726 (100)	239 (100)	487 (100)	

*statistically significant difference

Table 4 Prevalence of GIT disorders among infected and non-infected children

	Infected No. (%)	Non-infected No. (%)	Total No. (%)	*P* value
Anorexia				
Yes	72 (30.1)	26 (5.3)	98 (13.5)	<0.00001*
No	167 (69.9)	461 (94.7)	628 (86.5)	
Nausea or vomiting				
Yes	59 (24.7)	12 (2.5)	71 (9.9)	<0.00001*
No	180 (73.3)	475 (97.5)	655 (90.1)	
Abdominal pain				
Yes	145 (60.7)	43 (8.8)	188 (25.9)	<0.00001*
No	94 (39.3)	444 (91.2)	538 (74.1)	
Bloating				
Yes	92 (38.5)	19 (3.9)	111 (15.3)	<0.00001*
No	147 (61.5)	468 (96.1)	615 (84.2)	
Constipation or diarrhea				
Yes	102 (42.7)	38 (7.8)	140 (19.3)	<0.00001*
No	137 (57.3)	449 (92.2)	586 (80.7)	
Blood in stool				
Yes	31 (13.0)	0 (0.0)	31 (5.0)	<0.00001*
No	208 (87.0)	478 (100.0)	695 (95.0)	
Total	239 (100)	487 (100)	726 (100)	

*statistically significant difference

to different research settings and different characteristics of participants regarding socio-demographic, behavioral, and environmental characteristics. Also, the availability and quality of health services is an additional factor. Moreover, the different laboratory techniques used for parasitological diagnosis may have a role in this variable prevalence.

Also, variable findings were observed between studies conducted in Saudi Arabia [33–35] with prevalence rates 17.7%, 57.4%, and 5.3%, respectively. However, the most recent and powerful study [35] revealed a marked reduction in the prevalence of intestinal parasitic infection (5.3%) indicating improvement in the socio-economic and environmental conditions, personal hygiene and awareness, and the provided health services.

Similarly, much more variability was observed between Ethiopian studies [19, 32, 36–39] with prevalence rates ranging from 21.5 to 84.3%. Also, a systematic review and meta-analysis study [40] was conducted to identify the epidemiology of intestinal parasitic infection among preschool and school-aged children which included 83 studies from 1997 to 2019 and examined 56,786 stool specimens. It revealed that the prevalence of parasitic infection was 48% (95% CI: 42–53%) and the infection trend decreased by 17% (95% CI: 2.5–32%) every 6 consecutive years. This high prevalence of parasitic infection indicates bad environmental sanitary conditions and a low level of personal hygiene and awareness.

There were significant differences between infected and non-infected children regarding age, educational stage, residence, monthly family income, and mother's educational level. Despite male students constitute most of the infected children (53.0%). However, there is no significant gender difference regarding IPIs (P=0.5). There were variable findings between Egyptian studies regarding gender differences where some studies [22, 23, 27, 28, 31] revealed similar findings with insignificant gender differences while other studies [21, 25, 29, 30] revealed significant gender differences. However, despite this variability, all of these studies except one [25] revealed a higher prevalence of IPIs among male students. This can be explained by their marked outdoor activity with more exposure to infectious pathogens. Also, insignificant gender differences were observed in studies conducted in Saudi Arabia [33–35] and in some Ethiopian studies [19, 36, 39].

Also, there is a highly significant difference between infected and non-infected children regarding their age. Children of the age group between 6 and 10 years have the highest prevalence of IPIs (46.6%) whereas other age groups (11–14 and 15–18 years) have lower prevalence (36.4% and 18.0%, respectively). This may be due to risky behavioral activities, little hygiene, and awareness of small age students about prevention and control measures in comparison with bigger age groups [32]. Similar findings were observed in other Egyptian [20, 21, 25] and Ethiopian studies [38, 39]. Also, primary school children have a higher prevalence of IPIs (55.7%) than preparatory and secondary school children (28% and 16.3%, respectively) with highly significant differences. This finding agreed with the finding of Workneh et al. [37] and Dessie et al. [38] where there were significant associations between the grade level of children and IPIs with a higher probability of infection among low-grade children. They attributed this association to behavioral factors and little children's understanding of disease processes. Also, lower grade students have less developed immunity towards parasitic infection. However, the effect of age as an additional and confounding variable cannot be excluded.

There is a highly significant difference between infected and non-infected children regarding residence where most of the infected children were rural residents (61.1%). Similar findings were observed in other Egyptian studies [15, 23, 31]. Rural children mostly have risky behavior such as walking poor footed, water and domestic animal contact, poor fingernails and hand hygiene, and defecation in the open agricultural field which consequently leads to more soil contamination with parasites [15].

Also, a highly significant difference was found between infected and non-infected children regarding family income where most of the infected children were belonging to families with a monthly income of fewer than 4000 L. E (73.7%). Low-income families mostly have poor housing conditions with overcrowded and unsanitary housing conditions, malnourished children, and less educated parents and consequently have less personal hygiene and little awareness of parasites prevention and control measures. A similar finding was found by *Hailegebriel* [19] where the probability of parasitic infection among low-income family children was six and half times children from high-income families. However, insignificant findings were observed in similar studies [35, 36]. This may be due to statistical reasons such as a small sample size or a little number of infected children which was insufficient to give statistically significant findings [35].

Concerning parental education, there is a significant difference in IPIs of children regarding mothers' education only (P=0.02). This indicates that mothers are more influential in preventing parasitic infections among their children. This is due to a longer time of contact with their children contrary to fathers who spend most of their time outside doors. The educated mother has more awareness about parasitic infection prevention and control and their impact on their children and consequently more able to protect their children. A significant effect of the mother's education was observed in similar studies [21, 25, 41]. However, some studies [20, 33] revealed significant differences between infected and non-infected children regarding both fathers' and mothers' educations while other studies [35, 37] have found no significant differences.

Regarding the behavioral and environmental factors, there were highly significant differences between infected and non-infected children regarding these factors with a considerable proportion of children having an unsanitary environment, little fingers hygiene, poor hand washing practice, and risky health behavior. These findings explain the high prevalence of parasitic infection among studied children which indicates improper implementation of prevention and control measures that are effective in reducing the IPIs such as the provision of safe drinking water, proper sewage and refuse disposal, improvement of personal hygiene and environmental sanitation, increased public health awareness, and community involvement activities [42].

There were highly significant differences between infected and non-infected children regarding the GIT disorder with much more prevalence among infected children and highly significant differences (p <0.00001). These findings agreed with findings of similar studies [19, 23, 28, 30]. However, the presence of GIT symptoms can be helpful for the early detection of parasitic infections.

Study limitations

The following limitations may be considered when interpreting the study findings: (i) the study was conducted in a single locality (Aga district) in Dakahlia governorate. So, the generalization of the findings to other localities of the governorate or overall Egypt must be taken with caution. However, to increase the power of the study and its repetitiveness we increase the sample size by approximately 100% of the calculated sample. Also, being a cross-sectional study conducted at one point of time, seasonal variation in the children's IPIs cannot be detected. (ii) Diagnosis of children's IPIs was carried out by taking a single stool sample from each child. However, stool samples were checked by an associate professor in the field of medical parasitology (second author) to minimize the possibility of misdiagnosis. (iii) Antigen test to differentiate between *E. histolytica* and *E. dispar* was not carried out.

Conclusions

This study reveals that IPIs still have a high prevalence among school children with a considerable proportion of infected children being multi-infected. E. Histolytica and G. Lambilia were the most prevalent parasites. Socio-demographic factors related to parasitic infection were age, stage of education, residence, monthly family income, and maternal education. Also, there were highly significant differences between infected and non-infected children regarding all environmental and behavioral risk factors. Also, there were highly significant differences between infected and non-infected children regarding the prevalence of GIT symptoms. The study findings revealed the urgent need for IPIs prevention and control measures through an organized multi-sectoral complementary approach that involves policy-makers, health and educational organization, community and religious leaders, and mass media to increase the public awareness about IPIs, personal hygiene, environmental sanitation, and provision of accessible health services.

Abbreviations

A. lumbricoides: *Ascaris lumbricoides*; *A. duodenale*: *Ancylostoma duodenale*; *E. vermicularis*: *Enterobius vermicularis*; *E. histolytica/dispar*: *Entamoeba histolytica/disper*; *G. lambilia*: *Giardia lambilia*; GIT: Gastro-intestinal tract; *H. nana*: *Hymenolepis nana*; IPIs: Intestinal parasitic infections; *S. mansoni*: *Schistosoma mansoni*; WHO: World Health Organization.

Acknowledgements

The authors want to thank all the selected children and their families for their participation in the study. Also, the authors are deeply grateful to the educational authority at Aga district and staff members of the selected schools for their unlimited cooperation and support.

Authors' contributions

Authors are contributed equally to framing the conceptual issues of research, and questionnaire design. Abu Sheishaa GA was responsible for the data collection process (including data collectors training and supervision) and stool analysis while Ahmed HM was responsible for data analysis and interpretation, and manuscript writing. Both authors agreed the final research report.

Funding

Not applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Institutional Research Ethics and the declaration of Helsinki. Approval of the ethical committee at Al Azhar faculty of medicine for boys was obtained with reference number R-12-2536. The reference number for ethical committee approval is not available. Participation in the study was completely voluntary with the anonymity of the participants. At the beginning of data collection, there was a written informed consent that must be approved by children's family. Confidentiality of the collected data was strictly maintained.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

Author details

[1]Department of Public Health and Community Medicine, Faculty of Medicine, Al-Azhar University, Cairo, Egypt. [2]Department of Parasitology, Faculty of Medicine, Al-Azhar University, Cairo, Egypt.

Received: 3 July 2021 Accepted: 17 December 2021
Published online: 31 January 2022

References

1. World Health Organization (2010) Working to overcome the global impact of neglected tropical diseases: first WHO report on neglected tropical diseases. WHO, Geneva
2. Collier P (2007) The bottom billion: why the poorest countries are failing and what can be done about it. Oxford University Press, Oxford
3. World Health Organization (2004) Prevention and control of schistosomiasis and soil-transmitted helminthiasis. WHO/CDS/CPE/PVC, Geneva
4. Mahfouz AA, El-Morshedy H, Farghaly A et al (1997) Ecological determinants of intestinal parasitic infections among pre-school children in an urban squatter settlement of Egypt. J Trop Pediatr 43(6):341–344. https://doi.org/10.1093/tropej/43.6.341
5. World Health Organization (1987) Technical Report Series 749: Prevention and control of intestinal parasitic infections. WHO, Geneva
6. Yakubu N, Musa G, Yakubu SE (2003) Seasonal changes in the distribution and infection rate of Schistosoma intermediate hosts in River Kubanni and its tributaries. Bio Res Com 15:207–214
7. Wang LD, Guo JG, Wu XH et al (2009) China's new strategy to block Schistosoma japonicum transmission: experiences and impact beyond schistosomiasis. Trop Med Int Health 14:1475–1483. https://doi.org/10.1111/j.1365-3156.2009.02403.x
8. Bethony J, Brooker S, Albonico M et al (2006) Soil-transmitted helminth infections: ascariasis, trichuriasis, and hookworm. The lancet 6;367(9521):1521-32. https://doi.org/10.1016/S0140-6736(06)68653-4
9. Dickson R, Awasthi S, Williamson P et al (2000) Effects of treatment for intestinal helminth infection on growth and cognitive performance in children: systematic review of randomised trials. BMJ 320(7251):1697–1701. https://doi.org/10.1136/bmj.320.7251.1697
10. Taylor-Robinson DC, Maayan N, Soares-Weiser K et al (2015) Deworming drugs for soil-transmitted intestinal worms in children: effects on nutritional indicators, haemoglobin, and school performance. The Cochrane Library. https ://doi.org/10.1002/14651 858.CD000 371. pub6.
11. Haque R (2007) Human intestinal parasites. Journal of health, population, and nutrition 25(4):387. http://www.ncbi.nlm.nih.gov/pmc/articles/pmc2754014/.
12. Awasthi S, Bundy DA, Savioli L (2003 Aug 21) Helminthic infections. Bmj. 327(7412):431–433. https://doi.org/10.1136/bmj.327.7412.431
13. El-Sherbini GT, Abosdera MM (2013) Risk factors associated with intestinal parasitic infections among children. J Egypt Soc Parasitol 43:287–294 https://doi.org/10.21608/jesp.2013.96267
14. Wikipedia (2021): Dakahlia governorate. Available at: https://en.wikipedia.org/wiki/Dakahlia_Governorate Accessed at: 10/6/2021.
15. Farghly AM, Mohamed SM, Abdel-Rahman SA et al (2016) The relation between the prevalence of soil transmitted parasites in the soil and among school children in Zagazig district, Sharkyia Governorate, Egypt. Journal of Parasitic Diseases 40(3):1021–1029. https://doi.org/10.1007/s12639-014-0627-z
16. Engels D, Nahimana S, Gryseels B (1996) Comparison of the direct faecal smear and two thick smear techniques for the diagnosis of intestinal parasitic infections. Transactions of the Royal Society of Tropical Medicine and Hygiene 1;90(5):523-5. https://doi.org/10.1016/S0035-9203(96)90304-1

17. Garcia JA, Martin AM (1985) Perez MJ (1985) Valoración de los métodos utilizados en el diagnóstico de parasitosis intestinales. Laboratório. 79:473
18. Martin LK, Beaver PC (1968) Evaluation of Kato thick-smear technique for quantitative diagnosis of helminth infections. The American journal of tropical medicine and hygiene 1;17(3):382-91. https://doi.org/10.4269/ajtmh.1968.17.382
19. Hailegebriel T (2017) Prevalence of intestinal parasitic infections and associated risk factors among students at Dona Berber primary school, Bahir Dar, Ethiopia. BMC infectious diseases 17(1):1–8. https://doi.org/10.1186/s12879-017-2466-x
20. Hussein YH, Fahmy HH, Sewilam DE (2021) Current status and associated risk factors of intestinal parasitic infections among primary school children in Al Qurain district, Sharkia governorate. The Egyptian Family Medicine Journal 5(1):68–81 https://doi.org/10.21608/efmj.2021.27021.1023
21. El-Sherbini GT, Abosdera MM (2013) Risk factors associated with intestinal parasitic infections among children. Journal of the Egyptian Society of Parasitology 43(1):287–294 https://doi.org/10.21608/jesp.2013.96267
22. Bayoumy A, Ibrahim WL, Abou El Nour BM et al (2016) The parasitic profile among school children in El-wadi El-gadded governorate, Egypt. Journal of the Egyptian Society of Parasitology 46(3):605–612 https://doi.org/10.21608/jesp.2016.88265
23. El-Nadi NA, Omran EK, Ahmed NS et al (2017) Current status of intestinal parasites among elementary school children in Sohag, Egypt. J Adv Parasitol 4(2):33–40 https://doi.org/10.17582/journal.jap/2017/4.2.33.40
24. El-Masry HM, Ahmed YA, Hassan AA et al (2007) Prevalence, risk factors and impacts of schistosomal and intestinal parasitic infections among rural school children in Sohag Governorate. Egyptian J Hospital Med 29(1):616–630 https://doi.org/10.21608/ejhm.2007.17705
25. Yones DA, Othman RA, Hassan TM et al (2019) Prevalence of gastrointestinal parasites and its predictors among rural Egyptian school children. J Egyptian Soc Parasitology 49(3):619–630 https://doi.org/10.21608/jesp.2019.68065
26. Al Saadawy AS, Al Karyony IM, Bayoumy AM et al (2018) Parasitic Profile among Primary School Children in A Rural Area at Beheira Governorate, Egypt. The Egyptian Journal of Hospital Medicine 70(12):2042-9. http://doi: 10.12816/0045027.
27. Sakr MA, Abd El-fattah LA, Sayed MH et al (2016) Prevalence of intestinal parasites among primary school children in farskour city, dameitta governorate. Al-Azhar Journal of Ped 19(1):1580–1594
28. Mohammad KA, Mohammad AA, Abu El-Nour MF et al (2012) The prevalence and associated risk factors of intestinal parasitic infections among school children living in rural and urban communities in Damietta Governorate, Egypt. Academia Arena 4(5):90–97
29. Monib ME, Hassan AA, Attia RA et al (2016) Prevalence of intestinal parasites among children attending Assiut University Children's Hospital, Assiut, Egypt. J Adv Parasitol. 3(4):125–131 https://doi.org/10.14737/journal.jap/2016/3.4.125.131
30. Ahmed FA (2013) Intestinal parasites among primary school children in urban and rural Tanta, Gharbia, Governorate. Egypt. Egypt. J. Exp. Biol. 9(2):257–262
31. Dyab AK, El-Salahy MM, Abdelmoneiem HM et al (2016) Parasitological Studies on some intestinal parasites in primary school children in Aswan Governorate, Egypt. Journal of the Egyptian Society of Parasitology 46(3):581–586 https://doi.org/10.21608/jesp.2016.88262
32. Sitotaw B, Mekuriaw H, Damtie D (2019) Prevalence of intestinal parasitic infections and associated risk factors among Jawi primary school children, Jawi town, north-west Ethiopia. BMC infectious diseases 19(1):1-0. https://doi.org/10.1186/s12879-019-3971-x.
33. Al-Megrin WA (2015) Assessment the prevalence of intestinal parasite and associated risk factors among preschool children in Riyadh, Saudi Arabia. Research Journal of Parasitology 10(1):31–41
34. Alsubaie AS, Azazy AA, Omer EO et al (2016) Pattern of parasitic infections as public health problem among school children: A comparative study between rural and urban areas. Journal of Taibah University Medical Sciences 11(1):13–18. https://doi.org/10.1016/j.jtumed.2015.10.006
35. Bakarman MA, Hegazi MA, Butt NS (2019) Prevalence, characteristics, risk factors, and impact of intestinal parasitic infections on school children in Jeddah, Western Saudi Arabia. Journal of epidemiology and global health 9(1):81 https://dx.doi.org/10.2991%2Fjegh.k.190219.001
36. Gelaw A, Anagaw B, Nigussie B et al (2013) Prevalence of intestinal parasitic infections and risk factors among schoolchildren at the University of Gondar Community School, Northwest Ethiopia: a cross-sectional study. BMC public health 13(1):1–7. https://doi.org/10.1186/1471-2458-13-304
37. Workneh T, Esmael A, Ayichiluhm M (2014) Prevalence of intestinal parasitic infections and associated factors among Debre Elias primary schools children, East Gojjam Zone, Amhara Region, North West Ethiopia. J Bacteriol Parasitol. 5(1):1. https://doi.org/10.4172/2155-9597.1000181
38. Dessie A, Gebrehiwot TG, Kiros B et al (2019) Intestinal parasitic infections and determinant factors among school-age children in Ethiopia: a cross-sectional study. BMC Res Notes 12(1):1–6. https://doi.org/10.1186/s13104-019-4759-1
39. Gebretsadik D, Tesfaye M, Adamu A et al (2020) Prevalence of Intestinal Parasitic Infection and Its Associated Factors Among School Children in Two Primary Schools in Harbu Town, North East Ethiopia: Cross-Sectional Study. Pediatric Health, Medicine and Therapeutics 11:179 https://dx.doi.org/10.2147%2FPHMT.S252061
40. Chelkeba L, Mekonnen Z, Alemu Y (2020) Epidemiology of intestinal parasitic infections in preschool and school-aged Ethiopian children: a systematic review and meta-analysis. BMC public health 1;20(1):117. https://doi.org/10.1186/s12889-020-8222-y
41. Quihui L, Valencia ME, Crompton DW et al (2006) Role of the employment status and education of mothers in the prevalence of intestinal parasitic infections in Mexican rural schoolchildren. BMC public health 6(1):1–8. https://doi.org/10.1186/1471-2458-6-225
42. Daryani A, Hosseini-Teshnizi S, Hosseini SA et al (2017) Intestinal parasitic infections in Iranian preschool and school children: A systematic review and meta-analysis. Acta tropica 1;169:69-83. https://doi.org/10.1016/j.actatropica.2017.01.019.

Publisher's Note