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Prevalence associated risk factors of Hymenolepis nana infection among children in Sohag.

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Abstract

Background: *Hymenolepis nana* is the most common cestode in human which has detrimental impact on host nutritional status. Several environmental and socio-economic factors are responsible for its continued persistence in children.

Objective: To estimate the prevalence of *H. nana* infection in outpatients attending Sohag hospitals and correlation with some of its risk factors and Clinical manifestations.

Methods: Cross-sectional study was conducted during the period from November 2018 to June 2019. A totalof 500 stool samples were examined fromoutpatient children aged 1-15 years attending Sohag Hospitals by direct fecal smear, Lugol's iodine and formal-ether concentration technique. Risk factors and Clinical manifestations were collected using a structured questionnaire. Chi-square and logistic regression analyses were used for data analysis.

Results: Results indicated that the overall prevalence of H. nana in children under study was 5.8%. Multivariate analysis indicated that age of 1-8 years (p-value<0.03; AOR=2.9; 95% CI=1.1 -7.8), with uneducated mothers (p-value<0.04; AOR=3.1; 95% CI=1.1-9.1), consuming unwashed vegetables and fruits (p-value<0.01; AOR=4.9; 95% CI=1.4-17.2), poor hand washing before eating and after toilet (p-value<0.005; AOR=5.6; 95% CI=1.6-19.2) as the significant risk factors of H. nana infection among these communities. The infection was significantly higher among those who had abdominal pain (p-value<0.001), anorexia (p-value<0.005) and underweight participants (BMI<18.5kg/m^2) (p-value<0.01) when compared to their asymptomatic counterparts.

Conclusions: The present study highlighted on prevalence of *H. nana* infection in children Sohag Governorate, Egypt and provided that, *H. nana* infection is a public health problem and there is an urgent need for efforts towards ensuring adequate control of the infection in Sohag Governorate especially in children of school age.

Keywords: *H. nana* prevalence, Children, Sohag, Egypt

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Introduction

H. nana is the most prevalent parasite tapeworms in human [1]. It is a cosmopolitan parasite and it is more prevalent in warm climates [2]. Infection was more common in children than in adults and was often found within family [3].

It is the only tapeworm that can be transmitted directly from person to person and differs from almost all other tapeworms in being able to complete its entire life cycle in a single host [4].

The prevalence of *H. nana* could be related to a number of factors such as poor hygiene, inadequate sanitation, overcrowding, low education and low socioeconomic status [5]. Another important factor which affects its prevalence is the presence of asymptomatic people in the community who can be considered as the main source of infection through continuously excreting the eggs with their stools [6].

Infection due to *H. nana* was often asymptomatic when the level of infection was low but when the level of infection was heavy and chronic, these infections can cause diarrhea, abdominal pain, headaches and dizziness.

The aims of the present study were to estimate the prevalence of *H. nana* infection in outpatient children attending Sohag hospitals and correlation with some of its risk factors and clinical manifestations [7].

Materials and Methods

Study area

This study was carried out in Sohag Governorate, Upper Egypt. Sohag is located in the southern part of the country toward 467 km to south of Cairo. It covers an extent of the Nile Valley with a total area of 1547 km, with estimated 5,338,025 people [8].

Ethics statement

The study was approved by scientific ethics committee of Sohag University. The informed consents were obtained from selected patients or children's guardians before data and samples collection with a brief explanation of the methodology and the objective of this study [9].

Study design

A cross-sectional study was conducted on 500 outpatients aged 1 to 15 years attending the lab of Sohag University Hospital and Endemic Diseases Hospital during the period from November 2018 to June 2019 in Sohag Governorate, Egypt [10].

Demographic and lifestyle were obtained through a survey questionnaire. The questionnaire included age, sex, residence, maternal educational level, family size, presence of infected siblings, washing of vegetables and fruits before consumption, washing hands before eating and after defecation, trimming of finger nails periodically, presence of associated symptoms as abdominal pain, anorexia, diarrhea and vomiting. BMI was also recorded [11].

Sample collection and laboratory processing

Fresh stool sample was collected from each patient in a sterile, covered and labeled plastic container [12]. A portion of each stool specimen was examined macroscopically for presence of worms or their segments and microscopically by direct smear method and Lugol's iodine; there mining part of the sample was preserved in 10% formalin solution and transported to the laboratory. The stool examinations were performed using formal ether concentration technique. It is worth mentioning here that detecting other types of parasites was not in the focus of this study. Smears were reported as positive if *H. nana* eggs were detected.

Statistical analysis

Data were analyzed by using SPSS 25.0 (Statistical Package for Social Science, version 25.0). Univariate logistic regression analysis was performed to verify the association between H. nana and socio-demographic, behavioral and hygienic factors using Chi square test (2). Odds ratios along with 95% confidence interval (95% CI) were estimated to measure association strength between presence of infection and risk factors. The significant variables in the univariate analysis were further included in the multivariate logistic regression analysis. In addition, the association between the infection and clinical features were calculated by chi square test. p-value of less than 0.05 was considered statistically significant for all tests.

Results

Demographic characteristics

During the study period, 500 fecal samples were collected from outpatient children attending the lab of Sohag University Hospital and Endemic Diseases Hospital during the period from November 2018 to June 2019 in Sohag Governorate, Egypt. 213 (42.6%) were boys and the rest 287 (57.4%) were girls. The patients' age ranged between 1 and 15 years. The mean age of patients ± SD was 8.5 years ± 3.8.282 live in rural areas whereas 218 in urban areas [13].

Prevalence and distribution of H. nana infection

The prevalence of *H. nana* infection was estimated to be 5.8% (29/500). Of 29 patients, 15 were males and 14 were females [14]. The prevalence of *H. nana* among males was 7.1% (15/213) where in females the prevalence was 4.8% (14/287). Confection of *H. nana* with *Giardia lamblia* was found in 4 patients (0.8%), also *H. nana* with *Endameba histolytic* was detected in two patients (0.4%).

Relation between H. nana infection and age groups

The study group was divided into 7 age groups. There was a significant association between *H. nana* prevalence and the age groups 1-3 (5%), 3-5years (6.6%), 5-7 years (17.6%), 7-9 years (7.5%), 9-11 years (3.2%), 11-13 years (2.9%) and 13-15 years (1.6%) (p-value<0.005) [15]. The *highest prevalence* was *observed* among *age group* of 5-7 *years.* Prevalence of *H. nana* infection according to age group is illustrated in Figure 1.

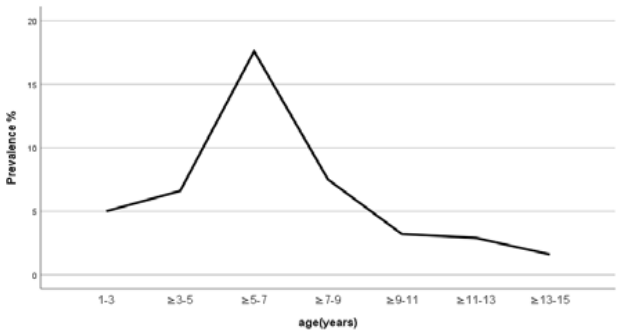

Figure 1. *Prevalence of H. nana infection by age groups among 500 outpatients in Sohag.*

Possible risk factors for H. nana infection

The results of univariate regression analysis for risk factors associated with *H. nana* infection were reported in (Table1) [16]. The patients with younger age group 1-8 years had a significantly higher prevalence compared with older age group 8-15 years (p-value<0.01; COR=2.5; 95% CI=1.1-5.5). However, there was no significant association between the gender and the infection (p-value<0.3; COR=1.4; 95% CI=0.6-3.1) [17]. The patients in rural areas were 2.5 times more prone to *H. nana* infection than those living in urban areas (p-value<0.03; COR=2.5; 95% CI=1.1-6.1).Also, patients with uneducated mothers were more likely to be infected with *H. nana infection* than those with educated mothers (p-value<0.01; COR=2.7; 95% CI=1.2-5.8) [18]. As well, the patients from large households with family sizes more than 5 members were significantly higher prevalence of *H. nana* infection than those from smaller families (p-value<0.04; COR=2.4; 95% CI=1.1-5.5). In addition, patients residing with infected siblings were 2.3 times more at risk of *H. nana* infection than those residing with non-infected siblings (p-value<0.02; COR=2.3; 95% CI=1.1-5.1). Besides, patients who consumed raw or unwashed vegetables and fruits had higher odds ratio to be infected than those who did not consume them (p-value<0.0001; COR=4.3; 95%CI=1.9-9.7). Further, patients who did not have a hand washing habit before eating and after defecation were 4.5 times more likely to be infected compared with their counter parts (p-value<0.001; COR=4.5; 95% CI=1.8-11.4).Moreover, patients who did not have the habit of trimming of their fingernails were 3.9 times more likely to be infected than those who trim their fingernails (p-value<0.002; COR=3.9; 95% CI=1.6 -9.4).

Table 1. *Univariate analysis of socio-demographic and hygienic behavioral risk factors associated with H. nana infection among 500 outpatients in Sohag.*

Variables	No. Examined	No. infected %	Crude OR (95% CI)	p value
Age (years)				
44204	202	18 (8.9%)	2.5 (1.1-5.5)	<0.01*
≥ 8-15	298	11 (3.6%)	1	
Gender				
Male	213	15 (7.1%)	1.4 (0.6-3.1)	<0.3
Female	287	14 (4.8%)	1	
Residence				
Rural	282	22 (7.8%)	2.5 (1.1-6.1)	<0.03*
Urban	218	7 (3.2)	1	
Maternal/guardian educational level				
Illiterate	195	18(9.2%)	2.7 (1.2-5.8)	<0.01*
Educated	305	11(3.6%)	1	
Family size				
≥ 5members	267	21(7.8%)	2.4 (1.1-5.5)	<0.04*
<5members	233	8(3.4%)	1	
Infected siblings				
Yes	192	17(8.8%)	2.3 (1.1-5.1)	<0.02*
No	308	12(3.8%)	1	
Washing vegetables and fruits before consumption				
No	180	20(11.1%)	4.3 (1.9-9.7)	<0.0001*
Yes	320	9(2.8%)	1	
Washing hands before eating and after defecation				
No				
Yes	238	23 (9.6%)	4.5 (1.8-11.4)	<0.001*
	262	6 (2.2%)	1	
Finger nails trimming				
No	230 270	22 (9.5%)	3.9 (1.6-9.4)	<0.002*
Yes		7 (2.5%)	1	
*: p value<0.05 was considered significant				

Significant risk factors from univariate analysis were entered into multivariate logistic regression model to eliminate possible confounding relationships among variables. Multivariate logistic regression analysis retained 4 risk factors that remained significantly associated with *H. nana* infection among studied participants. The results confirmed that those aged 1-8 years (p-value<0.03; AOR=2.9; 95% CI=1.1-7.8) [19],with uneducated mothers (p-value< 0.04; AOR=3.1; 95% CI=1.1-9.1),with consuming unwashed vegetables and fruits (p-value<0.01; AOR=4.9; 95% CI=1.4-17.2) and with poor hand washing before eating and after defecation (p-value<0.005; AOR=5.6; 95% CI=1.6-19.2) were at higher odds ratio of having *H. nana* infection when compared with their counterparts (Table 2).

Table 2. *Multivariate analysis of risk factors associated with H. nana infection among 500 outpatients in Sohag.*

Variables	Adjusted OR (95% CI)	p value
Age (years)	2.9 (1.1-7.8)	<0.03*
Residence	0.1 (0.004-2.1)	<0.1
Maternal/guardian educational level	3.1 (1.1-9.1)	<0.04*
Family size	1.1 (0.1-8.9)	<0.8
Infected siblings	1.9 (0.7-5.2)	<0.2
Washing vegetables and fruits before consumption	4.9 (1.4-17.2)	<0.01*
Washing hands before eating and after defecation	5.6 (1.6-19.2)	<0.005*
Finger nails trimming	0.9 (0.1-6.1)	<0.9
*: P value <0.05 was considered significant		

Clinical features associated with H. nana infection

The symptoms selected for the study were abdominal pain, anorexia, diarrhea, vomiting and headache. Body mass index (BMI) was calculated by dividing a patient's weight (in kilograms) by his or her height (in meters, squared). BMI was classified as the following, BMI less than 18.5 was underweight and BMI more than 18.5 was normal weight [20].

Among the participants, 186 (37.2%) individuals who were referred to the medical laboratories for checkup had no symptoms and 314 (62.8%) individuals suffered from at least one symptom. [21] The prevalence of *H. nana* was insignificantly higher in symptomatic patients than in asymptomatic carriers (p-value<0.4).*H. nana* infection was significantly higher among those with abdominal pain (p-value<0.001), anorexia (p-value< 0.005) and underweight (BMI less than 18.5) (p-value<0.01) compared to their asymptomatic counterparts [22]. However, it was not significantly associated with diarrhea (p-value<0.1), vomiting (p-value<0.2) and headache (p-value<0.6) (Table 3).

Table 3. *Prevalence of H. nana infection according to clinical manifestations among 500 outpatients who referred to the medical laboratories in Sohag.*

Clinical manifestation	No. examined	No. infected %	p-value
Symptomatic			
Yes	314	20 (6.3%)	<0.4
No	186	9 (4.8%)	
Abdominal pain			
Yes	194	20 (10.3%)	<0.001*
No	306	9 (2.9%)	
Anorexia			
Yes	168	17 (10.1%)	<0.005*
No	332	12(3.6%)	
Diarrhea			
Yes	165	6 (3.6%)	<0.1
No	335	23 (6.8%)	
Vomiting			
Yes	92	3 (3.2%)	<0.2
No	408	26 (6.3%)	
Headache			
Yes	102	7 (6.8%)	<0.6
No	398	22 (5.5%)	
(BMI)			
Underweight (BMI< 18.5 kg/m^2)	196	18 (9.1%)	<0.01*
Normal weight (BMI >18.5 kg/m^2)	304	11 (3.6%)	
*: P value <0.05 was considered significant			

Discussion

Hymenolepis is an important disease in environment due to its high frequency among preschool and school children and its constant identifiable clinical manifestations [23].

In the current study, the prevalence of *H. nana* found in 500 outpatients aged1 to 15 years was 5.8% and was more or less close to those reported in Egypt; 3.9% among patients in Dakahlia, 3% among rural participants in Menoufia, 5.8% among patients in Assiut, 3% among children in Aswan, 4% among children receiving chemotherapy in Sohag, 5% among diabetic patients, 5% among school-aged children and 7% of random fecal samples using mini-FLOTAC method in three previous studies in Sohag respectively. Also, the prevalence was close to 8.3% among individuals in Brazil, and 7.8% among children in rural Mexico.

While lower prevalence rates were reported 0.5% among patients in Poland and 0.6% among study individuals in Iran. By contrast, the higher prevalence rates were reported 13.8% among study subjects in Ethiopia, 32.6% among preschool children in Sudan and 17.4%among children in rural areas of Peru. These variations may be associated with differences in climatic conditions, environmental sanitation, previous control intervention, socioeconomic status of inhabitants and differences of host susceptibility to parasitic infections.

In the present study, there was a significant association between the prevalence and the age groups (p-value<0.005) with *highest prevalence* among *age group* of 5-7 *years due to poor hygiene in younger ages.* These results agreed with in India who noticed that *H. nana* prevalence among urban slum dwellers decreased with increasing age and the infection of age groups were 15.09% male and 6.8% female in 1-6 years, 18.3% male and 9.6% female in 8-10 years, 15.9% male and 4% female in 11-20 years and 10.2 % male and 2.8 % female in 21-30 years. Also were close to results presented by in Peru who reported that there was a significantly association between *H. nana* prevalence and the age groups of children (p-value<0.02).

In the present study, univariate regression analysis showed that males (7.1%) had a higher prevalence of the infections than females (4.8%) however no significant association was found between the gender and the infection (p-value<0.3; COR=1.4; 95% CI=0.6-3.1).The same results were met with those of in Burkina Faso who found *H. nana* infection was not significantly associated with gender (p-value<0.963).These results opposed the results by in Sudan who found that male children were more likely to get infected by *H. nana* compared to female children (p-value< 0.001; OR=2.123; 95% CI=1.451-3.106) because males are more likely to spend time outdoors away from their home; therefore hygiene habits would be less optimal compared to females.

The present study revealed that patients with younger age group 1-8 years (8.9%) had a significantly higher prevalence of *H. nana* infection compared with older age group 8-15 years (3.6%)(p-value<0.01; COR=2.5; 95% CI=1.1-5.5).These results were supported by in Sudan who detected that infection of *H. nana* was significantly prevalent among older age group (2.5-5.0 years) compared to the younger age group (less than 2.5 years) (p-value<0.001). This may be explained by the fact that the elder age group was more likely to contact infections from the environment. Also, the results did not differ from the results by [24] in Burkina Faso who showed that the infection was significantly associated with age with the highest prevalence among the school children of 7 years old (p-value<0.021).

The current study revealed that the patients in rural areas (7.8%) were 2.5 times more prone to H. nana infection than those living in urban areas (3.2%) (p-value<0.03; COR=2.5; 95% CI=1.1-6.1). Which was supported by [25] in Iran who revealed that the prevalence of intestinal helminthes parasites among children was significantly associated with residing in rural regions (p-value<0.001; OR=4.2; 95% CI=2.1-10.6). However, these results disagreed with study by [26] in Peru who found that the prevalence of *H. nana* among children of rural areas lower than peri-urban areas (p-value<0.001; OR=0.62; 95% CI=0.54-0.72)

The present work revealed that patients with uneducated mothers (9.2%) were more likely to be infected with *the H. nana infection* than those with educated mothers (3.6%) (p value<0.01; COR=2.7; 95% CI=1.2-5.8).These results were in accordance with [27] in Assiut who reported that the low level of paternal education was significant risk factors for parasitic infections (OR=2.86, 95% CI=2.08-3.93).

In the present study, the patients from large households with family sizes more than 5 members (7.8%) were significantly higher prevalence of infection than those from smaller families (3.4%) (p-value<0.04; COR=2.4; 95% CI=1.1-5.5).These results agreed with study in Sohag who showed that intestinal helminth infections among schoolchildren were significantly higher with large family sizes more than 5 member (p-value<0.006).

As regard life style and health care behavior risk factors, the present work cleared that consuming of raw or unwashed vegetables and fruits (p-value<0.0001; COR=4.3; 95%CI = 1.9-9.7), poor a hand washing before eating and after defecation (P value<0.001; COR=4.5; 95%CI=1.8- 11.4), poor trimming of fingernails *(*p-value<0.002; COR= 3.9; 95%CI = 1.6-9.4) and presence of infected siblings (p-value<0.02; COR=2.3; 95% CI=1.1-5.1) were significantly *associated* with *the prevalence of H. nana infection*. The same results were met with [27] in Assiut who found that poor personal hygiene and infected siblings were risk factors for worm infection in school aged children (OR= 1.94,95% CI=1.40-2.67, OR= 4.17,95% CI= 2.80-6.23). Also, study by [28] in Ethiopia who showed that untrimmed fingernails among street children were significantly associated with parasitic infections (AOR=2.03; 95% CI=1.02-4.06), as well, the results by in Iran who revealed that prevalence of intestinal helminthic parasites among children was significantly associated with poor hand washing before eating (p-value<0.001; OR=5.2; 95% CI=2.2-12.5;) and consuming raw or unwashed vegetables and fruits (p- value<0.001; OR=4.8; 95% CI=2.3-11.2).

In the current study, the multivariate logistic regression analysis retained 4 risk factors that remained significantly associated with *H. nana* infection among studied participants. The results confirmed that the age of 1-8 years (p-value<0.03; AOR=2.9; 95%CI=1.1-7.8), low mother's education (p-value<0.04; AOR=3.1; 95% CI=1.1-9.1), consuming unwashed vegetables and fruits (p-value<0.01; AOR=4.9; 95% CI=1.4-17.2) and poor

hand washing before eating and after defecation (p-value<0.005; AOR=5.6; 95% CI=1.6-19.2) were retained as significant risk factors of *the* infection among these people. The same results were met with in Peru who found that level of education of the mother (p-value<0.01; OR=1.11; 95% CI=1.05-1.17) and age under 10 years (p-value< 0.05; OR=0.67; 95% CI=0.44-1.00) were retained as significant risk factors for *H. nana* infection in the multivariate *analysis.*

The prevalence of *H. nana* was insignificantly higher in symptomatic patients (6.3%, 20/314) than in asymptomatic carriers (4.8%, 9/186) (p-value<0.4). This was in agreement with a study from Bangkok by [29] who found that most *H. nana* infected children were asymptomatic regardless of worm burden.

In the present study, the prevalence of *H. nana* infection was significantly higher among those with abdominal pain (p-value<0.001), anorexia (p-value<0.005) and underweight (BMI less than 18.5) (p-value<0.01) compared to asymptomatic counterparts. However, it was not significantly associated with diarrhea (p value<0.1), vomiting (p-value<0.2) and headache (p-value<0.6).These results did not differ from the results by [30] in Ethiopia who revealed that the prevalence of *H. nana* infection was statistically significant in stunted children compared to normally nourished children (p-value<0.05).The same results were met with in Iran who noticed that *H. nana* infections among urban slum dwellers were less severe than other cases of helminthic or protozoa but had a significant association with abdominal pain. However, these results differed from the results by in Brazil, who reported that *H. hana* infection was significantly associated with diarrhea (p-value<0.05).

According to the results of our study, the most susceptible patient to the infection was between 1-8 years, had low mother's education level, had poor hand washing habit before eating and after defecation, consumed unwashed vegetables and fruits, was mostly asymptomatic or suffered from abdominal pain, anorexia and with BMI less than 18.5 kg/m2.

Conclusion

A macro porous resins separation process for the separation and recovery of (R, S)-2, 3-DCP from treated waste water was developed. HZ-818 resins were tested and found suitable for this separation. The separation permits to extract (R, S)-2, 3-DCP with high purity. It can be applied in the bioremediation of TCP; it lowers the incubation period of the enzyme and the amount of enzyme loaded to degrade the less favored enantiomer (S)-2, 3-DCP in the pathway, easy recovery of the product.

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