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Original Research Article

An Epidemiological Study of *Hymenolepis nana* Infection and Some Associated Intestinal Parasites among Children in the City of Samarra

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Abstract: ***Background*:** One of the most common intestinal parasites affecting people, especially children, is *Hymenolepis nana*. ***Aim of the Study*:** The purpose of this study was to determine the risk variables linked to hymenolepiasis in children and to evaluate its prevalence. This study also evaluated blood glucose, insulin, iron, copper, zinc, and selenium. ***Materials and Methods*:** 584 stool samples were collected from children who visited pediatric outpatient clinics in Samarra city from July 2023 to the end of March 2024. ***Result*:** The results showed an infection rate of 3.9%, with 57.4% diagnosed by flotation and sedimentation and 42.5% diagnosed by direct examination. Symptomatic infection was present in 72.2% of the children, while 27.7% were asymptomatic. The highest infection rate was among children aged 7-9 years (40.7%). The current study showed non-significant differences in the level of insulin between infected children and control (p-value > 0.05). Blood glucose, selenium, zinc, and iron levels decreased in children infected with *H. nana* that were (92.04±21.2 mg/dl, 189.74±59.12 µg/dL, 48.31±5.52 µg/dL, 85.36±9.28 µg/dL) as compared with control that were (115.12±32.4 mg/dl, 253.61±20.77 µg/dL, 74.63±10.71 µg/dL, 145.91±16.53 µg/dL, respectively, at a p-value < 0.05. While statistically increasing the level of copper in infected children as compared with the control (219.27±17.61 and 116.89±23.74 µg/dL, respectively) at a p-value < 0.05. ***Conclusion*:** The prevalence of *H. nana* infection is influenced by factors such as age, sex, and source of water. Furthermore, there is an association between infection with *H. nana* and iron, zinc, and selenium deficiency.

Keywords: *Hymenolepis Nana*, Epidemiology Study, Insulin, Copper, Selenium, Zinc, Iron.

Introduction

Human infections with cestodes from the genus Hymenolepis are referred to as hymenolepiasis. Cestodes can be classified as either cyclophyllidean or pseudophyllidean. Hymenolepis is recognized as a member of the cyclophyllidean group and is identified by the presence of four sucking-like features in the scolex or head. The suckers are divided into two groups: armed suckers, which have hook-like features, and unarmed suckers, which do not. A single ring of hooks is seen on the suckers of Hymenolepis. The dwarf tapeworm *Hymenolepis nana* (*H. nana*) is thought to be the primary source of infections in humans among the Hymenolepis species. Rats have also been known to contract it(Hussein, 2025; Willcocks *et al.*, 2015).

In Cairo in 1851, Bilharz discovered a helminth infection in a boy's small intestine that would later be known as hymenolepiasis. Humans are infected by two species of Hymenolepis: Both Hymenolepis diminuta and *Hymenolepis nana* are found throughout the world, however *H. nana* is the more common parasite(Thompson, 2015). Primarily a rodent parasite, *H. nana* is a neglected zoonotic helminth that is commonly known as the dwarf tapeworm because of its small size, which is just 1 mm wide and 2-4 cm long(Goudarzi *et al.*, 2021).

The genus Hymenolepis is distinguished by its primitive rostellar apparatus and unarmed scolex. The primary definitive hosts of the zoonotic dwarf, *H. nana*, are rodents. Both humans and rats are frequently infected with the dwarf

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tapeworm, *Hymenolepis nana*. Children living in warm, arid settings with inadequate sanitation had the highest prevalence and biggest parasite burden of *H. nana* infections worldwide(Hamid *et al.*, 2015) There are two types of life cycles: direct and indirect. Autoinfection can occur in nonimmune hosts; the gut of a single host is where the eggs are created, hatched, and finish their life cycle. Arthropods are used as intermediary hosts in the indirect cycle(GÖNENÇ, 2002). Primary stage *H. nana* infections frequently show no symptoms. However, the host has symptoms like nausea, dizziness, diarrhoea, and abdominal discomfort as the illness advances to the chronic stage. Low intestinal absorption of vitamin B12 is associated with *H. nana* infections(Al-Olayan *et al.*, 2020)

In children, *H. nana* has been linked to diarrhoea and other gastrointestinal symptoms, including irritability, diarrhoea, anorexia, and abdominal pain. Furthermore, a link between *H. nana* and anemia *(Cabada et al., 2016)*

The infection is transmitted by the fecal-oral pathway, insufficient hand hygiene, and the ingestion of contaminated food, water, or intermediate hosts. Upon ingestion of the tapeworm ova, they mature into an adult worm of 15 to 40 millimetres in length. Symptoms vary from asymptomatic colonization to anemia, stomach discomfort, and diarrhea. Intestinal parasite infections can lead to significant pathological effects, including diarrhoea, anorexia, abdominal distension with gas, weight loss, abdominal pain, nausea, vomiting, fever, and may also result in intestinal obstruction or impede the absorption of essential nutrients such as proteins, carbohydrates, vitamins, and minerals vital for human health(Willcocks *et al.*, 2015).

Iron, copper, and zinc are vital micronutrients for growth, development, and reproduction; deficiencies in these micronutrients can lead to significant disruptions in enzymatic, physiological, and cellular functioning (H. M. Taher, 2024). Zinc deficiency specifically undermines the immune system, potentially resulting in heightened vulnerability to infections and an escalation in the severity and frequency of diarrhoeal, malarial, and respiratory infections, among other health issues(Lazarte *et al.*, 2015). Most research examining the correlation between inadequate micronutrient status and intestinal parasite infections in children have concentrated on zinc and iron(García *et al.*, 2025). Selenium is a crucial antioxidant and immunomodulatory trace element. It primarily participates in the manufacture of selenoproteins, including glutathione peroxidase (GPx) and thioredoxin reductase (TrxR), to mitigate oxidative stress and tissue inflammation resulting from parasite infections(Avery & Hoffmann, 2018). Selenium also has significant immunomodulatory effects via influencing the functional status of macrophages. Selenium specifically induces a phenotypic transition in macrophages from the classically activated proinflammatory phenotype to the alternatively activated anti-inflammatory, a process in which the cyclooxygenase (COX)-dependent synthesis of cyclopentenone prostaglandin serves a crucial regulatory function(Lu, 2025).

Materials and Methods

584 fecal samples from children were collected in clean, tightly sealed plastic containers with lids. A questionnaire was then distributed to gather information such as age, gender, residence, symptoms, socioeconomic status, animal ownership, and personal hygiene practices. Families who provided the requested information were considered to have given their tacit consent for its use in this study, while those who provided incomplete information were excluded.

Stool Sample Examination

Direct Examination: Samples were examined using the direct wet swab method employed by many researchers. The following steps were followed: A drop of physiological saline solution was placed on a clean glass slide. A small amount of stool was then applied using wooden sticks, covered with another slide, and examined under a microscope using a 10x x 40 lens to confirm the presence of worm eggs and the cystic vegetative stages of protozoa (Garcia, 2001).

Zinc-Sulphate Flotation Concentration to discharge cysts from faeces, 1-2 grams was combined with enough sterile water with a glass rod. The mixture was filtered via four gauze layers. Transfer the filtrate to test tubes and centrifuge for 5 minutes at 1000 rpm. To dissolve the silt, a little distilled water was added to the test tubes after discarding the supernatant. Water was added to the tube and centrifuged. The washing and precipitation process is continued until the supernatant is clear. The precipitate is treated with zinc sulphate solution after discarding the transparent substance. After centrifuging the test tubes at the same speed and duration, the supernatant is carefully extracted with a Pasteur pipette and deposited on a glass slide with a drop of Lockle's iodine solution for microscopy. (Garcia, 2001).

Blood Sample Collection

Five millilitres of venous blood were obtained from each case and control following an overnight fast. The blood samples were maintained at room temperature without agitation for approximately 1 hour to facilitate clotting, followed by centrifugation at 3000 rpm for 15 minutes to collect serum. The serum samples were subsequently stored at -80°C until utilised.

Assessment of Biochemical Parameters and Minerals

The serum levels of insulin were evaluated using ELISA. The plate was pre-coated with antibodies that are specific to human insulin. The concentrations of human insulin exhibited a positive correlation with the coloration of the substrate solution. The process concludes with the introduction of an acidic stop solution, after which the absorbance is assessed at a wavelength of 450 nm. Spectrophotometers were utilised for iron, zinc, selenium, copper, and blood glucose(Nuttall *et al.*, 1995).

Ethical Approval

Ethics approval for this study was waived by the Research and Ethic Committee of Faculty of Samara University.

Statistical Analysis

Statistical Package for Social Science (SPSS) version 23 was used to code, input, and analyse the collected data. Numbers and percentages were employed to analyse qualitative data. For quantitative data analysis, the mean and standard deviation were employed. P-values ≤ 0.05 were used to determine the significance of differences. The relevant statistical tests were used to analyse the relationships. In order to compare the two groups under study, the Shapiro-Wilk test was utilised to verify the normality of the distribution, while the Student t test and Mann Whitney test were employed to determine whether the quantitative variables were normally or abnormally distributed.

RESULT

The results of the study shown in Table (1) revealed that the infection rate with the *H. nana* parasite was 3.9% of the total 584 samples.

Table 1: The percentage of samples tested for the *H. nana*.

No of examined samples	No. of positive cases	Percentage
584	23	3.9%

According to the examination method, the current results showed that the number of infections diagnosed by the sedimentation and flotation method was 14 cases, representing 60.8%, while there were only 9 cases, representing 39.2%, using direct examination. As shown in Table (2).

Table 2: The percentage of diagnosed samples for the *H. nana* according to different methods

Method of examination	No. of positive cases	Percentage
Direct examination	9	39.2%
Sedimentation and flotation method	14	60.8%

Regarding the water source, the number of infections among people using sterilized water reached 7 cases, representing 26.1%, while users of tap water recorded 16 cases, representing 73.9%. As shown in Table (3).

Table 3: The percentage of diagnosed samples for the *H. nana* according to source of water

Source of water	No. of positive cases	Percentage
sterilized water	7	26.1%
tap water	16	73.9%

The results showed that 9 cases had clinical symptoms, representing 39.2%, and 14 cases did not show symptoms, representing (60.8%). As shown in Table (4).

Table 4: The percentage of diagnosed samples for the *H. nana* according to symptoms

Symptoms	No. of positive cases	Percentage
Symptomatic	9	39.2%
A symptomatic	14	60.8%

The results showed that the highest infection rate was among children in the (7-9) age group representing (47.8%), and the lowest infection rate was among children under 3 years old, representing (4.3%). As shown in Table (5).

Table 5: The percentage of diagnosed samples for the *H. nana* according to age groups

Age groups	No. of positive cases	Percentage
< 3 years	1	4.3%
4-6	3	13%
7-9	11	47.8%
10-12	8	34.7%

The results showed that the highest infection rate in male representing (65.2%), and the lowest infection rate in female, representing (34.8%). As shown in Table (6).

Table 6: The percentage of diagnosed samples for the *H. nana* according to sex

Age groups	No. of positive cases	Percentage
Male	15	65.2%
Female	8	34.8%

According to the residence, the results showed that the number of infections in the rural reached 17 cases, representing 73.9%, while the urban recorded 6 cases, representing 26.1%. As shown in Table (7).

Table 7: The percentage of diagnosed samples for the *H. nana* according to residence

Residence	No. of positive cases	Percentage
urban	6	26.1%
rural	17	73.9%

According to the months of the year, the highest infection rate was in September, with 5 cases (21.7%), and the lowest infection rate was in January and March, with one case each (4.3%), while there were no cases in February. As shown in Table (8).

Table 8: The percentage of diagnosed samples for the *H. nana* according to months

Months	No. of positive cases	Percentage
July	3	13%
August	3	13%
September	5	21.7%
October	3	13%
November	4	17.3%
December	3	13%
January	1	4.3%
February	0	0%
March	1	4.3%

The results showed that Co-infections associated with the *H.nana* parasite, including *E.histolytica*, which was 26%, followed by *E.coli* at 13%, and the lowest infection rate was for the *T.hominis* and *E.vermicularis* parasites at 4.3%. As shown in Table (9).

Table 9: Co-infections among *H.nana* infection

Type of parasite	No. of positive cases	Percentage
E.histolytica	6	26%
E.coli	3	13%
G.lamblia	2	8.6%
T.hominis	1	4.3%
E.vermicularis	1	4.3%

The current study showed non significant differences in the level of insulin between infected children and control (p-value> 0.05). Blood glucose, selenium, zinc, iron level decrease in children infected with *H. nana* that were (92.04±21.2 mg/dl, 189.74±59.12 µg/dL, 48.31±5.52 µg/dL, 85.36±9.28 µg/dL) as compared with control that were (115.12±32.4 mg/dl, 253.61±20.77 µg/dL, 74.63±10.71 µg/dL, 145.91±16.53 µg/dL) respectively, at (p-value < 0.05).While statisticaly increase level of copper in infected children as compared with control (219.27±17.61, 116.89±23.74) µg/dL respectively, at (p-value < 0.05).

Table 10: Level of parameters in Children infected with *H. nana* and control

Parameters	Children infected with *H. nana* (n:23)	Control (n:20)	P-value
Insulin mIU/ L	13.72±8.1	11.33 ±7.02	0.06
Blood glucose	92.04±21.2	115.12±32.4	0.02
Selenium mg/dl	189.74±59.12	253.61±20.77	0.001
Zinc(µg/dL)	48.31±5.52	74.63±10.71	0.001
Iron(µg/dL)	85.36±9.28	145.91±16.53	0.001
Copper(µg/dL)	219.27±17.61	116.89±23.74	0.001

DISCUSSION

The present study agree with (Bakr *et al.*, 2009) revealed that 3% of the stool samples under examination had *H. nana* eggs. In another study(El Shazly *et al.*, 2006), *H. nana* eggs were found in 3.9% of the stool samples that were analyzed in a different investigation. A study by (Almeida España & Cedeño Rosero, 2018) presented symptoms of patient infected with *H. nana* including headache, nausea, vomiting, generalized abdominal pain, epigastric pain, neck pain, and arthralgia.

The present study agree with (Gelaw *et al.*, 2013; Hamid *et al.*, 2015; Safar & Eldash, 2015) the prevalence of *H. nana* infection was higher in males than in females. In contrast, no differences in the prevalence rates of *H. nana* between female and male children (Bagayan *et al.*, 2015).

According to age, the results regarding dwarf tapeworm infection and age group showed that the most affected age group is school students, who tend to frequently consume food and drinks from vendors that do not meet health standards. The present study agree with (J. H. Taher, 2017) that showed a significant difference ($P < 0.05$) of the patient ages (6-12) in comparison to other ages, while the lowest percentage was seen in the age (18-24). Other study (Alemneh *et al.*, 2017; Alli *et al.*, 2011) reveals that the high prevalence of parasitic infections among pre-school children might be due to the habits, poor water supply and lack of environmental sanitation, especially where children eat, drink, exercise development activities and play. In addition, low body immune system response malnourished children might be responsible for high infection rate.

The results showed that those who drank tap water were more likely to contract the parasite than those who used sterilized water, and this is attributed the effect of drinking water on the rate of parasite infection, given that the sources of this water used in homes are tap water as a source of drinking water, may be due to the exposure of water transmission pipes to corrosion or breakage and the contamination of the water with parasitic agents, as well as the lack of effect of the parasite stages on disinfectants.

This result agree with (Alkholy *et al.*, 2024). The study results also showed the presence of several types of intestinal parasites, including Entamoeba histolytica, *G.lamblia*, Entamoeba coli, *T.hominis, E.vermicularis*. The presence of this percentage of intestinal parasite infection may be due to the lack of clean water, which may be contaminated with parasite cysts that are not affected by the chlorination process carried out to disinfect drinking water.

The spread of the parasite in certain seasons of the year is due to changes in temperature during the months of the year, as a decrease in temperature reduces the growth and development of the parasite.

The present study showed decrease level of iron in children infected with H.nana. This result suggested occurrence of malnutrition in children infected with parasite because the parasite cause poor absoption for minerals in addition to diarrhea. The present study agree with (Alkholy *et al.*, 2024) that showed the serum levels of zinc, iron, and selenium decreased in patient infected with different parasite and H.nana were with them. Research indicates that individuals with parasitic infections not only exhibited deficiencies in specific micronutrients, but their serum levels also increased following the administration of antiparasitic medications. Nonetheless, certain studies indicate that this reduction may result from impairments and mucosal damage, which, in isolation, could restrict zinc absorption (Roxström-Lindquist *et al.*, 2006). Consequently, this disruption may affect the activity of digesting enzymes, including lipases, proteases, and disaccharidases, as well as the secretion of cytopathic chemicals that harm the intestinal epithelium.(Buret *et al.*, 1992).

The iron deficiency in this study may result from various sources, including reduced intake and inadequate absorption. Due to the necessity of iron for parasite development and reproduction, its use by parasites cannot be disregarded. A study by (Peralta *et al.*, 2023) shown a correlation between *H. nana* infection and anemia. The prevalence of anaemia was 89.8%, with some children exhibiting an increase to 92%, and 34.5% of underweight and borderline weight children among boys, indicating a significant difference (Safar & Eldash, 2015). A further investigation discovered substantial evidence correlating parasite illness with diminished serum levels of selenium and various other essential trace elements (Alkholy *et al.*, 2024). Moreover, reduced consumption of vitamins and food has been linked to intestinal parasite infections, manifested by symptoms including abdominal pain and anorexia. Iron and zinc function as immunomodulators and contribute to immune system responses at mucosal membranes (García *et al.*, 2025).

CONCLUSION

The prevalence of *H. nana* infection is influenced by factors age, sex, source of water. Furthermore, there is association between infection *H. nana* and iron, zinc, selenium deficiency.

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