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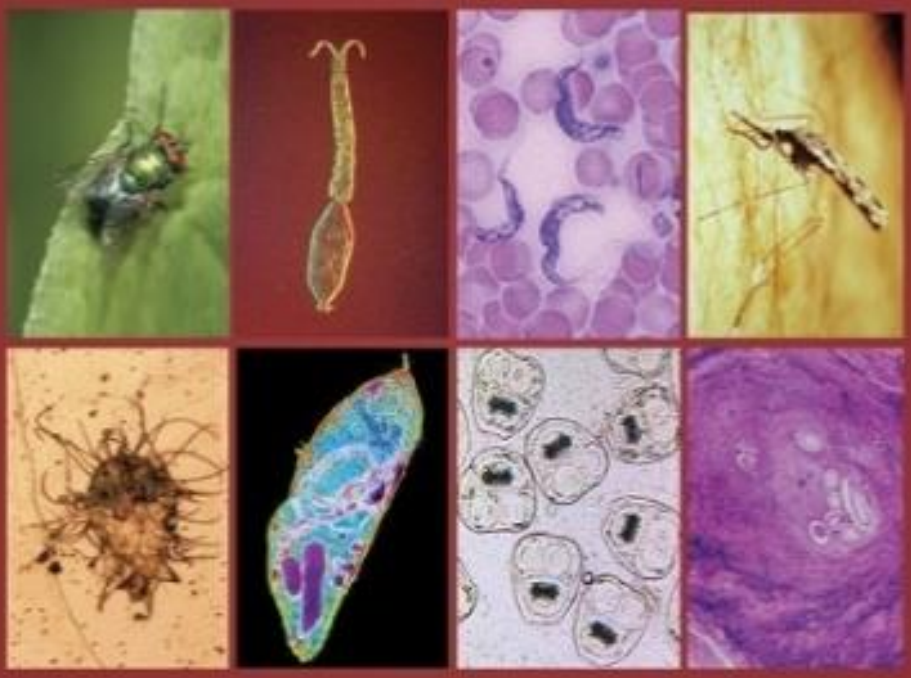

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Concomitant Infection of *Helicobacter pylori* and Intestinal Parasites in Children Attending Benha University Hospital

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ABSTRACT

Background: Children frequently experience gastrointestinal (GI) symptoms such as diarrhoea and stomach pain. Intestinal parasites and *Helicobacter pylori* are prevalent causes of GI pain and important infectious pathogens burdening global public health. The present study's objective is to determine how *H. pylori* infections and related intestinal parasites affect paediatric patients' clinical presentation. **Methods:** This cross-sectional study included 70 children less than 18 years old of both sexes suffering from GI symptoms suggestive of intestinal parasitic or *H. pylori* infection and admitted to Benha University Hospitals' paediatric department. Every patient underwent a thorough history review, physical examination, and laboratory analysis. The source of the water supply, a history of GI manifestations such like diarrhoea, abdominal pain, abdominal swelling, vomiting, hematemesis, or rectal bleeding, as well as the results of the endoscopy. Patients were also tested for the presence of intestinal parasites and *H. pylori* infection by testing for *H. pylori* stool antigens, additionally, all stool samples were tested for the existence of helminthic and/or protozoal diseases. *H. pylori* caga virulence factor was analysed by real-time PCR**Results:** Twenty-six (37.1%) patients were positive for *H. pylori* infection, 23 (32.9%) had a parasitic infection and 21 (30.0%) had a concomitant infection (*H. pylori* and parasites). Clinical manifestations (abdominal pain, abdominal distension, vomiting and diarrhea) were insignificantly different among the studied groups. **Conclusions:** Additional research is necessary to understand the mutual impact of co-infection between *H. pylori* and other parasites on immunological, molecular and ultrastructural levels, and the consequent effect on the emergence of various clinical presentations.

INTRODUCTION

Children frequently experience gastrointestinal (GI) problems like diarrhoea and abdominal discomfort. Every year, there are over 1.7 billion cases of paediatric diarrhoea worldwide (Selbuz and Buluş, 2020). *Giardia lamblia*, *Entamoeba histolytica*, and *Cryptosporidium* species. are only a few of the pathogenic organisms that can cause diarrhoea in children (Verma *et al.*, 2019).

Intestinal parasites and *Helicobacter pylori* are infectious diseases with significant global public health implications and are typical causes of GI disorders (Pomari *et al.*, 2020). Attributable to inadequate sanitation, contaminated water, hot, humid weather, inadequate housing, and overcrowding, intestinal parasites are a key contributor to sickness and mortality, particularly in developing nations (Al-Yousofi *et al.*, 2022).

A Gram-negative bacterium known as *H. pylori* is linked to both stomach cancer and peptic ulcers. The prevalence of *H. pylori* infection is estimated to be greater than 50% worldwide with low- and middle-income countries having the largest burden (LMICs*)* (Savoldi *et al.,* 2018).

Similarly, intestinal parasites afflict millions of people worldwide, increasing the likelihood that they will also contract *H. pylori* (Majid *et al.,* 2019).

Numerous investigations have identified *H. pylori* infection and intestinal parasitic infections, particularly giardiasis, as potential etiological causes for GI symptoms such as recurring stomach pain and diarrhoea. In underdeveloped nations, there is a significant amount of evidence linking *G. lamblia* infection with *H. pylori* infection. It is essential to choose an appropriate treatment to achieve infection eradication that takes into account the relationships between various infectious agents (Abd El Hameed *et al.,* 2021, Tilahun *et al.,* 2022).

The purpose of the current study is to assess the influence of *H. pylori* infection and concomitant intestinal parasitic infection on the clinical presentation of paediatric patients.

MATERIALS AND METHODS

This cross-sectional research included 70 children who were tested for the presence of intestinal parasites and *H. pylori* and were admitted to the Department of Pediatrics, Benha University Hospitals. The study was done after approval of the institutional ethical committee (Rc.13.8.2023). Consent to participate was obtained from the patients' guardians and proper management was performed according to diagnosis. The study was conducted between the months of March 2022 to March 2023.

Inclusion criteria: Patient's age <18 years old, both sexes, complaining of GI symptoms suggestive of intestinal parasites and/or *H. pylori* infection.

Exclusion criteria: Patient's refusal to participate, children of patients who underwent antiparasitic, antibiotic, or *H. pylori* medication within the previous month before visiting the GI clinics. Additionally, other causes of GI symptoms such as bacterial or viral infections, or other dietary or nutritional problems were ruled out from the study.

Every patient underwent a thorough history- taking procedure (age, sex, BMI and residency). Patients were asked about water sources and previous GI problems such as diarrhoea hematemesis or rectal haemorrhage, abdominal distension, nausea, and stomach pain. Results of endoscopic procedures, such as investigating the presence of chronic gastritis and antral gastritis, bulbar duodenitis, and erosive duodenitis were also recorded.

Sample Collection and Processing:

Biopsy specimens' culture was performed in a biological safety cabin and then preserved at −80°C deep freezer for further molecular processing. The specimens were discharged with the aid of a sterile swab into two commercial culture media: blood agar (Columbia agar + 5% sheep blood, BioMérieux) and *Helicobacter* selective agar media (Pylori agar, BioMérieux). The samples were incubated for 15 days at 37°C in a micro-aerobic atmosphere (5% O_2, 10% CO_2, and 85% N_2). *H. pylori* colonies are small, translucent to yellowish colonies, which can be identified based on a Gram-negative helical-shaped in Gram-staining procedure followed by positive oxidase, catalase, and urease tests, along with the confirmation by MALDI-TOF mass spectrometry (Bruker).

In addition to testing for *H. pylori* stool antigens, all stool samples were tested for the existence of helminthic and/or protozoal diseases. The following procedures were used; each participant provided three consecutive faecal samples, which were all collected in a wide-mouthed, clean, dry container with a label (Ruenchit,

2021).The faeces cups were immediately brought to the lab for inspection, where the following was performed:

Direct wet mount smear method was studied under the microscope at low and high magnifications. The material was next examined for protozoa by applying an iodine drop onto the edge of the coverslip.The sample was concentrated utilizing formalin-ethyl acetate (FEA) sedimentation, which was followed by the transfer of the sediment to a clean glass slide for examination. Kinyoun's Acid-Fast stain was employed to permanently stain the smear, which was kept in 10% formalin (cold method). Every stool sample was exposed to copro-antigen detection utilizing an on-site *H. pylori* Ag fast test from CTK BIOTECH for the purpose of *H. pylori* antigen identification utilizing immunochromatographic immunoassay testing (ICT) (Bradbury *et al.,* 2022).

H. pylori Caga Virulence Factor Analysis by Real-Time PCR:

Utilizing the MagNA Pure LC 2.0 Instrument, the entire DNA was taken from 200 mg of faeces (Roche, Monza, Italy). As an internal control for isolation and amplification procedures, *Phocine Herpes Virus type-1* (PhHV-1), was introduced to each sample ***(Perandin et al., 2018)***. All the amplification reactions were conducted utilizing 5 µL of DNA and utilizing SsoAdvanced universal probes supermix (BioRad, Milan, Italy), primers cagA-F 5′-TCAAGAACCAGTTCCCCATGTC-3′ and cagA-R 5′-CTCTAGCTTCAGGCGGTAAGC-3′, and probe HEX-5′-ACCAGATATAGCCACTACC-3′.

The programme was made up of 50 cycles of 15 seconds at 95 °C, 30 seconds at 58 °C, and 30 sec at 72 °C. The first phase took 3 minutes at 95 °C. The CFX96 system was utilized for all reactions and data analytics (BioRad, Milan, Italy) (Deng *et al.,* 2020).

Sample Size Calculation:

G. power 3.1.9.2 (Universität Kiel, Germany) was utilized to calculate the sample size. According to a prior study, sample size was established by comparing the prevalence of GI symptoms (abdominal distension) in cases with *G. lamblia* infection to cases with *H. pylori* infection alone and instances with co-infection of both (58.8% vs. 45.8% vs. 71.4%) (Abd El Hameed *et al.,* 2021). According to the following criteria: 0.05 error and an 80 percent study power. To combat dropout, four additional cases were introduced. Seventy patients were assigned as a result.

Statistical Analysis:

SPSS version 28 was utilized for statistical analysis (IBM Inc., Armonk, NY, USA). The ANOVA (F) test was utilized to contrast the two sets of quantitative variables, which were provided as mean and standard deviation (SD). Chi-square test was utilized to analyze qualitative variables, which were provided as frequency and percentage. Diagnostic sensitivity was used to measure the incidence of true positive results in patients' groups. Statistical significance was deemed as a two tailed P value < 0.05.

RESULTS

In our study, 26 (37.1%) of patients had *H. pylori* infection, 23 (32.9%) had a parasitic infection and 21 (30.0%) had a concomitant infection (*H. pylori* and parasites). Table 1 shows the type of parasitic infection where *Blastocystis spp*. was the most widespread spp., the second most common being *E. coli* species.

Table 1: Distribution of parasitic infection**.**

Parasite	Parasitic infection (n=23)
Blastocystis spp.	11 (15.7%)
E. coli	6 (8.6%)
E. nana	4 (5.7%)
S. mansoni	4 (5.7%)
E. dispar	3 (4.3%)
D. fragilis	2 (2.9%)
E. histolytica	2 (2.9%)
G. intestinalis	2 (2.9%)
S. stercoralis	2 (2.9%)
E. hartmanni	1 (1.4%)
A. duodenale	1 (1.4%)
H. nana	1 (1.4%)

Data displayed as frequency (%)

Baseline characteristics (age, gender, weight, and height) and type of water supply were insignificantly different among the studied groups. Patients from rural areas showed a significantly higher incidence of *H. pylori* infection (P=0.020) (Table 2).

Table 2: Baseline characteristics of the studied groups.

		H. pylori infection (n=26)	Parasitic infection (n=23)	Concomitant infection (n=21)	P value
Age (years)		9.31 ± 3.64	8.26 ± 4.21	10.29 ± 3.95	0.239
Gender	**Male**	12 (46.2%)	15 (65.2%)	10 (47.6%)	0.348
	Female	14 (53.8%)	8 (34.8%)	11 (52.4%)	
Weight (Kg)		26.35 ± 8.11	27.13 ± 8.13	26.57 ± 6.51	0.936
Height (cm)		120.12 ± 6.39	117.3 ± 10	119.95 ± 7.1	0.403
Residence	**Urban**	4 (15.4%)	12 (52.2%)	9 (42.9%)	**0.020***
	Rural	22 (84.6%)	11 (47.8%)	12 (57.1%)	
Type of water supply					
Tap water		9 (34.6%)	10 (43.5%)	11 (52.4%)	0.807
Filtered water		7 (26.9%)	6 (26.1%)	4 (19%)	
Pumped water		10 (38.5%)	7 (30.4%)	6 (28.6%)	

Data displayed as mean ± SD or frequency (%), *: statistically significant as P value <0.05

Regarding the clinical manifestations, abdominal pain was recorded in 11 cases (42.3%) in the *H. pylori* group, 7 (30.4%) cases of the parasitic infection group and 6 cases (28.6%) in the concomitant infection group. Abdominal distension was reported in 8 cases (30.8%) in *H. pylori* group, 6 (26.1%) cases in the parasitic infection group and 7 (33.3%) cases in the concomitant infection group. Vomiting occurred in 5 (19.2%) cases in *H. pylori* group, 2 (8.7%) cases in parasitic infection group and 2 (9.5%) cases in the concomitant infection group. Diarrhea occurred in 2 (7.7%) cases in the *H. pylori* group, 8 (34.8%) cases in the parasitic infection group and 6 (28.6%) cases in the concomitant infection group. There was no significant difference between the occurrence of clinical manifestations among the studied groups. (Fig. 1).

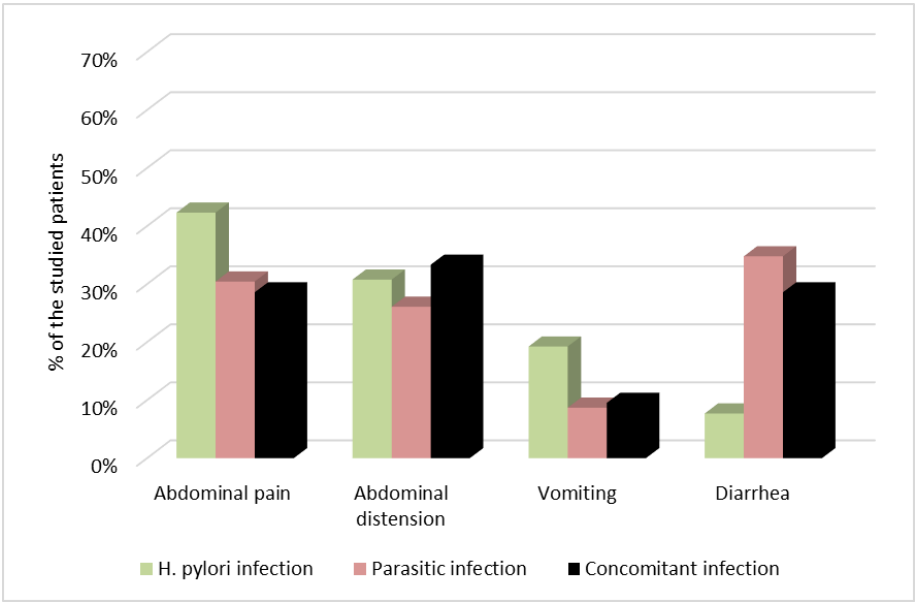

Fig. 1: Bar chart showing Clinical manifestations of the studied groups.

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Regarding the endoscopic findings, chronic gastritis was recorded in 2 (7.69%) cases in *H. pylori* group, 4 (17.39%) cases parasitic infection group and 4 (19.05%) cases in the concomitant infection group. Chronic gastritis and erosive duodenitis occurred in 6 (23.08%) cases in *H. pylori* group, 6 (26.09%) cases in parasitic infection group and 7 (33.33%) cases in the concomitant infection group. Antral gastritis and bulbar duodenitis occurred in 4 (15.38%) cases in *H. pylori* group, 2 (8.7%) cases in parasitic infection group and 3 (14.29%) cases in the concomitant infection group (Table 3).

Table 3 : Endoscopic findings of the studied groups.

	***H. pylori* infection (n=26)**	**Parasitic infection (n=23)**	**Concomitant infection (n=21)**	**P value**
Chronic gastritis	2 (7.69%)	4 (17.39%)	4 (19.05%)	0.839
Chronic gastritis and erosive duodenitis	6 (23.08%)	6 (26.09%)	7 (33.33%)	
Antral gastritis and bulbar duodenitis	4 (15.38%)	2 (8.7%)	3 (14.29%)	

Data presented as frequency (%).

Regarding the genes distribution in *H. pylori* strains, 19 (73.07%) patients were positive for CagA and 7 (26.92%) patients were negative for CagA (Table 4).

Table 4: Genes distribution in *H. pylori* strains of studied patients.

		n=26
CagA	**Positive**	19 (73.07%)
	Negative	7 (26.92%)

Data presented as frequency (%).

Table 5, shows that there was significant correlation between *H. pylori* genotypes and abdominal pain and abdominal distension (P=0.033, 0.045), whereas there was insignificant correlation between *H. pylori* genotypes and other clinical manifestation (vomiting and diarrhea).

Table 5: Correlation between various *H. pylori* genotype and clinical manifestations.

	CagA Positive (n=19)	**CagA Negative (n=7)**	
Abdominal pain	8 (42.11%)	3 (42.86%)	**0.033***
Abdominal distension	6 (31.58%)	2 (28.57%)	**0.045***
Vomiting	4 (21.05%)	1 (14.29%)	0.057
Diarrhea	1 (5.26%)	1 (14.29%)	NS

*: statistically significant as P value <0.05.

Table 6: Comparison between molecular results and ICT results for h. pylori as regards sensitivity

	PCR	**ICT**
Positive	25	23
Negative	1	3
Sensitivity	96.15%	88.46%

PCR: polymerase chain reaction, ICT: immunochromatographic

Microscopic Findings:

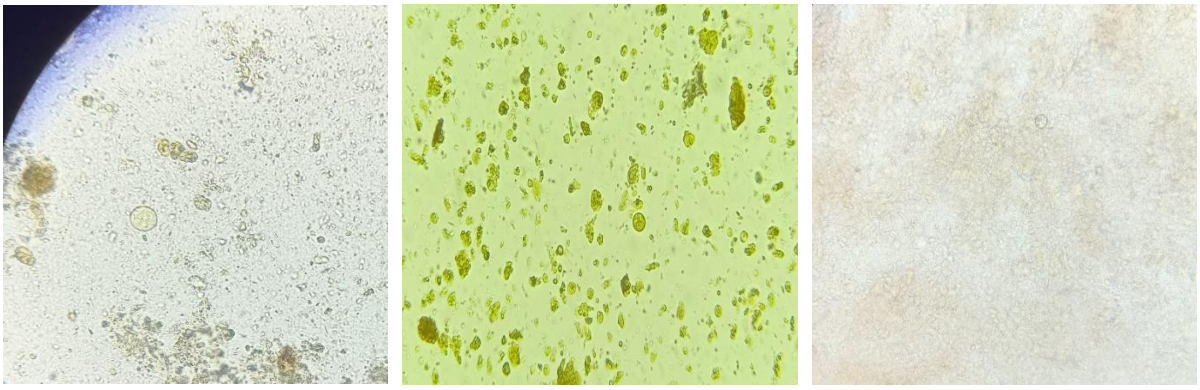

Fig. 2: Light microscopic picture showing *Entamoeba histolytica* cyst stained with iodine (x 400).

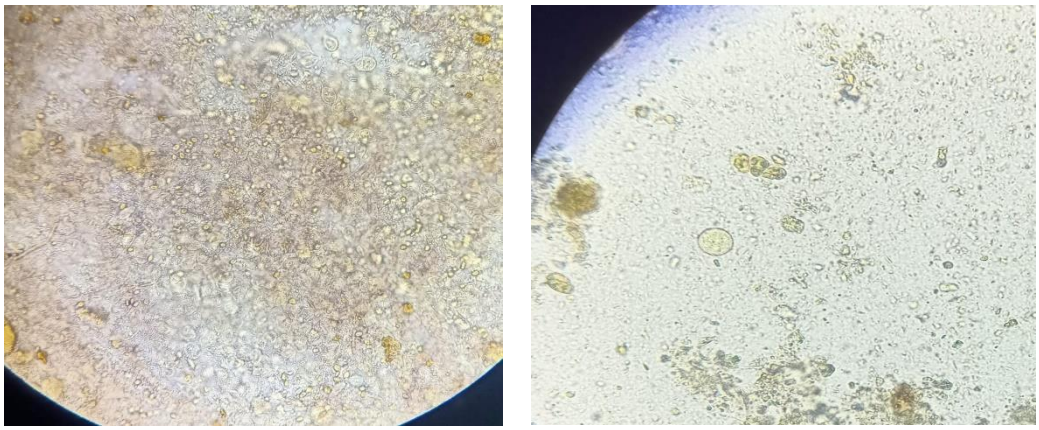

Fig. 3: Light microscopic picture showing *Giardia* cyst and trophozoite stained with iodine (x 400).

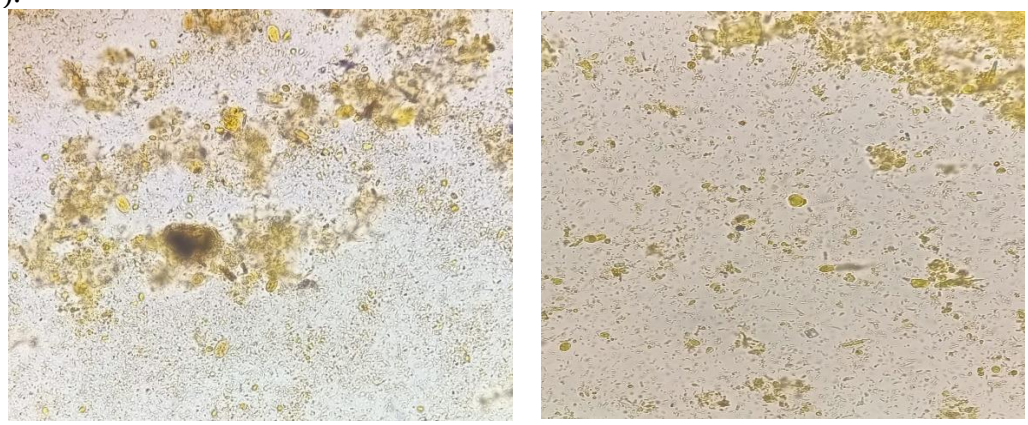

Fig. 4: Light microscopic picture showing *Blastocyst* stained with iodine (x400).

DISCUSSION

A gram-negative bacillus called *Helicobacter pylori*, which colonises the gastrointestinal mucosa is commonly acquired throughout childhood and may linger into adulthood (Malfertheiner *et al.*, 2023). It could be asymptomatic or show a variety of GI symptoms, such as dyspepsia, chronic epigastric discomfort, hematemesis, vomiting, ulcers, or even gastric cancer. There is considerable debate over the connection between *H. pylori* infection and diarrhoea in children (Kakiuchi *et al.*, 2019). *Monoclonal antibodies may identify H. pylori copro-antigen in stool with great specificity and*

sensitivity by utilising immunechromatography (Ng *et al.,* 2019, Obaid *et al.,* 2021).

In a cohort of adults visiting a centre for tropical disorders in North-Eastern Italy the vast majority of participants were from Africa (Pomari *et al.,* 2020). *H. pylori* infection was prevalent in most people, and most of them were $cagA^+$, suggesting potential mechanisms of aiding the entry of other pathogens (Kusters *et al.,* 2006).

In our study, *H. pylori* infection affected 26 patients (37.1%) of the overall group, while parasitic infections affected 23 (32.9%) and concurrent infection affected 21 (30.0%) patients (*H. pylori* and parasites). Numerous investigations have demonstrated that intestinal parasites and *H. pylori* infection are related (El-Badry *et al.,* 2017, Ibrahim *et al.,* 2019, Spotts *et al.,* 2020).

Gastric juice normally produces an environment that is unfavourable to harmful germs. As stated by the location and length of the infection, *H. pylori* alters the gastric acid output. In addition, the bacteria can damage the gastric mucosal barrier, providing an ideal environment for intestinal parasitosis (Wroblewski *et al.,* 2010, Waldum *et al.,* 2016).

Ghallab and Morsy reported that *Cryptosporidium spp.* (32%), *Blastocystis* (68%), *E. histolytica* complex (27%), and *G. lamblia* (31%) were more prevalent in *H. pylori*-infected patients at Kafrelsheikh University Hospital than in individuals without the infection (Ghallab and Morsy, 2020).

It is important to note that polymicrobial interactions in the intricate intestinal niche can have a significant impact on how a disease develops *(Frisan, 2021)*. In fact, the coexistence of intestinal protozoa and *H. pylori* might cause an increased T helper (Th1) response that worsens mucosal damage and does not successfully eliminate the infection (Hussain *et al.,* 2020). Few studies examined diabetic individuals' simultaneous infection with *Cryptosporidium* and *H. pylori* (Htun *et al.,* 2018). In a study by Fadl *et al.,* 4 (10%) diabetic patients were found to have co-infections with *Cryptosporidium* and *H. pylori*, although there was no statistically significant variation between them and the three patients who also had *Blastocystis* infection (Fadl *et al.,* 2021). Pomari et al. studied concurrent infection of *H. pylori* and intestinal parasites in 93 subjects and found that 61 (66%) subjects had *H. pylori* infection (Pomari *et al.,* 2020).

In a study by Abd El Hameed et al., 150 children of both sexes, ages 1 to 15 and suffering from gastrointestinal complaints were studied to ascertain the connection between *H. pylori* infection and parasitic diseases. They discovered that 88 patients (58.6%) had intestinal parasitic infection, and 63 patients (42%) tested positive for the *H. pylori* faecal antigen. Intestinal protozoa were substantially more common (92%) than intestinal helminths (Abd El Hameed *et al.,* 2021).

We discovered that *E. coli spp*. was the second most prevalent spp. after *Blastocystis spp*. Pomari et al. in their cohort, observed that those with intestinal parasitic infections had a greater incidence of *H. pylori* infection than did patients who were not affected. The interaction of *H. pylori* with *Blastocystis* spp. was the most abundantly reported, making it the most common type of intestinal parasite. A larger percentage of people with *E. coli* and *E. nana* infections were discovered among those who had *H. pylori* infection, despite that the association was not statistically significant (Pomari *et al.,* 2020).

A study done on 115 Egyptian patients with irritable bowel syndrome (IBS) revealed that 27% of those with *H. pylori* also had *Blastocystis* (El-Badry *et al.,* 2018). Recently, it was discovered that chronic diarrhoea in Pakistani patients was significantly correlated with *Blastocystis* and *H. pylori* coinfection (67 %) (Yakoob *et al.,* 2018).

In a prior study investigating the prevalence and subtypes of *Blastocystis*, it was shown that co-infection occurred in 46% of samples that tested positive for the parasite, with *D. fragilis* being the most common co-infecting parasite (Piubelli *et al.,* 2019). The most prevalent infections impacting people in low and middle-income countries were found to be *H. pylori*, *E. hystolytica/dispa*r, and *G. intestinalis* (Moreira *et al.,* 2005).

Moreover, Abd El Hameed et al. revealed that 75 patients had mono parasitic infections, with *G. lamblia* (35.2%) and the *Entamoeba histolytica/E. dispar* complex (22.7%) being the most frequently found parasites. *Blastocystis hominis* and *Hymenolepis nana* parasites were next in frequency. Thirteen patients had the mixed parasitic infection, with the following combinations: *Blastocystis hominis* and *Entamoeba histolytica/E. dispar* complex (5 patients), *Blastocystis hominis* and *G. lamblia* (3 patients), *G. lamblia* and *Entamoeba histolytica/E. dispar* complex (4 patients), *Entamoeba histolytica/E. dispar* complex and *Cryptosporidium*, and *Entamoeba histolytica/E. dispar* complex and *Crypto* (one patient), all without statistical significance (Abd El Hameed *et al.*, 2021). These findings were similar to outcomes by Cheng et al. in China and Hestvik et al. in Uganda who determined that that overall detection of *H. pylori* infection was 46.6 and 44.3 percent, respectively (Cheng *et al.,* 2009, Hestvik *et al.,* 2010). Previous work had examined the co-infection of *H. pylori* and parasitic illnesses (Seid *et al.,* 2018, Yousif Abd Elbagi *et al.,* 2019). Intestinal parasites and the *H. pylori* bacterium both colonize the gastrointestinal tract (GIT) and are common in young children. Additionally, similar mechanisms of transmission (such as the feco-oral route), low socioeconomic levels, and unsanitary environments may all contribute to the coexistence of both illnesses (Sabah *et al.,* 2015).

A comparable study that investigated 363 adult patients from Ethiopia found that those with *H. pylori* infection had considerably greater *G. lamblia* prevalence (22.3%) than those without it (Seid *et al.,* 2018). Likewise, G. intestinalis was the predominant (20.1 %) coexisting parasite in 427 non-symptomatic children from Uganda with a prevalence of *H. pylori* of 44.3% (Ankarklev *et al.,* 2012). Moreira et al. did not discover a significant connection between *H. pylori* seropositivity and *E. histolytica* infection (Moreira *et al.,* 2005). However, Torres et al. indicated that those who carried the parasite *E. histolytica* had a considerably lower prevalence of *H. pylori* infection than those who did not. In order to determine the existence of an association, if any, well-designed cohort type research is required (Torres *et al.,* 2003).

In a study by Pomari et al., both *Blastocystis* and *H. pylori* were frequently identified in participants who tested positive. It is likely that their presence in the stool of those who had gastrointestinal symptoms was a coincidental discovery rather than a cause of their symptoms (Pomari *et al.,* 2020). An earlier study found that participants without IBS symptoms had a higher *D fragilis* proportion in fecal samples than participants Rome III criteria for IBS (35% vs 23%; P = .03), as was *Blastocystis* (22% of controls vs 15% of cases; P = .09), and a greater percentage of participants without IBS symptoms carried more than 1 species of parasite (16% of controls vs 8% of cases; P = .05) (Krogsgaard *et al.,* 2015) .

In the current study, there were little differences in the clinical signs (abdominal discomfort, abdominal distension, vomiting, and diarrhoea) between the groups under study.

In various cases, the most often noted complaints were diarrhoea, distension, and abdominal pain. Okyay et al. and Escobedo et al. exhibited a significant correlation between parasite infections and diarrhoea or stomach pain (Okyay *et al.,* 2004, Escobedo *et al.,* 2008). Abd El Hameed et al. reported that cases with individual *H. pylori*

infection exhibited higher rates of vomiting and hematemesis (Abd El Hameed *et al.,* 2021). Dore et al. reported that children who had nausea or vomiting had a considerably greater rate of *H. pylori* infection compared to children who did not exhibit these symptoms. The distinction between the location of an infection for intestinal parasites (lower gastrointestinal tract) and *H. pylori* (upper gastrointestinal tract) may explain this variation in symptoms. However, diverse GIT symptoms found in patients (negative for both parasitic and *H. pylori* infection) were linked to other infectious (bacterial and viral) and non-infectious (dietary and feeding) reasons that had been identified (Dore *et al.,* 2012). In the group with an *H. pylori* infection, which occurred less frequently, diarrhoea was not considered to be a notable symptom (Abd El Hameed *et al.,* 2021). This may be attributed to the fact that the virulence factor of *H. pylori* (VAC A cytotoxin) in their study might not be the one which promotes diarrhea with *H. pylori* (Passaro *et al.,* 2001).

Unlike what we had anticipated, in a study by Abd El Hameed et al., there was a statistically significant variation in the frequency of diarrhoea between cases with parasite and *H. pylori* co-infection (35.6%) and cases with parasitic infection alone (63.2%) (Abd El Hameed *et al.,* 2021). A number of studies have documented how *H. pylori* infection slows the progression of diarrhoea in *H. pylori*-infected individuals, which could be a result of the gastric immunological response being activated (Salama *et al.,* 2019).

Abdominal pain, distension and diarrhea were the most frequently recorded complaints among different cases and were found to be more frequent in cases of parasitic infection alone than those with *H. pylori* infection (Abd El Hameed *et al.,* 2021). Similarly, Okyay et al. and Escobedo et al. demonstrated strong association between parasitic infections and abdominal pain or diarrhea (Okyay *et al.,* 2004, Escobedo *et al.,* 2008). Vomiting is one of the typical symptoms of *H. pylori* infection, coinfection cases were more likely to have hematemesis (17.9%%) than those of *H. pylori* infection alone (37.5%) (Abd El Hameed *et al.,* 2021). Abd El Hameed et al. exhibited that *H. pylori* infection may be able to reduce the diarrhoea brought on by intestinal parasites. In contrast, parasitic infection may lessen the frequency of vomiting brought on by *H. pylori* infection in cases where both infections are present (Abd El Hameed *et al.,* 2021).

We found that of 26 positive cases, 19 (73.07%) patients were positive for CagA and 7 (26.92%) patients were negative for CagA.

In Khater *et al.* study, CagA positive were 50%, while 48.39% were negative for cagA and 1.61% was mixed (Hassan Khater and AlFaki, 2022). Similar results were obtained by Akeel et al., who detected cagA in 49.2% of H. pylori strains *(Akeel et al., 2019)*. The results also were similar to the studies by Momenah et al., Marie et al., Kadi et al. 14 in Saudi Arabia, they found cagA prevalences were 52.4%, 62% and 81.8% respectively (Momenah and Tayeb, 2007, Marie, 2012, Kadi *et al.,* 2014). In Egypt, Abu Taleb et al. reported the prevalence of cagA was about 57% in their studied group (Abu-Taleb *et al.,* 2018).

Our study had several limitations because it was a single-center study with a small sample size.

Conclusions: Additional research on the impact of co-infection on the fine structures of H. pylori and other parasites may be necessary to understand the effects of the two organisms on one another, and ultimately on the emergence of various clinical presentations in patients.

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Conflict of Interest: Nil

Ethical Statements: Approval of the institutional ethical committee (Rc.13.8.2023) at Faculty of Medicine Benha university.

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