Comparative Study of the Incidence of Co-Infection of Soil-Transmitted Helminths and *Helicobacter pylori* among Children and Women of Reproductive Age Living in Slum Settlements in Rivers State.

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ABSTRACT

Background: Soil-transmitted parasites, bacterial and other biological contaminants constitute the major causes of food-borne diseases often transmitted through food and water borne routes contaminated with faeces in developing countries. Children and Women of reproductive age (WRA) have high of getting infected and being potential sources of pathogenic micro-organisms.

Objective: This study was aimed to assess and compare the prevalence and risk factors of soil-transmitted helminths and *Helicobacter pylori* (*H. pylori*) among school-aged children and women of reproductive age at selected area in Eleme Local Government Area, Rivers State.

Methods: Cross-sectional study was conducted 580 participants were enrolled in May-August 2019. The gastrointestinal parasites were examined with wet mount and formol-ether concentration techniques. Chi-square (χ2) test was used to evaluate the association between categorical variables and infection prevalence using SPSS version 21, values were considered significant when the p-value was less than 0.05.

Results: The overall prevalence of soil-transmitted helminths among children was 12.3% (37/300) whereas WRA had 12.5% (35/280). *Trichuris trichura* was found to be prominent among the children with 18 (6.0%) while *Ascaris lumbricoides* 10 (3.6%) was most prevalent among WRA. Gender based Prevalence was 56.8% (21/37) and 43.2% (16/37%) for males and females respectively. The age-related prevalence is most common among age group 11-15 years. This prevalence was not statistically significant (*p*>0.05). *H. pylori* infection prevalence among the children and WRA were 11.7% (35/300) and 26.8% (75/280). The gender-related prevalence among the males had 18 (51.4%) and females 17 (48.6%) of the children group. The age group 1-5 years showed high prevalence of *H. pylori* than other groups. Among WRA, age group 23-27 and 33-37 years had equal prevalence of 20 (26.7%). In consideration of co-infection between children and WRA, *A. lumbricoides* coinfection *H. pylori* 15 (53.5%) was most prevalent among children while among women of reproductive age, hookworm co-infection *H. pylori* 8 (50.0%) was most prevalent. Risk factors that were statistically significant (p<0.05) were among those who wash hands with soap after playing/touching soil and those dewormed in the last three months.

Conclusion: The distribution soil-transmitted helminth infections co-infection *H. pylori* among children and WRA is low, however strategic planning of treatment regimen of community based should be encouraged.

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Keywords: Co-infection, Soil-Transmitted Helminths, *Helicobacter pylori,* Children, Women of Reproduction Age, Eleme.

1. INTRODUCTION

Soil-transmitted parasites are highly prevalent worldwide, particularly in low-income regions, such as most African, Southeast Asian, and Latin American countries [1]. In the latter region, 20-30% of the inhabitants, specifically those younger than 15 years, develop recurrent parasitosis. Soil-transmitted parasites represent an overlooked health issue in Latin America, perhaps because they are not considered a component of the unfavorable conditions that perpetuate the cycle of poverty [2]. In fact, over the long term, diseases caused by these intestinal parasites can lead to diminished learning capacity in childhood and reduced economic productivity in adulthood [3, 4].

Soil-transmitted helminths cause significant nutritional morbidity [5]. It has been estimated that the total number of disability-adjusted life years (DALYs) lost due to soil-transmitted helminths infections is: between 1.2 and 10.5 million for *A. lumbricoides;* between 1.8 and 22.2 million for *T. trichiura*; and between 1.6 and 6.4 million for hookworm [6, 7]. The wide-ranging estimates result from the variability in extrapolating published prevalence and intensity data obtained from localized surveys conducted in endemic areas over time.

According to WHO, out of 17 Neglected Tropical Diseases (NTDs), eight diseases are intestinal parasitic infections. These parasitic infections cause immense human morbidities as they play their role in aiding poverty and hampering the development of the country. The population groups at high risk for STH morbidity include preschool children (1-4 years), school-age children (5-14 years) and women of reproductive age (WRA) (15-49 years) [8].

Helicobacter pylori is a Gram-negative bacterium that colonizes human gastric mucosa, leading to chronic antral gastritis and peptic ulcer disease. It is also associated with serious diseases, including gastric cancer and gastric mucosa associated lymphoid tissue lymphoma [9]. *H. pylori* was found in biopsy specimens of most of the patients with chronic gastritis, duodenal ulcer or gastric ulcer, suggesting that this organism may have a role in the causation of these disease conditions. *H. pylori* is a gram-negative spiral-shaped bacillus. The organism is known to cause infection in humans worldwide [10]. The prevalence of H. pylori infection is about 50% globally [11]. The prevalence varies in relation to geographical location, ethnicity, age and socioeconomic status of the population, being higher developing countries than in the developed ones [11]. *H. pylori* prevalence is estimated to be 79.1% in Africa, and the World Health Organization estimates that 600 million school children live in areas with a high risk of parasite transmission [12, 13].

The frequency of co-infections adds to the complexity of understanding disease, as different organisms can have potentially synergistic or antagonistic interactions, impacting treatment, clinical outcomes, and susceptibility to other diseases [14, 15, 16, 17]. Previous studies have shown the rates of co-infection with Helicobacter pylori (*H. pylori*) and one or more other intestinal parasites ranging from 22.4% to 44.3% in various populations [18, 19, 20, 21, 22]. Previous studies showed that geographic area, age, gender, race, educational level, sanitation, and socioeconomic status are among the factors that influence the prevalence of *H. pylori* infection [23].

Owing to the fact that, there is rarity of information on co-infections of soil-transmitted helminths and *H. pylori* among school age children and women of reproductive age in Eleme Local Government, this study was aimed to evaluate the incidence and risk factors of coinfection.

2. MATERIALS AND METHODS

2.1 Study Area

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This was carried out in selected areas of Eleme Local Government Area, Rivers State. It has a coordinates of latitude 5^{o}04'60.00" N and longitude 6^{o}38'59.99" E.

2.2 Study Design

It was a cross-sectional study carried out among 580 participants aged between 1 and 38 & above years enrolled from April - July 2019. Participants were categorized into sex and age groups. Questionnaire were given to the participants for information of their sociodemographic factors and personal hygiene.

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A cross-sectional design was employed to analyse the prevalence of *Helicobacter pylori* and various soil-transmitted helminths and the relevant co-infection status among study participants. Various social and demographic risk factors were analysed in association with the co-infection prevalence rates among participants.
Written, informed consent was obtained from parents prior to delivering an interviewer led questionnaire to collect demographic and lifestyle information from parents of children and women of reproductive age.

2.3 Sample Collections

Participants received leak proof, plastic containers to collect ~~fecal~~faecal samples with clear instructions. All collected stool samples were screened for soil-transmitted helminths by using direct smear examination for stool samples, formol-ether sedimentation concentration technique. Two millilitres (2) mL blood sample was collected and the serum obtained and was examined serologically for *H. pylori* immunoglobulin G (IgG) antibodies.

2.4 Laboratory Analysis

2.4.1 Direct Wet Mount Microscopy

A wooden applicator was used to mix another portion of the stool sample, approximately 2 mg, with 0.85% NaCl solution to suspend the stool. The uniform suspension was placed under a 22 × 22-mm coverslip for evidence of parasitic infection. At x10 objective lens, the sample was examined for parasitic cysts, ova, and/or mobile trophozoites. At x40 objective lens, specific parasite species were identified.

2.4.2 Formol-Ether Concentration Technique

In this technique, an applicator was used to homogenize about 1 g of the stool sample in 8 mL of formol saline. The resulting emulsification was allowed to stand for 10 minutes. It was sieved using a cotton gauze in a centrifuge tube. Three (3) mL of diethyl ether was added and mixed vigorously for 1 minute. This was followed by centrifugation for 1 min at 3000 rpm. The supernatant was decanted, the remaining sediment was subjected to microscopic examination for parasitic ova and larvae.

2.4.3 *H. pylori* Status

H. pylori was detected using immune chromatographic rapid test kits (Global *H. pylori* test kit, China), which is nationally approved and used for serological diagnosis of *H. pylori* infection. The manufacturers' instruction was strictly followed for diagnosis of *H. pylori* infection to determine the presence of antibodies. Monoclonal anti-*H. pylori* antibodies were used to capture antibodies while ~~peroxidaseconjugated~~peroxidase conjugated monoclonal antibodies were used for detection. Approximately 1 to 2 drops of blood serum were added to the test well, in which a double antigen chromatographic lateral flow immunoassay was performed Following a 15-min wait period, the test was read for analysis. The presence of both control and test lines was defined as a positive result, even in the case of the control line being much darker than the test. However, if the only line present was the control, this test was considered negative.

2.5 Data Analysis

Data was analysed using SPSS Version 22. Associations between categorical variables and *H. pylori* was determined using the Chi square test. A p-value of <0.05 was considered statistically significant at 95% confidence interval.

3. RESULTS AND DISCUSSION

Results

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A total of 700 questionnaires was distributed, only 580 questionnaires were returned. Of the 580 respondents, males were 115 (19.8%) while females are 465 (80.2%).

3.1 Socio-demographic Results

A total of 700 questionnaires was distributed, only 580 questionnaires were returned. Of the 580 respondents, males were 115 (19.8%) while females are 465 (80.2%). There were 31.7% who were between 16 and 18 years of age (95), followed by 28.3% aged 1 to 5 (85), 21.7% between 6 to 10 years old (65) and 18.3% for 11 to 15 years old (55) among the children respondents. Among the women respondents, 30.4% who were between 33 and 37 years of age (85) followed by 20.7% between 23 and 27 years (58), while 18.3% between 28 and 32 years (54) and 38 & above and between 18 and 22 years had 15.3%(43) and 14.3%(40) respectively.

Children of 33.3% had a history of been dewormed in the past three months (100). There were 80 children respondents who had hand washing with soap after toilet, 65 of them had their hands washed with soap after playing/touching soil, while 35 of them wash fruits and vegetables before eating and 45 put on footwear outside the house.

Table 1: Demographic Characteristics of Respondents

Age group	No. examined	*H. pylori*	STH	AL	TT	HW	Chi-Square (χ^2) (*p*-value)
Children							0.31 (0.5777)
Sex							
Male	115	18(51.4)	21(56.8)	6(54.5)	11(61.1)	3(42.9)	
Female	185	17(48.6)	16(43.2)	5(45.5)	7(38.9)	4(57.1)	
Total	**300**	**35(11.7)**	**37(12.3)**	**11(3.6)**	**18(6.0)**	**8(2.7)**	
Children							
1 – 5yrs	85(28.3)	12(34.3)	11(29.7)	3(27.2)	5(27.8)	2(25.0)	
6 – 10yrs	65(21.7)	8(22.9)	7(19.0)	2(18.2)	3(16.7)	3(37.5)	
11-15 yrs	55(18.3)	6(17.1)	11(29.7)	4(36.4)	6(33.3)	1(12.5)	
16-18 yrs	95(31.7)	9(25.7)	8(21.6)	2(18.2)	4(22.2)	2(25.0)	
Total	**300(100)**	**35(11.7)**	**37(12.3)**	**11(3.6)**	**18(6.0)**	**8(2.7)**	

WRA						
18 – 22	40(14.3)	15(20.0)	8(22.9)	2(20.0%)	1(12.5%)	5(29.4%)
23 – 27	58(20.7)	20(26.7)	9(25.7)	2(20.0%)	3(37.5%)	4(23.5%)
28 – 32	54(18.3)	8(10.6)	7(20.0)	2(20.0%)	2(25.0%)	3(17.6%)
33 – 37	85(30.4)	20(26.7)	8(22.9)	3(30.0%)	2(25.0%)	3(17.6%)
38 & above	43(15.3)	12(16.0)	3(8.5)	1(10.0%)	0(00.0%)	2(11.8%)
Total	**280**	**75(26.8)**	**35(12.5)**	**10(3.6)**	**8(2.8)**	**17(6.1)**

Legends: STH: Soil-transmitted helminths; WRA: Women of Reproductive Age; Children; AL: *Ascaris lumbricoides*; TT: *Trichuris trichiura*; HW: Hookworm; *p*>0.05

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3.2 Distribution of *H. pylori* and Soil-Transmitted Helminth Infections

Overall, 12.3% (37/300) of the children were infected with at least one soil-transmitted helminths while the women of reproductive age had 12.5% (35/280).

Trichuris trichiura was the most prevalent soil-transmitted helminths (6.0%) followed by *Ascaris lumbricoides* (3.6%) among the children while hookworm was most prevalent (6.1%) followed *Ascaris lumbricoides* (3.6%) among the Women of Reproductive Age. *H. pylori* was detected in 11.7% of children (35/300) while WRA had 26.8%(75/280) (Table 1).

Among the male respondents, 20(55.6%) had soil-transmitted helminths while 18(51.4%) were infected with *H. pylori*. Of the 20 male respondents affected with soil-transmitted helminths, *Trichuris Trichiura* 11(61.1%) was most prevalent, followed by *Ascaris lumbricoides* 6(54.5%) and hookworm 3(42.9%). Similarly, female respondents with soil-transmitted helminths were 16(44.4%) and those with *H. pylori* were 17(48.6%). The most prevalent was also *T. Trichiura* 7(38.9%) followed by *A. lumbricoides* 5(45.5%) and hookworm 4(57.1%).

Children of age group 1-5years, had a total of 85 respondents of which 10(27.8%) were soil-transmitted helminths while *H. pylori* had 12(34.3%). Among the soil-transmitted helminths identified, *Trichuris Trichiura* 5(27.7%) was most prevalent and the least was *A. lumbricoides*.

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Similarly, women of reproductive age group between 23 and 27 years had most prevalent of soil-transmitted helminths (25.7%), followed by age group between 18 and 22 years and 33 and 37 years (22.9%) each while age group between 28 and 32 years and 38 years & above had 20.0% and 8.5% respectively. However, findings were considered statistically insignificant (*p*=0.5777).

H. pylori infections of the WRA was most prevalent among age group between 23 & 27 and 33 & 37 years (20.7%) and the least was between age group 28 and 32 years (10.6%) (Table 1).

3.3 Co-infection Prevalence.

Of the 300 School age children with complete data for both soil-transmitted helminths and *H. pylori*, 9.3% (28/300) were co-infected with soil-transmitted helminths and *H. pylori*, while 5.7% (16/280) of the women of reproductive age were co-infected with soil-transmitted helminths and *H. pylori* (Table 2).

Table 2: Co-infection of Soil-Transmitted Helminths and *H. pylori.*

Soil-Transmitted Helminths	No. Positive Children (%)	No. Positive WRA (%)
A. lumbricoides + *H. pylori*	15(53.5)	3(18.7)
Hookworm + *H. pylori*	8(28.6)	8(50.0)
T. trichiura + *H. pylori*	5(17.9)	5(31.3)
Total	**28(9.3)**	**16(5.7)**

3.4 Risk factors for Soil-transmitted helminths and *H. pylori* Co-infection among Children and WRA.

This study as assessed the association of potential risk factors with the prevalence of soil-transmitted helminths and *H. pylori* among children and women of reproductive age. Using Chi-Square statistic, it revealed that children age and gender is not significantly associated with prevalence of infection (soil-transmitted helminths and *H. pylori*). However, risk factors such as washing hands with soap after playing/touching soil and deworming in the last three months have significant association with prevalence of infection (soil-transmitted helminths and *H. pylori*). Other risk factors are not significantly associated with prevalence of infection (soil-transmitted helminths and *H. pylori*) (Table 3).

Table 3: Risk Factors of Children Prevalence.

	Number Examined	***H. pylori***	**STH**	**Chi-Square (χ^2)**	**p-value**
Wash hands with soap after toilet					
Yes	80 (100)	10 (12.5)	9 (11.3)	0.33	0.5657
No	220 (100)	25 (11.4)	28 (12.7)		
Wash hands with soap after playing/touching soil					
Yes	65 (100)	18 (27.7)	8 (12.3)	6.77	0.0093*
No	235 (100)	17 (7.2)	29 (12.3)		
Wash fruits and vegetables before eating					
Yes	35 (100)	9 (25.7)	10 (28.6)	0.06	0.8065
No	265 (100)	26 (9.8)	27 (10.2)		
Deworm in the last three months					
Yes	100 (100)	17 (17.0)	6 (6.0)	7.85	0.0051*
No	200 (100)	18 (9.0)	31 (15.5)		
Wears footwear outside the house					
Yes	45 (100)	20 (44.4)	19 (42.2)	0.24	0.6242
No	255 (100)	15 (5.9)	18 (7.1)		

Legends: *H. pylori: Helicobacter pylori***;** STH: Soil-transmitted helminths; *: p<0.05

Similarly, the Chi-Square statistic for women of reproductive age revealed that age is not significantly associated with prevalence of infection (soil-transmitted helminths and *H. pylori*). More so, the risk factors are not significantly associated with prevalence of infection (soil-transmitted helminths and *H. pylori*).

Consequently, the children and women of reproductive age were not significantly associated with prevalence of soil-transmitted helminths and *H. pylori* infection (Table 4).

Table 4: Risk Factors of Women of Reproductive Age (WRA) Prevalence.

	Number examined	***H. Pylori***	**STH**	**Chi-Square (χ^2)**	**p-value**
Wash hands with soap after toilet					
Yes	91 (100)	20 (22.0)	5 (5.5)	1.98	0.1594
No	189 (100)	55 (29.1)	30 (15.9)		
Wash hands with soap after playing/touching soil					
Yes	74 (100)	30 (40.5)	8 (10.8)	2.96	0.0853
No	206 (100)	45 (21.8)	27 (13.1)		

Wash fruits and vegetables before eating					
Yes	45 (100)	22 (48.9)	10 (22.2)	0.01	0.9203
No	235 (100)	53 (22.6)	25 (10.6)		
Deworm in the last three months					
Yes	70 (100)	37 (52.9)	16 (22.9)	0.11	0.7401
No	210 (100)	38 (18.1)	19 (9.0)		
Wears footwear outside the house					
Yes	40 (100)	40 (100)	18 (45.0)	0.05	0.8231
No	240 (100)	35 (14.6)	17 (7.1)		

Legends: *H. pylori: Helicobacter pylori***;** STH: Soil-transmitted helminths

Discussion

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Children are of high risk for soil-transmitted helminths morbidity including preschool children (1-4 years), school-age children (5-14 years) [8]**.** Women of reproductive age are a large and diverse group of individuals who are at different stages in their reproductive life. Each stage presents different challenges for patient care programmes in terms of delivery strategies [24]. It is observed from the result that, the overall occurrence rate of soil-transmitted helminths among the children and the women of reproductive age (WRA) were relatively low (12.3% and 12.5%). This rate was found to be lower than the rate reported in Nepal by 18.3% [25].

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Simultaneous human colonization by soil-transmitted parasites and *H. pylori* are a common phenomenon. Moreover, the two groups of pathogens share the similar predisposing factors [16]. The prevalence of *H. pylori* however in this study is moderately low among the school age children (11.7%) and the women of reproductive age (26.8%).

In previous study in Turkey, lower occurrence rate of 7.61% was reported by Ugras and Miman [26]. The findings were not statistically significant (p>0.05). In our opinion, it means that soil-transmitted helminths and *H. pylori* has no significant association in infection rate.

Ascaris lumbricoides, Trichuris trichiura and hookworm were reported as the most prevalent soil-transmitted helminths identified in this study. This finding is in agreement with study by Ford et al. [25] in Nepal and Rahman et al. [27] in Bangladesh.

T. Trichiura was found to be more prevalent among school age children, on the contrary, women of reproductive age had *A. lumbricoides* as most prevalent soil-transmitted helminths.

Other studies have reported on associations with various species of protozoa and soil-transmitted helminths [28, 16, 29, 30]. Prevalence of endemic variations have been in several studies that show different prevalence rates of species identified in different geographical locations may contribute to discrepancies in the clinical outcome of gastric cancer, possibly due to the ways in whichspecific species of microorganisms interact [30]. The distribution of soil-transmitted helminths and *H. pylori* among the gender had 56.8% prevalence of soil-transmitted helminths and 51.4% prevalence of *H. pylori* among school age children. Studies in Nigeria, Palestine, Egypt, and Iran have found no differences between males and females regarding *H. pylori* infection [31, 32, 33, 34].

On the age group prevalence among the children, 1-5yrs and 11-15yrs had 29.7% each for soil-transmitted helminths while *H. pylori* had 1-5yrs and 16-18yrs of 34.3% and 25.7% prevalence. Among the women of reproductive age, age prevalence of soil-transmitted helminthswas recorded among 23-27yrs with 25.7%, 23-27yrs and 33-37yrs had 26.7% prevalence each for *H. pylori.* On the contrary, Fadul et al. [35] reported high prevalence rate of 50% among age group >66 years old.

Among the school age children, *Ascaris lumbricoides* + *H. pylori* co-infection were the most prevalent with 53.5%, on the contrary, hookworm + *H. pylori* co-infection recorded 50.0% prevalent among the women of reproductive age. Seid et al. [20] and Ankarklev et al. [19]; reported co-infection of *Giardia* spp with *H. pylori* in children with 22.3%.

Other studies have reported on associations with various species of protozoa and soil-transmitted helminths [28, 16, 29, 30].

In this study, the washing of hands with soap after playing/touching soil among other risk factors was found to be statistically significant (p<0.05). nevertheless, other studies in Ethiopia had sources of drinking water and maternal education to be significantly associated with the prevalence of co-infection of intestinal parasites and *H. pylori* [20, 36].

Limitations of this study is the unavailability of the advance laboratory techniques for diagnosis to show real correlation of soil-transmitted helminths and *H. pylori.*

4. CONCLUSION

Ascariasis is more in occurrence among *H. pylori* participants in the children category compared to the women of reproductive age group. Infection rate was not affected by gender. The highest infection rate was reported in the 1-15 and 46-60 age group among *H. pylori* patient and 31-45 years age group among the control patients.

REFERENCES

1. Barreto SM, Miranda JJ, Figueroa JP, Schmidt MI, Munoz S, Kuri-Morales PP, et al. Epidemiology in Latin America and the Caribbean: current situation and challenges. Int J Epidemiol. 2012;41(2):557-71. https://doi.org/10.1093/ije/dys017 PMID: 22407860.
2. Speich B, Croll D, Fu¨rst T, Utzinger J, Keiser J. Effect of sanitation and water treatment on intestinal protozoa infection: a systematic review and meta-analysis. Lancet Infect Dis. 2016;16(1):87-99. https:// doi.org/10.1016/S1473-3099(15)00349-7 PMID: 26404667.
3. Berkman DS, Lescano AG, Gilman RH, Lopez SL, Black MM. Effects of stunting, diarrhoeal disease, and parasitic infection during infancy on cognition in late childhood: a follow-up study. Lancet. 2002;359(9306):564-71. https://doi.org/10.1016/S0140-6736(02)07744-9 PMID: 11867110.
4. PAHO. Pan American Health Organization. Epidemiological profiles of neglected diseases and other infections related to poverty in Latin America and the Caribbean. 2009. Available from: https://www. paho.org/per/index.php?option=com_docman&view=download&alias=274-epidemiological-profilesneglected-diseases-other-infections-related-to-poverty-in-latin-america-caribbean-4&category_slug=enfermedades-desantendidas-001&Itemid=1031.
5. Joseph SA, Mupfasoni D, Montresor A. Evaluation of the large-scale administration of drugs for the control of soil-transmitted helminthiasis: review of the evidence of morbidity. PLoS Negl Trop Dis. 2017 (in press).
6. Murray CJ, Vos T, Lozano R, Naghavi M, Flaxman AD, Michaud C, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2012;380(9859):2197-223. https://doi.org/10.1016/S01406736(12)61689-4 PMID: 23245608.
7. Pullan RL, Smith JL, Jasrasaria R, Brooker SJ. Global numbers of infection and disease burden of soil transmitted helminth infections in 2010. Parasit Vectors. 2014;7(37). https://doi.org/10.1186/1756-33057-37 PMID: 24447578.
8. WHO. Soil-transmitted helminthiases: eliminating soil-transmitted helminthises as a public health problem in children: progress report 2001-2010 and strategic plan 2011-2020. Geneva, Switzerland: World Health Organization, 2012. WHO/HTM/NTD/PCT/2012.4.
9. Sethi A, Chaudhuri M, Kelly L, Hopman W. Prevalence of *Helicobacter pylori* in a first nations population in Northwestern Ontario. Can Fam Physician. 2013;59(4):e182-e7.
10. Blecker U. *Helicobacter pylori*-associated gastroduodenal disease in childhood. South Med J. 1997;90:570-76. [DOI: 10.1177/000992289603500401].
11. Hunt RH, Xiao SD, Megraud F, Leon-Barua R, Bazzoli F, van der Merwe S. et al. *Helicobacter pylori* in developing countries. World Gastroenterology Organization Global Guideline. J Gastrointestin Liver Dis. 2011;20(3):299-304. [DOI: 10.1097/MCG.0b013e31820fb8f6].
12. Sitotaw B, Mekuriaw H, Damtie D. Prevalence of intestinal parasitic infections and associated risk factors among Jawi primary school children, Jawi town, North-West Ethiopia. BMC Infect Dis. 2019;19:341.

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13. Melese A., Genet C, Zeleke B, Andualem T. *Helicobacter pylori* infections in Ethiopia; prevalence and associated factors: a systematic review and metaanalysis. BMC Gastroenterol. 2019;19:8.
14. Chard AN, Baker KK, Tsai K, Levy K, Sistrunk JR, Chang HH, et al. Associations between soil-transmitted helminthiasis and viral, bacterial, and protozoal enteroinfections: a cross-sectional study in rural Laos. Parasit Vectors. 2019;2:216.
15. Mcardle AJ, Turkova A, Cunnington AJ, 2018. When do co-infections matter? Curr Opin Infect Dis. 2018;31(3):209-15.
16. Krzyzek P, Gosciniak G. Frequency and immunological consequences of *Helicobacter pylori* and intestinal parasite co-infections: a brief review. Ann Parasitol. 2017;63(4):255-63.
17. Queiroz DM, Rocha AM, Crabtree JE. Unintended consequences of *Helicobacter pylori* infection in children in developing countries: iron deficiency, diarrhea, and growth retardation. Gut Microbes. 2013;4(6):494-504.
18. Zeyrek D, Zeyrek F, Cakmak A, Cekin A. Association of *Helicobacter pylori* and giardiasis in children with recurrent abdominal pain. Turkiye Parazitol Derg. 2008;32(1):4-7.
19. Ankarklev J, Hestvik E, Lebbad M, Lindh J, Kaddu-Mulindwa DH, Andersson JO, Tylleskar T, Tumwine JK, Svard SG. Common coinfections of *Giardia intestinalis* and *Helicobacter pylori* in non-symptomatic Ugandan children. PLoS Negl Trop Dis. 2012;6(8):e1780.
20. Seid A, Tamir Z, Kasanew B, Senbetay M. Co-infection of intestinal parasites and *Helicobacter pylori* among upper gastrointestinal symptomatic adult patients attending Mekanesalem hospital, northeast Ethiopia. BMC Res Notes. 2018;11:144.
21. Sabet EA, El-Hadi H, Mohamed DS, Sheneef A, Fattouh M, Esmat MM. Gastritis; *Helicobacter pylori* or *Giardia lamblia* infection or both. Egypt J Med Microbiol. 2009;18(4):165-78.
22. Ibrahim A, Ali YB, Abdel-Aziz A, El-Badry AA. 2019. *Helicobacter pylori* and enteric parasites co-infection among diarrheic and non-diarrheic Egyptian children: seasonality, estimated risks, and predictive factors. J Parasit Dis. 2019;43(2):198-208.
23. Brown LM. *Helicobacter pylori*: epidemiology and routes of transmission. Epidemiol Rev. 2000;22(2):283-97.
24. Mofid LS, Gyorkos TW. The Case for Maternal Postpartum Deworming. PLoS Negl Trop Dis. 2017;11(1):e0005203. https://doi.org/10.1371/journal.pntd.0005203 PMID: 28056019.
25. Ford ND, Bichha RP, Parajuli KR, Paudyal N, Joshi N, Whitehead RD, Jr, et al. Factors associated with anemia in a nationally representative sample of nonpregnant women of reproductive age in Nepal. Matern Child Nutr. 2020;e12953. https://doi.org/10.1111/mcn.12953.
26. Ugras M, Miman O. The prevalence of intestinal parasites in children with *Helicobacter pylori* gastritis evaluated retrospectively. Turkish J Parasitol. 2014;37(4):245-48. doi: 10.5152/tpd.2013.3191.
27. Rahman AS, Sarker SA, Ahmed T, Islam R, Wahed MA, Sack DA. Relationship of intestinal parasites, *H. pylori* infection with anemia or iron status among school age children in rural Bangladesh. Gastroenterol Hepatol Res. 2013;2(9).
28. Yakoob J, Abbas Z, Khan R, Tariq K, Awan S, Beg MA. 2018. Association of *Helicobacter pylori* and protozoal parasites in patients with chronic diarrhea. British J Biomed Sci. 2018;75(3):1-5.
29. Fuenmayor-Boscán AD, Hernández IM, Valero KJ, Paz AM, Sanrea LB, Rivero Z. 2016. Association between *Helicobacter pylori* and intestinal parasites in an Añu indigenous community of Venezuela. Indian J Gastroenterol. 2016;35(2):106-12.
30. Ek C, Whary MT, Ihrig M, Bravo LE, Correa P, Fox JG. Serologic evidence that ascaris and toxoplasma infections impact inflammatory responses to *Helicobacter pylori* in Colombians. Helicobacter. 2012;17(2):107-15.
31. Obiageli ER, Ivan EC. Prevalence of *Helicobacter pylori* and its associated peptic ulcer infection among adult residents of Aba, Southeastern, Nigeria. Int J Curr Microbiol Appl Sci. 2016;5(6):16-21.
32. Mezeid N, Shaldoum F, Al-Hindi A, Mohamed FSA, Darwish ZE. Prevalence of intestinal parasites among the population of the Gaza Strip, Palestine. Ann Parasitol. 2014;60(4):281-89.

33. Hamed ME, Hussein HM, El Sadany HF, Elgobashy AA, Atta AH. Seroprevalence of *Helicobacter pylori* infection among family members of infected and non-infected symptomatic children. J Egypt Soc Parasitol. 2013;43(3):755-66.
34. Shokrzadeh L, Baghaei K, Yamaoka Y, Shiota S, Mirsattari D, Porhoseingholi A, Zali, MR. (2012). Prevalence of *Helicobacter pylori* infection in dyspeptic patients in Iran. Gastroenterol Insights. 2012;4(1):24-27.
35. Fadul N, Ahmed M, Elamin T, Elfaki M, Elsayid M. (2016). Prevalence rate of *Giardia lamblia/Helicobacter pylori* co-Infections in Khartoum State, Sudan. Int J Sci Res. 2016;5(3):181-90.
36. Spotts H, Walelignb S, Tesfaye M, Desta K, Tsegaye A, Taye B. Concurrent infection of intestinal parasites and *Helicobacter pylori* among school-age children in Central Ethiopia. Parasite Epidemiol Control. 2020;11:e00177.