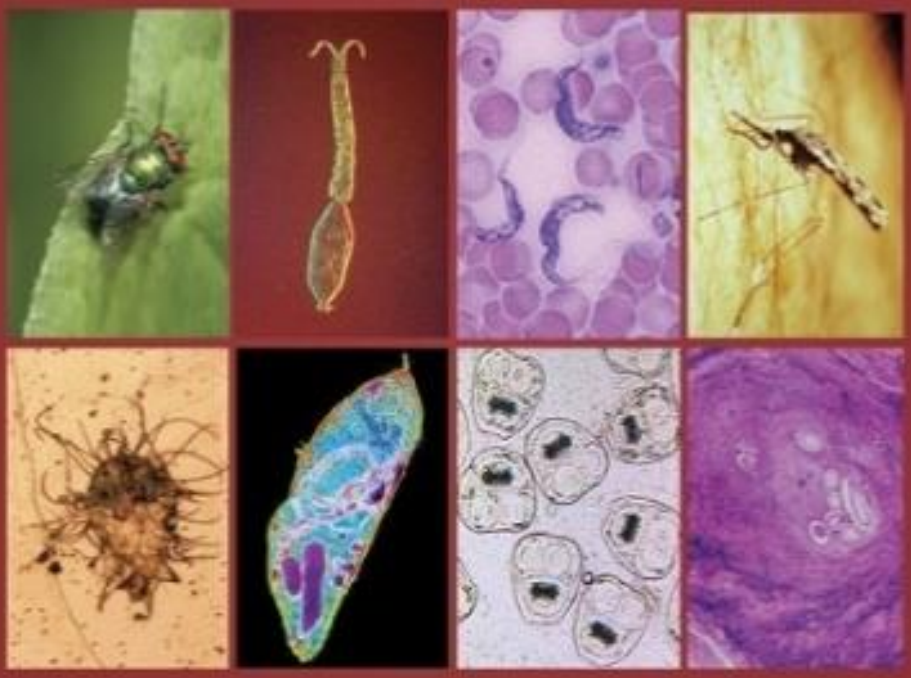
EGYPTIAN ACADEMIC JOURNAL OF

BIOLOGICAL SCIENCES

E

MEDICAL ENTOMOLOGY & PARASITOLOGY



ISSN
2090-0783

WWW.EAJBS.EG.NET

Vol. 14 No. 2 (2022)

Citation: *Egypt. Acad. J. Biolog. Sci. (E-Medical Entom. & Parasitology Vol.14(2) pp **181-188**(2022)*
DOI: 10.21608/EAJBSE.2022.274615

Egypt. Acad. J. Biology. S2ci., 14 (2):181–188 (2022)

Egyptian Academic Journal of Biological Sciences
E. Medical Entomology & Parasitology

ISSN: 2090–0783
www.eajbse.journals.ekb.eg

Helicobacter pylori Infection and Intestinal Parasites; A Brief Review

Asmaa R. Abd-Alghany, Reham Refaat Mostafa and Gehad A. Bassiouni
Department of Medical Parasitology, Faculty of Medicine, Cairo University, Cairo, Egypt
E-mail : asmaa.ramadan@kasralainy.edu.eg

REVIEW INFO
Review History
Received:21/9/2022
Accepted:1/12/2022
Available:5/12/2022

Keywords:
Helicobacter *pylori*-intestinal parasites-risk.

ABSTRACT

Human infection by *Helicobacter pylori* (*H.pylori*) and intestinal parasites simultaneously is a common health problem, especially in developing countries. *H.pylori* infection often leads to the development of different gastrointestinal complaints. Both groups of pathogens have the same predisposing factors and play an important role in gastrointestinal pathology in individuals having these co-infections, furthermore, it can affect the host's immune response. However, data on the magnitude and risk factors of these co-infections are limited. Here we tried to spot the light on this important relationship.

INTRODUCTION

Helicobacter pylori is a type of gram-negative bacterium found in the stomach's mucus layer of humans leading to chronic gastric inflammation (Alfarouk *et al.*, 2019). It affects 70–90% of the population in developing countries (Gillespie & Hawkey, 2006). In Africa, this bacterium infects 80% of the population as the infection is acquired during childhood (Smith *et al*., 2019). Also in Egypt, the seropositivity of anti-*Helicobacter* IgG was found to be 79.8% when compared with the controls (Hanafi *et al*.,2017).

The infection by *H.pylori* commonly occurs by three different routes: oral-oral infection, gastro-oral infection and feco-oral infection. Also, the infection can occur through contaminated water and food or infected animals. (Eusebi *et al.*, 2014; Khalifa *et al.*, 2010). Low socioeconomic status, overcrowding and contaminated water supplies are important risk factors for this infection (Crowe, 2019 and Mezmale *et al.*, 2020). It is a well-known cause of peptic ulcers and it is an important risk factor for gastric carcinoma (Lesbros-Pantoflickova *et al.*, 2007). This type of cancer is considered the sixth most common cancer worldwide and the third most common cause of cancer death (Lee *et al*., 2022).

Colonization of *H. pylori* in the stomach modulates the host immune system stimulating the release of inflammatory cytokines with neutrophils, lymphocytes, plasma cells and macrophage infiltration and contributing to the development of malignant complications of infection (Chan *et al.,* 2004). Oster *et al.,* (2022) found a negative impact of this immunomodulation leading to the consideration that this infection can decrease the results of cancer immunotherapies.

H. pylori also leads to many extra-gastroduodenal manifestations such as idiopathic thrombocytopenic purpura, iron-deficiency anaemia, chronic liver and cardiovascular diseases (Pellicano *et al*., 2008& de Korwin *et al.,* 2017). Mohammad *et al*., (2008) reported that *H. pylori* infection was extremely high among Egyptian school children.

As regards Parasitic infections, they are more or less neglected to constitute a global health problem (Taghipour *et al.*, 2021), especially among children (Harhay *et al.,* 2010). The World Health Organization estimated that in areas with high parasite transmission, about 600 million children are at risk (Sitotaw *et al.*, 2019; Melese *et al.,* 2019). The prevalence of infections is increased by geographic, ecology, socioeconomic factors, poor water supplies, decreased general sanitation and low income (Amer *et al.*, 2018). Contamination of food and water is a common source of infection by different intestinal parasites (Moses *et al.*, 2013).

Co-infection with many types of parasites affecting the gastrointestinal tract is usually seen in developing countries. This co-infection leads to damage in the intestinal mucosa of the affected patient resulting in malnutrition and also the affection of the immune system may take place. (Harhay *et al.,* 2010). In spite of the increased improvement in sanitation and hygiene in Egypt, intestinal parasites are still a significant Challenge (Monib *et al.*, 2016).

Co-infection of *Heliobacter pylori* with intestinal parasites is common as they share the same modes of infection and the same environmental conditions (Abd El Hameed *et al.,* 2021). Common risk factors include contaminated water supplies, defecation in the soil and low personal hygiene (Awuku *et al.,* 2017; Hernández *et al.,* 2019; Sitotaw *et al.,* 2019). Parasitic infection and *H. pylori* should be considered with low hygiene style and impaired immunity in diabetic children *(*Rady *et al.,* 2019).

The urease production by *H. pylori* facilitates the crossing of the stomach by these intestinal parasites (David *et al.*, 2006). The increased production of pro-inflammatory cytokines such as *IL-2* and *IFN-γ* caused by *H. pylori* leads to changes in the gastric environment, and diminished acid production (Padol and Hunt, 2004). As a result of this diminished acid production, infection of the stomach by other organisms becomes much easier (Hosni *et al.,* 2012; Windle *et al.,* 2007). This reduction in gastric acid secretion occurs when *H. pylori* are present in the corpus region of the stomach. However, it was found that when these bacteria are present in the antrum region of the stomach, the production of gastric acid is increased. (Konturek *et al.,* 2006).Abd Elbagi *et al*., (2019) concluded that gastrointestinal parasites are more common in *H. pylori*-infected patients compared to non-infected ones. Different consequences can occur as a result of this co-infection such as malnutrition and dehydration (Awuku *et al.,* 2017; Smith *et al.,* 2018; Melese *et al.,* 2019; Sabet *et al.,* 2009; Sitotaw *et al.,* 2019; Hernández *et al.,* 2019; Queiroz *et al.,* 2013).

H. pylori and Protozoal Intestinal Infections:

Protozoa are microorganisms that are formed of a single rapidly growing cell, they may live intracellular or extracellular in the host resulting in many adverse effects such as fatigue, malnutrition, abdominal pain, or even ulcerations in the digestive tract (Abdullah *et al.,* 2016). Both *H. pylori* infection and protozoa infection leads to the recruitment of Th1 cells. This exacerbates the damage to the gastric mucosa (Haque, 2007; Maizels & Yazdanbakhsh, 2003).

In children in Africa, it was found that infected patients with *G. lamblia* had three times increased risk of infection with *H. pylori* (Ankarklev *et al.,* 2012). Kibru *et al.,* (2014) in Ethiopia found that there was a significant association between intestinal parasites and *H. pylori* infection. Schmid *et al.,* (2021) in Switzerland found that *G. lamblia* and H. *pylori* were important common causes of gastrointestinal disorders. Also, Yakoob *et al*., (2018) found a strong correlation between H. *pylori* and common protozoal infections (*E. histolytica* and *Blastocystis* sp infections) in affected people suffering from chronic diarrhoea. Ahmed *et al*., (2018) found a significant

correlation between them in patients with gastrointestinal complaints (P≤0.005). *Entamoeba histolytica/dispar* (55.5%) was the commonest parasite detected in positive cases with *H. pylori.*

H. pylori and *G. lamblia* were found among organic causes of recurrent abdominal pain, with different prevalences mainly in developing countries (Eldash *et al.*, 2013). Consequently, the early diagnosis helped patients to escape chronic gastritis complications (Sigthorsson *et al.*, 2001), and progression into painful stomach ulcers due to the excessive release of gastrin hormone (Gulcelik *et al.*, 2005). Zeyrek *et al.*, (2008) found that 22.4% of patients with recurrent abdominal pain were infected with both Giardia and *H. pylori.* In several studies, it was found that *H. pylori* infection increased the co-infection by *Giardia lamblia by* three times, and in another study, *Giardia lamblia* infection represented *22.3*% of co-infecting parasites found among *H. pylori*-infected patients (Ankarklev *et al.*, 2012; Seid *et al.*, 2018).

In our country, Egypt, Abou Holw *et al., (*2009) studied the effect of such an association on fifty *giardiasis* patients. Results showed significant upper gastrointestinal symptoms (epigastric pain and anorexia) in patients co-infected with *H. pylori.* Also, endoscopic and histopathologic examinations showed significant gastric lesions in this category of patients when compared to those infected with *G. lamblia* only. In a study done in Tanta, the co-infection between *H. pylori* and *E. histolytica* or *G. lamblia* was high affecting nearly half of the patients included in the study (Sabah *et al.*, 2015). El-Badry *et al.*, (*2017*) found that among 63 cases of *giardiasis* by both microscopy and PCR, 52.5% were co-infected with *H. pylori.* Co-infection was more frequent with assemblage B (50.9%) than assemblage A (40%) and concluded that this co-infection is common in school-age children. Ghallab and Morsy, (2020) showed a significant association between *H. pylori* and protozoan-causing diarrhea. These protozoan parasites were with *G.lamblia, E. histolytica/dispar, Cryptosporidium parvum and Blastocystis hominis.* (Nasr *et al.*, 2022) found that the prevalence of H. pylori co-infection with parasites was 2%.

H. pylori and Helminthic Intestinal Infections:

Unlike protozoa that stimulate Th1 recruitment, helminthic infections lead to Th2 polarization. A study held on mucosal samples from the stomach showed reduced expression of pro-inflammatory cytokines and predominant Th2 response (higher level *IL-4*) among patients with this co-infection (Fuenmayor-Boscán *et al.*, 2020). So, the infection of a human with H. pylori and helminths may protect against inflammations within the gastrointestinal tract and is linked with the enhancement of the regenerative processes (Haque, 2007; Maizels & Yazdanbakhsh, 2003). Concurrent helminthic infections in animal models showed to decrease the severity of gastritis induced by *H. pylori* (Fox *et al.*, 2000). *H. pylori* infection was considered a cause of gastric carcinoma in humans but on the contrary, large human populations living in Africa infected with *H. pylori* have low gastric cancer rates. This was called the "African enigma" (Bravo *et al.*, 2002). In spite of the high prevalence of *H. pylori* and helminthic infections in humans living in Venezuela and India, a low risk of gastric cancer was found (Fuenmayor-Boscán *et al.*, 2020; Hussain *et al*., 2020). In one study in China, there was a decreased prevalence of *H. pylori*-induced atrophy due to concurrent helminthic infections (Du *et al.*, 2006). Another study reported that populations from the low-risk place of gastric carcinoma were infected with helminths (Whary *et al.*, 2005). So, there are differences in the prevalence of gastric cancer in spite of the high prevalence of *H. pylori* infection in some countries due to many reasons such as genetics, diet and helminthic infections (Kumar *et al*., 2021)

Treatment *of Helicobacter pylori* Infection and Intestinal Parasites:

Treatment for H. pylori infection depends on either a triple or quadruple treatment according to the patient location and socioeconomic status. Triple therapy is the common treatment for H. pylori infections which consists of amoxicillin, clarithromycin, and a proton pump inhibitor (PPI) and this regimen is given to the patient for 14 days. Recent guidelines support also 14 days of quadruple treatment, which contains three antibiotics and a proton pump inhibitor (Chey *et al*., 2017; Fallone *et al*., 2016 and Malfertheiner *et al*., 2017).

Benzimidazoles such as albendazole and mebendazole are the first line for the treatment of nematodes and tapeworm infections. Ivermectin is effective against adult and migrating larval stages of nematodes. Praziquantel is considered the drug of choice for most food-borne trematodes (Al-Wasidi *et al*., 2021). Metronidazole is the standard treatment for protozoal infections such as Entamoeba histolytica, Giardia lamblia, blastocysts, and Balantidium coli. The drug nitazoxanide is used for the treatment of cryptosporidiosis.Cyclosporiasis and iso sporiasis are treated with trimethoprim-sulfamethoxazole (Petri, 2003).

Conclusion:

Co-infection with many intestinal parasites is usually seen in developing countries including Egypt, and human infection by these parasites and *H. pylori* and is also a common phenomenon. Predisposing factors for this co-infection include low socioeconomic and contamination of water supplies. Co-infection of *H.pylori* and protozoa lead to the recruitment of Th1 cells leading to exacerbating the damage to the mucosa of the stomach. On the other hand, during co-infection of H.*pylori* and helminth infection, recruitment of Th2 cells occurs to protect against inflammations within the gastrointestinal tract. So, we should work on improving environmental sanitation, educating people and providing safe water supplies in order to control *H. pylori* and parasites.

REFERENCES

Abd El Hameed, YF., Boghdadi, AM., Ghobrial, CM., Hassan, MA. (2021). Association of Helicobacter pylori and parasitic infections in childhood: Impact on clinical manifestations and implications. *Journal of Parasitic Diseases*, 45, 3:790-6

Abd Elbagi, Y. Y., Abd Alla, A. B., & Saad, M. B. E. (2019). The relationship between Helicobacter pylori infection and intestinal parasites in individuals from Khartoum state, Sudan: a case-control study. *F1000Research*, 8.

Abdullah I., Tak H., Ahmad F., Gul N., Nabi S., Sofi T.A. (2016). Predominance of gastrointestinal proto zoan parasites in children: A brief review. *Journal of Health Education Research and Development*, 4: 194.

Abou Holw, S. A., Anwar, M. M., Heshmat, M. G., Enany, A. Y., & Rashad, M. M. (2009). Effect of concommitant Helicobacter pylori infection in patients with Giardiasis lamblia in Egypt. *Journal of the Egyptian Society of Parasitology*, *39*(2), 439-446.

Ahmed, A. K., Kamal, A. M., Mowafy, N. M., Hassan, E. E., Osman, H. A., & Aly, S. S. (2018). Association between entamoeba histolytica/ dispar and helicobacter pylori infections in patients with gastrointestinal complaints. *Journal of the Egyptian Society of Parasitology*, *48*(1), 31-34.

Alfarouk, K. O., Adil, H. H. B., Ahmed, N. A., AbdelRahman, M. R., Abdel, K. M., Sari, T. S. A., ... & Salvador, H. (2019). Helicobacter pylori the possible role of in gastric cancer and its management. *Frontiers in oncology*, 9, 75.

Al-Wasidi, A. S., Refat, M. S., Naglah, A. M., & Elhenawy, A. A. (2021). Different potential biological

activities of benzimidazole derivatives. *Egyptian Journal of Chemistry*, 64(5), 2631-2646.

Amer, OSO., Al-Malki, ES., Waly, MI., Al-Ageel, A., Lubbad, MY. (2018). Prevalence of intestinal parasitic infections among patients of King Fahd Medical City in Riyadh region, Saudi Arabia: a 5-year retrospective study. *Journal of parasitology research*, 80:762-74.

Ankarklev J., Hestvik E., Lebbad M., Lindh J., Kaddu-Mulindwa D.H., Andersson J.O., Tylleskar T., Tumwine J.K., Svard S.G. (2012). Common coinfections of *Giardia intestinalis* and *Helicobacter pylori* in non-symptomatic Ugandan children. *PLOS Neglected Tropical Diseases,* 6: e1780.

Awuku, Y.A., Simpong, D.L., Alhassan, I.K., Tuoyire, D.A., Afaa, T., Adu, P. (2017). Prevalence of helicobacter pylori infection among children living in a rural setting in sub- Saharan Africa. *BMC Public Health*,17, 360.

Bravo, L.E., van Doom, L.J., Realpe, J.L. (2002). Virulence-associated genotypes of Helicobacter pylori Do they explain the African enigma? *The American journal of gastroenterology*, *97*, 2839–2842.

Chan,W.Y., Hui, P.K., Leung, K.M., Chow, J.A. and Kwok, F.L. (1994). Coccoidal forms of Helicobacter pylori in the human stomach. *American journal of clinical pathology*, 102 (4): 503- 507.

Chey, W. D., Leontiadis, G. I., Howden, C. W., & Moss, S. F. (2017). ACG clinical guideline: treatment of Helicobacter pylori infection. *Official journal of the American College of Gastroenterology| ACG*, 112(2), 212-239.

Crowe, SE. (2019). Helicobacter pylori infection. *New England Journal of Medicine*, 380(12):1158-1165.

David, TJ., William, AP., Markell, EK., Vege, S. (2006). *Medical Parasitology*, 9. New York: Saunders Elsevier.

Du, Y.; Agnew, A.; Ye, X.-P.; Robinson, P.A.; Forman, D.; Crabtree, J.E. (2006). Helicobacter pylori and Schistosoma japonicum co-infection in a Chinese population Helminth infection alters humoral responses to H. pylori and serum pepsinogen I/II ratio. *Microbes and infection, 8*, 52–60.

El-Badry, A. A., Ghieth, M. A., Ahmed, D. A., & Ismail, M. A. (2017). Giardia intestinalis and helicobacter pylori co-infection: estimated risks and predictive factors in Egypt. *Journal of the Egyptian Society of Parasitology*, *47*(1), 19-24.

Eldash, HH., Bekhit, OE., Algameel, AA. (2013). Impact of *Helicobacter pylori*-giardiasis coinfection on children with recurrent abdominal pain. *Journal of the Egyptian Society of Parasitology*, 43, 2:509-16.

Eusebi L.H., Zagari R.M., Bazzoli F. (2014). Epidemiology of *Helicobacter pylori* infection. *Helicobacter*, 19: 1-5.

Fallone CA, Chiba N, van Zanten SV, Fischbach L, Gisbert JP, Hunt RH, Jones NL, Render C, Leontiadis GI, Moayyedi P, Marshall JK. (2016). The Toronto consensus for the treatment of Helicobacter pylori infection in adults. *Gastroenterology*, 151:51-69. e14.

Fox, J.G., Beck, P., Dangler, C.A., Whary, M.T., Wang, T.C., Shi, H.N., Nagler-Anderson, C. (2000). Concurrent enteric helminth infection modulates inflammation and gastric immune responses and reduces helicobacter-induced gastric atrophy. *Nature medicine, 6*, 536–542.

Fuenmayor-Boscán, A., Hernández-Rincón I., Arismendi-Morillo, G.,Mengual , E., Rivero, Z., Romero, G., Lizarzábal, M., Álvarez-Mon, M. (2020)**.** Changes in the severity of gastric mucosal inflammation associated with Helicobacter pylori in humans coinfected with intestinal helminths. *Indian Journal of Gastroenterology, 39*, 186–195.

Ghallab, M. M., & Morsy, S. M. (2020). Helicobacter pylori co-infected with common intestinal protozoa in gastrointestinal symptomatic patients. *Journal of the Egyptian Society of Parasitology*, *50*(2), 390-393.

Gillespie, S. H., & Hawkey, P. M. (2006)**:** *Principles and practice of clinical bacteriology*. John Wiley & Sons.

Gulcelik, NE., Kaya, E., Demirbas, B. (2005). *Helicobacter pylori* prevalence in diabetic patients and its relationship with dyspepsia and autonomic neuropathy. *Journal of endocrinological investigation*, 28:214-7.

Hanafi NF, Mikhael IL, Younan DN. (2017). Prevalence of Helicobacter pylori Antibodies in Egyptians with Idiopathic Thrombocytopenic purpura and in the General Egyptian Population: A Comparative Study. *International Journal of Current Microbiology and Applied Sciences*,.6: 2482-2492.

Haque, R. (2007). Human intestinal parasites: *The Journal of Health, Population and Nutrition,* 25: 387-391.

Harhay, MO., Horton, J., Olliaro, PL. (2010). Epidemiology and control of human gastrointestinal parasites in children. *Expert review of anti-infective therapy*, 8, 2:219-34.

Hernández, P.C., Morales, L., Chaparro-Olaya, J., Sarmiento, D., Jaramillo, J.F., Ordoñez, G.A., Cortés, F., Sánchez, L.K. (2019). Intestinal parasitic infections and associated factors in children of three rural schools in Colombia. A cross-sectional study. *PLoS One*, 14, e0218681.

Hosni H., Kamel M., Kotb M., Gheith M. (2012): Histopathological study of upper gastrointestinal tract for *Helicobacter pylori* and giardiasis in Egyptian children. *The Medical Journal of Cairo University,* 80: 283-291.

Hussain, Z., El-Omar, E., Lee, Y.Y. (2020). Dual infective burden of Helicobacter pylori and intestinal parasites: *Good or bad news for the host?. Indian Journal of Gastroenterology, 39*, 111–116.

Khalifa M.M., Sharaf R.R., Aziz R.K. (2010)**.** *Helicobacter pylori*: a poor man's gut pathogen?. *Gut pathogens*, 2(1), 1-12.

Kibru, D., Gelaw, B., Alemu, A., Addis, Z. (2014). Helicobacter pylori infection and its association with anemia among adult dyspeptic patients attending Butajira Hospital, Ethiopia. *BioMedCentral Infectious Diseases*, 14:656-60.

Konturek S.J., Konturek P.C., Konturek J.W., Plonka M., Czesnikiewicz-Guzik M., Brzozowski T., Bielanski W. (2006). *Helicobacter pylori* and its involvement in gastritis and peptic ulcer formation. *Journal of Physiology and Pharmacology*, 57: 29-50.

Korwin JD., Ianiro G., Gibiino G., Gasbarrini A. (2017). Helicobacter pylori infection and extragastric diseases in 2017. *Helicobacter*; 22, e 12411.

Kumar, S., Patel, G. K., & Ghoshal, U. C. (2021). Helicobacter pylori-induced inflammation: possible factors modulating the risk of gastric cancer. *Pathogens*, *10*(9), 1099.

Lee, Y. C., Dore, M. P., & Graham, D. Y. (2022)**.** Diagnosis and treatment of Helicobacter pylori infection. *Annual Review of Medicine*, 73, 4-1.

Lesbros-Pantoflickova, D., Corthesy-Theulaz, I., & Blum, A. L. (2007). Helicobacter pylori and probiotics. *The Journal of nutrition*, 137(3), 812S-818S.

Maizels, R. M., & Yazdanbakhsh, M. (2003). Immune regulation by helminth parasites: cellular and molecular mechanisms. *Nature Reviews Immunology*, *3*(9), 733-744.

Malfertheiner P., Megraud F., O'Morain CA., Gisbert JP., Kuipers EJ., Axon AT., Bazzoli F., Gasbarrini A., Atherton J., Graham DY., Hunt R., Moayyedi P., Rokkas T., Rugge M.., Selgrad M.., Suerbaum S., Sugano K., El-Omar EM (2017). Management of Helicobacter pylori infection the Maastricht V/Florence Consensus Report. *Gut*, 66:6-30.

Melese, A., Genet, C., Zeleke, B., Andualem, T. (2019). Helicobacter pylori infections in Ethiopia; prevalence and associated factors: a systematic review and metaanalysis. *BMC Gastroenterology*, 19, 8.

Mezmale L, Coelho LG, Bordin D, Leja M. Review. (2020). epidemiology of *Helicobacter pylori*. *Helicobacter*. ;25: e12734.

Mohammad, MA., Hussein, L., Coward, A., Jackson, SJ. (2008). Prevalence of *Helicobacter pylori* infection among Egyptian children: Impact of social background and effect on growth. *Public health nutrition*,11, 3:230-6.

Monib, M. E. M. M., Hassan, A. A. A. E., Attia, R. A. E. H., & Khalifa, M. M. (2016). Prevalence of intestinal parasites among children attending Assiut University Children's Hospital, Assiut, Egypt. *The Journal of Advances in Parasitology*, *3*(4), 125-131.

Moses, A, Uchenna, U, Michael, E. (2013). Prevalence of intestinal parasites from the fingers of school children in Ohaozara, Ebonyi-State, Nigeria. *American Journal of Biological, chemical and pharmaceutical sciences*, 1, 5:22-7.

Nasr, D. S., Al-Antably, A. S. A. G., Ismail, M. A., Zein, M. M., & Abdel- Aal, S. M. (2022). parasitological studies among egyptian patients attended diagnostic & research unit of parasitic diseases, kasr al-ainy teaching hospitals: a five-year retrospective study. *Journal of the Egyptian society of parasitology*, *52*(2), 295-300.

Oster, P., Vaillant, L., Riva, E., McMillan, B., Begka, C., Truntzer, C & Velin, D. (2022). Helicobacter pylori infection has a detrimental impact on the efficacy of cancer immunotherapies. *Gut*, *71*(3), 457 -466.

Padol I.T., Hunt R.H. (2004). Effect of Th1 cytokines on acid secretion in pharmacologically characterised mouse gastric glands. *Gu,t* 53: 1075-1081.

Pellicano R., Ménard A., Rizzetto M., Mégraud F. (2008). Helicobacter species and liver diseases: Association or causation?. *The Lancet infectious diseases*, 8: 254-260.

Petri Jr, W. A. (2003). Therapy of intestinal protozoa. *Trends in parasitology*, 19(11), 523-526.

Queiroz, D.M., Rocha, A.M., Crabtree, J.E. (2013). Unintended consequences of helicobacter pylori infection in children in developing countries: iron deficiency, diarrhea, and growth retardation. *Gut Microbes*, 4, 494–504.

Rady, H. I., Elkazazz, A., El Saftawy, E. A., & Abdelrazek, N. M. (2019). Parasites and Helicobacter pylori in Egyptian children with or without diabetes with gastrointestinal manifestations and high calprotectin level. *Journal of the Egyptian Society of Parasitology*, *49*(1), 243-248.

Sabah A.A., Gneidy M.R., Saleh N.M.K. (2015**).** Prevalence of *Helicobacter pylori* infection among adult patients with different gastrointestinal parasites in Tanta City district. *Journal of the Egyptian Society of Parasitology*, 45: 101-106.

Sabet, E.A., El-Hadi, H., Mohamed, D.S., Sheneef, A., Fattouh, M., Esmat, M.M. (2009). Gastritis; helicobacter pylori or Giardia lamblia infection or both. *Egyptian Journal of Medical Microbiology*,18, 165–178.

Schmid, MB, Brandt, S, Bannwart, F, Soldini,D, Noske, A. (2021). Giardia lamblia and Helicobacter pylori coinfection in gastrointestinal biopsies: A retrospective single-center analysis from Switzerland. *Annals of Diagnostic Pathology*, 53: 151756.

Seid, A., Tamir, Z., Kasanew, B., Senbetay, M. (2018). Co-infection of intestinal parasites and Helicobacter pylori among upper gastrointestinalsymptomatic adult patients attending Mekanepsalem Hospital, northeast Ethiopia. *BMC Research Notes*, 11, 1:144-8.

Sigthorsson, G., Tibble, J., Foster, R., Sherwood, R., Fagerhol, M. (2001). Fecal calprotectin and fecal occult blood tests in the diagnosis of colorectal carcinoma and adenoma. *Gut*, 3:402-8.

Sitotaw, B., Mekuriaw, H., & Damtie, D. (2019). Prevalence of intestinal parasitic infections and associated risk factors among Jawi primary school children, Jawi town, north-west Ethiopia. *BMC infectious diseases*, *19*(1), 1-10.

Smith, S., Fowora, M., & Pellicano, R. (2019). Infections with Helicobacter pylori and challenges encountered in Africa. *World journal of gastroenterology*, 25(25), 3183.

Taghipour, A., Ghodsian, S., Jabbari, M., Olfatifar, M., Abdoli, A. (2021). Global prevalence of intestinal parasitic infections and associated risk factors in pregnant women: A systematic review and meta-analysis. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 115, 5:457-70.

Whary, M.T., Sundina, N., Bravo, L.E., Correa, P., Quiñones, F., Caro, F., Fox, J.G. (2005). Intestinal Helminthiasis in Colombian Children Promotes a Th2 Response to Helicobacter pylori: Possible Implications for Gastric Carcinogenesis. *Cancer Epidemiology Biomarkers & Prevention*, 14*(6)*, 1464–1469.

Windle H.J., Kelleher D., Crabtree J.E. (2007). Childhood *Helicobacter pylori* infection and growth impairment in developing countries: A vicious cycle? *Pediatrics*, 119: e754-759.

Yakoob, J., Abbas, Z., Khan, R., Tariq, K., Awan, S., & Beg, M. A. (2018). Association of Helicobacter pylori and protozoal parasites in patients with chronic diarrhoea. *British journal of biomedical science*, *75*(3), 105-109.

Zeyrek, D., Zeyrek, F., Cakmak, A., & Cekin, A. (2008). Association of Helicobacter pylori and giardiasis in children with recurrent abdominal pain. *Türkiye Parazitoloji Dergisi*,*32*(1), 4-7.