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Helicobacter Pylori and Athlete Health

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Abstract

Helicobacter pylori (H. pylori) is an important infectious agent that can cause various digestive system problems such as gastritis, peptic ulcers, and, in advanced stages, stomach cancer. This review aims to emphasize the importance of H. pylori infection on athletes' health and current information about the microorganism by examining the importance of H. pylori on athlete performance. H. pylori is one of the most common pathogens in the world. One of this bacterium's most common disease manifestations is gastritis, a serious public health problem. Today, gastritis is one of the most common digestive system disorders. It can directly affect athletes' health and performance, especially those closely related to nutrition and digestion. If left untreated, H. pylori-induced gastritis can progress to ulcer formation and lead to more serious and chronic digestive problems. This chronic process can seriously affect athletes' nutrition, performance, and sleep patterns, all of which are critically important for optimal athlete performance. For all these reasons, this review aims to compile the current knowledge on H. pylori and its effects on athlete health and performance and to present the latest developments in diagnosis and treatment.

Keywords: Athlete, Digestive System, Health, Helicobacter Pylori, Performance.

INTRODUCTION

Helicobacter pylori

Helicobacter pylori is one of the most common bacterial pathogens, affecting more than half of the world's population. Initially identified as part of the Campylobacter genus, it has since been reclassified under the Helicobacter genus due to differences in its taxonomy. Despite its widespread prevalence, clinically apparent cases are relatively low. H. pylori is the leading cause of stomach and duodenal ulcers. Individuals infected with H. pylori have approximately a 20% chance of developing peptic ulcer disease and a 2% chance of developing stomach cancer over their lifetimes. The likelihood of developing these two conditions is higher in patients infected with bacterial strains that produce specific cytotoxins. Although effective antibacterial treatments are available, they can be lengthy and challenging. However, successfully eradicating H. pylori is crucial for reducing morbidity and mortality. For instance, studies have shown that eradicating H. pylori in patients with gastric mucosa-associated lymphoid tissue lymphoma results in approximately 80% improvement and regression of the lymphoma (FitzGerald and Smith, 2021; Reyes, 2023; Sharndama and Mba 2022; Suzuki et al., 2009).

H. pylori is a pathogen identified recently as having high clinical importance. It is thought that the difficulty of cultivating the bacteria has caused the studies on this pathogen to be postponed. For a long time, it was not considered due to the idea that no microorganism could survive in a very low stomach pH. The belief that the organisms found in the stomach could not colonize the gut and could not cause infection but only existed temporarily prevailed. Many scientists also believed that the microorganisms

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found in the stomach could be microorganisms coming from the upper digestive system, and it was argued that there could not be any microorganisms settled in such an acidic environment (Leja et al., 2019; Marshall and Warren, 1984).

The discovery of H. pylori also allows the evaluation of human migrations through its phylogeography. Paleomicrobiology studies on H. pylori were illuminated, especially with the discovery of the iceman Otzi, who died 5300 years ago. The bacterium has spread globally among humans. The microorganism has been used in different phylogeographic models that can be used to understand better both recent and ancient human migrations (Achtman, 2008; Maixner et al., 2016).

Humans have used plants to feed their wives and against infectious agents for periods before they were identified or known. Plants have also been used in digestive system disorders associated with H. pylori. Today, it is known that many endemic medicinal plants located in different parts of the world are used in the treatment and drug development industry due to their wide range of pharmacological properties (Ardalani et al., 2020; Silva et al., 2010; Wang, 2014).

H. pylori is an essential Gram-negative pathogen that can settle in the stomach and duodenum mucosa. It is associated with gastritis, ulcers, and stomach carcinoma. In addition to digestive system problems, H. pylori can affect the performance of athletes because it causes iron deficiency anemia and chronic inflammation. H. pylori causes chronic inflammation in the gastric mucosa and inhibits iron absorption. Long-term infection can cause iron deficiency anemia in the host. Since anemia will cause a decrease in hemoglobin levels in athletes, it can reduce the amount of oxygen going to the cells and thus directly affect the athlete's performance. In addition, digestive system problems associated with H. pylori will jeopardize the athlete's nutrition and cause inadequate and unbalanced nutrition, which can also cause performance loss.

This review aims to emphasize the importance of H. pylori in terms of athlete performance by examining the effects of H. pylori infection on athlete health and current information about this microorganism.

Pathogenesis and Virulence Characteristics

H. pylori is a motile, spiral, microaerophilic, Gram-negative bacterium with urease, catalase, and oxidase activity. These characteristics are vital for its survival in the acidic stomach environment. The bacterium's ability to produce urease enzyme helps convert urea into ammonia, thus neutralizing stomach acid and performing bacterial protein synthesis. The secretion of the urease enzyme is triggered by a gene possessed by the bacterium, regulating stomach pH. Urease enzyme constitutes approximately 1/10 of the total protein content of H. pylori. H. pylori infection triggers the intense release of phagocytic cells that try to kill it by releasing oxygen metabolites. Still, the microorganism's catalase activity allows H. pylori to survive this oxidative stress (Kalali et al., 2014; Bhattacharjee et al., 2024; Chmiela and Kupcinskas, 2019).

In return, the inflammatory response damages the gastric epithelial layer and allows H. pylori to multiply. In addition, thanks to the bacteria's flagella, colonization occurs in the gastric mucosa, and infection begins. H. pylori infection, which usually affects the gastric corpus, is associated with hypochlorhydria due to damage to parietal cells, and infection localized to the gastric antrum leads to an increase in gastrin production, resulting in duodenal ulceration (Chmiela and Kupcinskas, 2019).

An essential feature of H. pylori is its ability to resist very low stomach pH. The microorganism is required to overcome the protective mucus layer on the surface of the gastric mucosa by moving with the help of flagella. It has been reported that the ferric uptake regulator (Fur gene), which regulates iron homeostasis, acid acclimation, and oxidative response, is essential for H. pylori colonization. One study reported that Fur regulates the flagella motor switch of H. pylori. The LuxS enzyme of the bacteria plays a vital role in motility. Recently, it has been reported that another protein modulates motility. It has been reported that this protein is necessary for stomach colonization. Its deficiency leads to disruptions in the microorganism's secretory system and vacA functions (Sterbenc et al., 2019; Suerbaum and Michetti, 2002; Shiota et al., 2013).

Epidemiology

H. pylori infection is usually acquired during childhood in underdeveloped and/or developing countries, and chronic infection continues into adulthood. However, childhood H. pylori infections are rare in developed countries but more common in adults (Burucoa and Axon, 2017; Eusebi et al., 2014).

Exposure to H. pylori at an early age is associated with pathological gastric diseases ranging from atrophic gastritis to gastric ulcers and carcinoma. Late-onset infection most commonly occurs with duodenal pathology. The most common transmission routes of the microorganism during this period are fecal-oral and oral-oral. The prevalence of infection generally increases with age, and higher prevalence has been reported in Blacks and Hispanics than in Whites. H. pylori seroprevalence is reported to be approximately 30% in individuals younger than 30 years of age and over 60% in individuals aged 55-65 years. The prevalence of H. pylori also varies by ethnic group. For example, prevalence rates of over 20% in whites, over 50% in blacks, and over 60% in Mexicans have been reported. Transmission risk factors include living in crowded homes and intense person-to-person contact, such as sharing beds (Brown et al., 2022; Everhart et al., 2000).

Cancer Relationship

The virulence factors of pathogens such as cagA and vacA toxins in epithelial adhesion regions alter tissue physiology and morphology, worsening the prognosis of the infection. As a result of increased bacterial replication in infected patients, gastritis, duodenal ulcers, and gastric ulcers may develop. The continuous and widespread proliferation of bacteria can progress toward carcinogenesis. Today, the relationship between H. pylori and gastric cancer has been demonstrated in many studies. Gastric cancer is the third leading cause of cancer-related deaths worldwide, after lung and liver cancers. In both low- and high-risk populations, dietary habits, obesity, smoking, and particularly chronic infections with H. pylori, alongside genetic factors, are significant contributors to the development of gastric cancer (Wang et al., 2014; Lee et al., 2016; Muzaheed, 2020).

The eradication of H. pylori is vital for treating these diseases. Today, the traditional treatment of H. pylori relies on the combined use of clarithromycin, amoxicillin, tetracycline, and metronidazole with proton pump inhibitors and bismuth sulfate. Clinical observations report that the eradication rate of H. pylori with current treatment methods ranges between 60-80%. Antibiotic resistance, particularly to metronidazole and clarithromycin, significantly complicates treatment. Due to these problems, levofloxacin, rifabutin, and furazolidone are alternative options. However, the use and efficacy of rifabutin and furazolidone in H. pylori infections are limited due to the development of quinolone resistance and serious side effects. All these treatment challenges necessitate the search for new active molecules or efforts to improve the efficacy of existing drugs (Sexton et al., 2020; Yamaoka, 2024).

New Drug Research and Natural Products

Helicobacter pylori is a pathogen that infects more than half of the world's population and displays remarkable adaptability within the microbial environment. If left untreated, this gram-negative, spiral-shaped, microaerophilic bacterium can persist in an infected individual for a lifetime. H. pylori colonizes the mucosal layer of the stomach and the protective mucus, allowing it to evade the harmful effects of low gastric acid. One of its notable adaptations is its ability to shield itself from the damaging effects of gastric acid temporarily. The bacterium breaks down urea from the host into ammonia and carbon dioxide, which helps to neutralize the gastric environment. Its spiral shape and lophotrichous flagella facilitate effective movement through the thick mucus layer of the stomach. Additionally, H. pylori employs a pH- and urea-driven chemotaxis system, a mechanism that allows the bacterium to sense changes in pH and urea concentration and move towards more favorable conditions, to escape the harmful effects of gastric acid further. It maintains close interactions with the epithelial cells of the gastric wall by binding to specific protein and glycan-based receptors through outer membrane proteins that function as essential adhesins. These outer membrane proteins' expression, recombination, and phase variation are critical for their adhesion to the gastric epithelium (Sahle, 2022; Öztekin et al., 2021).

Low socio-economic level, inadequate fruit and fresh vegetable consumption, widespread use of tobacco products, and poor oral hygiene are among the risk factors for H. pylori. In the case of H. pylori infection

in the host, changes in the levels of hormones such as ghrelin and leptin reduce nutrient absorption and lead to malabsorption. This situation directly affects the health of the athlete. A study investigating Helicobacter pylori infection's role in iron deficiency anemia in adolescent athletes determined that the risk of iron deficiency anemia was 2.9 times higher in those with H. pylori infection. Iron is essential for the synthesis of hemoglobin. The iron within hemoglobin facilitates the transport of oxygen to cells. In athletes, iron deficiency leads to insufficient oxygen utilization. When oxygen utilization is inadequate, aerobic capacity decreases, lactic acid accumulates in the blood and muscles, endurance diminishes, and fatigue ensues (Choe et al., 2001).

Most new drug research focuses on natural products due to their low cytotoxic effects. Natural products derived from various plants have been traditionally used in folk medicine for gastric disorders for centuries. One of the commonly used plants for treating gastric diseases is licorice root. Licorice root has been reported to possess various pharmacological activities. It is the root of the plant Glycyrrhiza glabra. The active component of licorice root is glycyrrhizin (glycyrrhizic acid, glycyrrhizinate). Glycyrrhetinic acid is a hydrolytic product of glycyrrhizic acid, a component of licorice root. Licorice (Glycyrrhiza glabra) has been shown in various studies to have antibacterial, antiviral, anti-inflammatory, anti-ulcer, anti-allergic, antioxidant, and anti-tumoral activities. Additionally, our previous studies determined that glycyrrhetinic acid exhibits significant antimicrobial activity against H. pylori under in-vitro conditions (Lee et al., 2020; Rahnama et al., 2013; Çelik and Duran, 2019).

Due to their antimicrobial activities, microbial secondary bio-components have been another area of intense research in recent years. Probiotic microorganisms have become the focus of interest and are widely studied for their various pharmacological activities. The antimicrobial activities and immunoregulatory functions of probiotics such as Streptococcus, Lactobacillus, and Enterococcus species have been reported in numerous studies. Streptococcus thermophilus (S. thermophilus) and Lactobacillus casei (L. casei) are microorganisms found in many fermented foods and are highly beneficial to human health through their secretions, enzymes, and bioactive components. S. thermophilus is a thermophilic, Gram-positive coccus that grows in short chains with an optimal growth temperature of 42 °C. It is mainly used in the food industry for yogurt and cheese production. With the increasing studies on microbiota in recent years, its use as a probiotic has come to the forefront, and studies have shown that S. thermophilus can survive in the human gastrointestinal system. It has been reported that S. thermophilus has therapeutic properties in chronic gastritis caused by intense use of acetylsalicylic acid. The exopolysaccharides produced by the bacteria were found to inhibit ulcer formation by stimulating the immune system. Additionally, it is effective in cases of viral and bacterial diarrhea and diarrhea caused by antibiotic use. The bioactive metabolites of S. thermophilus have been determined to exhibit antibacterial activity against many bacteria, antioxidant activity, immunomodulatory properties, and positive effects on the gastrointestinal system barrier (Goderska et al., 2018; Liang et al., 2022;Tek, 2022).

Lactobacillus species are important probiotic bacteria widely used today in food, biotechnology, and pharmaceutical industries as probiotic starter cultures and vaccine strains. The secondary bioactive components of probiotic bacteria, such as L. casei, have been reported to have numerous positive effects on health. In one study using a mouse colitis model, both inactive and live strains of L. casei were shown to have therapeutic effects on an inflammatory bowel disease (IBD) model. Studies have reported significant effects of lactobacilli against H. pylori. Among these probiotic microorganisms, the use of L. paracasei as an adjunct therapy for H. pylori treatment and its role in modulating the intestinal microbiota have been demonstrated. The exopolysaccharides secreted by L. paracasei have also been reported to positively contribute to treatment (Haarhuis et al., 2022; Zolkiewicz et al., 2020).

In our previous study, we demonstrated the anti-H. pylori activity and immunoregulatory effects of glycyrrhetinic acid, S. thermophilus, and L. casei bioactive metabolites. In addition to in-vitro experiments, the anti-H.pylori activities of glycyrrhetinic acid, S. thermophilus, and L. casei bioactive metabolites and their combinations were effective in a rat gastritis model experimentally induced with H. pylori (Tek, 2022).

DISCUSSION and CONCLUSION

It is a fact that almost one in two people worldwide has H. pylori colonized in their stomach. Understanding how H. pylori can affect athletes' health is critical to managing their performance and overall well-being. Since athletes' intense training programs and match attendance directly trigger stress, they can create ideal conditions for colonized H. pylori to spread in the tissue. H. pylori is particularly susceptible to suppression of the immune response under increased stress conditions, and the bacteria can reach a high replication rate in the stomach. High H. pylori proliferation in athletes can lead to GI problems such as stomach pain, bloating, nausea, and indigestion. This can lead to irregular training and, therefore, performance losses. If H. pylori replication continues, the disease will progress and become chronic. This can lead to serious deconditioning and, therefore, athlete failure. In addition, H. pylori colonization and infection can lead to severe nutrient malabsorption in athletes. Since H. pylori infection can inhibit nutrient absorption, vitamin and mineral deficiencies, vital for athlete health, will also occur. This situation will lead to chronic fatigue, anemia, and loss of strength, further impairing athletic performance. In addition to these, since it will also affect the eating habits of athletes suffering from H. pylori-related digestive system disorders, a balanced and healthy nutrition problem will also arise. Due to all these, the athlete's performance can be seriously affected during training and sports competitions. Since it is not possible for athletes to avoid H. pylori colonization, it will be very important for both performance and protection to consume foods containing saprophytic bacteria and natural foods such as G. acid.

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REFERENCES

Achtman M. Evolution, population structure, and phylogeography of genetically monomorphic bacterial pathogens. Annu Rev Microbiol. 2008; 62:53-70.

Ardalani H, Hadipanah A, Sahebkar A. Medicinal Plants in the Treatment of Peptic Ulcer Disease: A Review. Mini Rev Med Chem. 2020; 20(8): 662-702.

Bhattacharjee A, Sahoo OS, Sarkar A, Bhattacharya S, Chowdhury R, Kar S, et al. Infiltration to infection: key virulence players of Helicobacter pylori pathogenicity. Infection. 2024; 52(2): 345-384.

Brown H, Cantrell S, Tang H, Epplein M, Garman KS. Racial Differences in *Helicobacter pylori* Prevalence in the US: A Systematic Review. Gastro Hep Adv. 2022;1(5):857-868.

Burucoa C, Axon A. Epidemiology of Helicobacter pylori infection. Helicobacter. 2017; 22 Suppl 1.

Çelik MM, Duran N. An experimental in-vitro study to evaluate the anti-helicobacter activity of Glycyrrhetinic acid}, Revista Romana de Medicina de Laborator, 2019; 27: 63-71.

Chmiela M, Kupcinskas J. Review: Pathogenesis of Helicobacter pylori infection. Helicobacter. 2019; 24 Suppl 1(Suppl Suppl 1):e12638.

Choe YH, Kwon YS, Jung MK, Kang SK, Hwang TS, Hong YC. Helicobacter pylori-associated iron-deficiency anemia in adolescent female athletes. J Pediatr. 2001; 139(1): 100-4.

Eusebi LH, Zagari RM, Bazzoli F. Epidemiology of *Helicobacter pylori* infection. Helicobacter. 2014; 19 Suppl 1:1-5.

Everhart JE, Kruszon-Moran D, Perez-Perez GI, Tralka TS, McQuillan G. Seroprevalence and ethnic differences in Helicobacter pylori infection among adults in the United States. J Infect Dis. 2000; 181(4): 1359-63.

FitzGerald R, Smith SM. An Overview of Helicobacter pylori Infection. Methods Mol Biol. 2021; 2283: 1-14.

Goderska K, Agudo Pena S, Alarcon T. Helicobacter pylori treatment: antibiotics or probiotics. Appl Microbiol Biotechnol. 2018 Jan;102(1):1-7.

Haarhuis JE, Kardinaal A, Kortman GAM. Probiotics, prebiotics and postbiotics for better sleep quality: a narrative review. Benef Microbes. 2022; 13(3): 169-182.

Kalali B, Mejías-Luque R, Javaheri A, Gerhard M. *H. pylori* virulence factors: influence on immune system and pathology. Mediators Inflamm. 2014; 2014: 426309.

Lee HA, Kim JY, Kim J, Nam B, Kim O. Anti-*Helicobacter pylori* activity of acomplex mixture of *Lactobacillus paracasei* HP7 including the extract of *Perilla frutescens var. acuta* and *Glycyrrhiza glabra*. Lab Anim Res. 2020; 36:40.

Lee YC, Chiang TH, Chou CK, Tu YK, Liao WC, Wu MS, Graham DY. Association Between *Helicobacter pylori* Eradication and Gastric Cancer Incidence: A Systematic Review and Meta-analysis. Gastroenterology. 2016; 150(5): 1113-1124.e5.

Leja M, Grinberga-Derica I, Bilgilier C, Steininger C. Review: Epidemiology of Helicobacter pylori infection. Helicobacter. 2019; 24 Suppl 1: e12635.

Liang B, Yuan Y, Peng XJ, Liu XL, Hu XK, Xing DM. Current and future perspectives for *Helicobacter pylori* treatment and management: From antibiotics to probiotics. Front Cell Infect Microbiol. 2022; 12: 1042070.

Maixner F, Krause-Kyora B, Turaev D, Herbig A, Hoopmann MR, Hallows JL, et al. The 5300-year-old Helicobacter pylori genome of the Iceman. Science. 2016; 351(6269): 162-165.

Marshall BJ, Warren JR. Unidentified curved bacilli in the stomach of patients with gastritis and peptic ulceration. Lancet. 1984; 1(8390): 1311-5.

Muzaheed. *Helicobacter pylori* Oncogenicity: Mechanism, Prevention, and Risk Factors. ScientificWorldJournal. 2020; 2020: 3018326.

Öztekin M, Yılmaz B, Ağagündüz D, Capasso R. Overview of *Helicobacter pylori* Infection: Clinical Features, Treatment, and Nutritional Aspects. Diseases. 2021; 9(4): 66.

Rahnama M, Mehrabani D, Japoni S, Edjtehadi M, Saberi Firoozi M. The healing effect of licorice (Glycyrrhiza glabra) on Helicobacter pylori infected peptic ulcers. J Res Med Sci. 2013; 18(6): 532-3.

Reyes VE. *Helicobacter pylori* and Its Role in Gastric Cancer. Microorganisms. 2023; 11(5): 1312.

Sahle Z. *Helicobacter pylori* Pathogenicity Islands and Giardia lamblia Cysteine Proteases in Role of Coinfection and Pathogenesis. Infection and Drug Resistance, 2022; 15: 21-34.

Sexton RE, Al Hallak MN, Diab M, Azmi AS. Gastric cancer: a comprehensive review of current and future treatment strategies. Cancer Metastasis Rev. 2020; 39(4): 1179-1203.

Sharndama HC, Mba IE. Helicobacter pylori: an up-to-date overview on the virulence and pathogenesis mechanisms. Braz J Microbiol. 2022; 53(1): 33-50.

Shiota S, Suzuki R, Yamaoka Y. The significance of virulence factors in Helicobacter pylori. J Dig Dis. 2013; 14(7): 341-9.

Silva DG, Stevens RH, Macedo JM, Albano RM, Falabella ME, Fischer RG. Presence of Helicobacter pylori in supragingival dental plaque of individuals with periodontal disease and upper gastric diseases. Arch Oral Biol. 2010; 55: 896-901.

Šterbenc A, Jarc E, Poljak M, Homan M. *Helicobacter pylori* virulence genes. World J Gastroenterol. 2019; 25(33): 4870-4884.

Suerbaum S, Michetti P. Helicobacter pylori infection. N Engl J Med. 2002; 347(15): 1175-86.

Suzuki H, Iwasaki E, Hibi T. Helicobacter pylori and gastric cancer. Gastric Cancer. 2009; 12(2): 79-87.

Tek E. Glycyrrhetinic asit, streptococcus thermophilus ve lactobacillus casei'nin helicobacter pylori'ye karşı in-vitro, in-vivo etkinliği ve moleküler mekanizmalar, Hatay Mustafa Kemal University, Sağlık Bilimleri Enstitüsü, Doktora Tezi, 2022.

Wang F, Meng W, Wang B, Qiao L. Helicobacter pylori-induced gastric inflammation and gastric cancer. Cancer Lett. 2014 Apr 10;345(2):196-202.

Wang YC. Medicinal plant activity on Helicobacter pylori related diseases. World J Gastroenterol. 2014; 20(30): 10368-82.

Yamaoka Y. Revolution of Helicobacter pylori treatment. J Gastroenterol Hepatol. 2024; 39(6): 1016-1026.

Zolkiewicz J, Marzec A, Ruszczyński M, Feleszko W. Postbiotics-A Step Beyond Pre- and Probiotics. Nutrients. 2020; 12(8): 2189.