Determination of Seroprevalence and Associated Factors of Helicobacter Pylori Infection among Bangladeshi and Somalian Students

Rabeya Nahar Ferdous a, Bashir Abubakar Mohamud a, Shah Md. Zahurul Haque Asna a and Mohammad Moniruzzaman b*

a Department of Microbiology, Bangladesh University of Health Sciences, Dhaka, Bangladesh. b Department of Immunology, BIRDEM General Hospital, Dhaka – 1000, Bangladesh.

Authors’ contributions

This work was carried out in collaboration among all authors. Authors RNF and MM conceptualized and designed the study with the input from SMHA. Authors RNF and BAM collected survey data and blood specimens and conducted laboratory experiments. Authors RNF, BAM and MM analyzed data from surveys and laboratories. Authors RNF and MM drafted the manuscript. Authors RNF, MM and SMZHA critically revised and edited the manuscript. Author MM supervised all the activities. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJRID/2022/v9i230266

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/84335

Received 01 January 2022
Accepted 04 March 2022
Published 17 March 2022

ABSTRACT

Helicobacter pylori (H. pylori) infections are the prime health concern nowadays as this may lead to peptic ulcer diseases and several types of stomach cancer. Factors including genetic, socioeconomic, ecological, personal hygiene and sanitation, and bacterial features are accountable for the predominance and development of disease. This study aimed to determine the prevalence of H. pylori and their association with age, sex, food habits and source, irregular meals, and physical activities among Bangladeshi and Somalian students. Cross-sectional structured questionnaires were used to collect demographic, food habits and lifestyle data. A total 80 Bangladeshi (32) and Somalian (48) students participated in this study. Selected students were invited to the laboratory to provide blood samples for H. pylori IgG antibody detection through Enzyme Linked Immuno-sorbent Assay (ELISA) method. Data from the survey and laboratory were analyzed using SPPS v.26. Multivariate logistic regression analysis was conducted to find an association between H. pylori infection and factors. Around 55% of the participants were found seropositive. Among them

*Corresponding author: E-mail: drmonirbirdem@gmail.com;
Somalian students were prevalently higher than Bangladeshi students. Mostly younger males were found seropositive regardless of age and educational level. Multivariate analysis revealed gender (OR:4.524, CI:1.526-13.407), ethnic origin (OR:4.200, CI:1.622-10.872), skipping of meals (OR:8.600, CI:0.984-75.151) and breakfast (OR:11.205, CI: 3.740-33.568) and physical activity levels (OR:0.286, CI:0.113-0.721) were significantly linked with H. pylori infections. More than two-third Somalian students (68.7%) were infected with H. pylori whereas one-third of Bangladeshi students were found positive. Somalian students were found to be less active and the pattern of skipping meals and breakfast was higher compared to Bangladeshi counterparts. Somalian students probably carried H. pylori infection from their native land, and less physical activity and mistiming of taking meals enhanced the infection. Communication barriers and food preferences could be other reasons. To prevent this infection, we suggest cleanliness, a healthy life style and nutritious meals with adequate physical activities are obligatory.

Keywords: Helicobacter pylori; Serological analysis; ELISA; IgG; Food habit.

1. INTRODUCTION

*H. pylori* is a helix-formed, curved rod shaped gram negative-bacteria, estimating a length of about 3μm with about 0.5μm in diameter. It colonizes at the host stomach more than half of the individuals worldwide are infected with *H. pylori* and the infection is the significant reason for peptic ulcers disease [1-4], gastritis [4,5], gastric lymphoma [6,7], and gastric carcinoma [8,9] particularly in adulthood [10-13]. However, the connection between non-ulcer indigestion and *H. pylori* has not been elucidated yet [10]. The diseases, caused by *H. pylori*, have been proved to be a great public health concern in developing countries. Poor hygiene and sanitation, and swarmed conditions have been reported as the major factors for *H. pylori* infections [14]. Infection with *H. pylori* is common in the early days of life, which remains regardless of innate and acquired immune responses [15,16]. Most of the *H. pylori* infections are asymptomatic, although, only 10-20% of infections develop clinical manifestations [17-20]. *H. pylori* infection is linked with a composite relation with hereditary [21], socioeconomic [17], ecological [22], and microbial factors [23]. A pilot serological study was conducted in 1997 revealed that 90% of asymptomatic individuals contained *H. pylori* infections. However, later the prevalence considerably declined to 67% [24,25]. Overall *H. pylori* infection prevalence in Pakistan (84%), India (79%), and Japan (41%) showed higher compared to the United States (USA) and Europe (<40%) [25]. A seroprevalence study on adult populations of Canada demonstrated that men (29.4%) were infected more compared to women (14.9%) [26]. The prevalence of *H. pylori* infection in the USA is higher in lower educated, low-income groups and among African Americans implying that socioeconomic conditions may have roles in disease progression after exposure to bacteria [27]. In addition, lifestyle and food habits have been showing potential factors of *H. pylori* infections [23]. Frequent meal skipping over a prolonged time could result in the augmented risk of increasing *H. pylori* infection and gastritis [28]. More than 90% of gastric cancers have been found linked to current or previous *H. pylori* infection and decreasing *H. pylori* infection is considered to be a key preventive measure against it [29,30]. Surprisingly, the reduction of gastric cancers has been found related to consuming more fresh fruits and vegetables and reducing consumption of salted and stored foods [31]. Additionally, physical activity possesses several benefits for physical and psychological wellbeing, which are thought to affect on peptic ulcer disease through somephysiochemicalsystems. This event could also increase the immune system’s capability to defuse the adverse effects of *H. pylori* and associated disorders [32-34].

Dhaka is capital and central hub for all socioeconomic, education, and technology of Bangladesh. In recent days, numbers of foreign students especially from Somalia, Nepal, Bhutan, India, Kashmir, and other countries, have been conferred their degrees in both private and public universities. Students, especially from African origin, face some obstacles in language, lifestyle, food habits, etc. in Bangladesh. To date, there is no available literature regarding the impact of irregular meals, lifestyle, and physical activities along with gender and age group on *H. pylori* infections among African, and Bangladeshi adults. This study aims to compare and conclude whether a prolonged meal skipping pattern, food habits, and physical activities are associated with increased risk of *H. pylori* infection among Somalian and Bangladeshi university students.
2. MATERIALS AND METHODS

2.1 Study Period and Location

This study was initiated in the last quarter of 2020 by the Bangladesh University of Health Sciences (BUHS). Formal approval of the study was obtained from the Institutional Review Board of BUHS Memo No: BUHS/ERC/EA/20/262 dated 13.11.2020. Data and blood specimens were collected from December 2020 to May 2021 from the local and foreign students residing in Dhaka city. All the laboratory works were conducted at the Immunology laboratory of Bangladesh University of Health Sciences.

2.2 Study Population

This study aimed to collect data and samples from 140 (equally divided into Bangladeshi and Somali students) with a 95% confidence interval and ±5% margin of errors. Due to the COVID-19 pandemic, the study population was limited to 80 (32 Bangladeshi and 48 Somali students) which finally have a 95% confidence interval and a 6.57% margin of errors. A cross-sectional method was applied to select participants. Each participant was informed about the aim and objectives of the research and written consent was taken from all participants. The consent forms were designed to explain the aims and nature of the study and the procedure they were needed to undergo. In addition, they were also clearly informed about the nature, purpose, and confidentiality in data handling. Participants had a choice to refuse to respond to any or the entire survey questions and they also have the right to withdraw from the on-going interview.

2.3 Questionnaire and Data Collection Technique

Participants were interviewed by using a pre-structured questionnaire. Socio-demographic information (e.g. ethnic origin, age, gender, and education level), Food habits (home/self-made foods, skipping meals pattern), and physical activity level data were also collected. Once the consent was obtained, participants were informed to be present at the laboratory for the interview and provide blood samples.

2.4 Blood Specimen Collection

A total of 80 blood samples were collected by trained medical assistants strictly following standard operational procedures. Disinfection of the phlebotomy site was done by swabbing the skin in small outward circles with 70% alcohol swab or cotton wool soaked in isopropyl alcohol. Approximately 5 ml venous blood from each participant was collected in the dry clean tube. Blood samples were allowed to clot to get serum samples. Centrifugation was done at 3000rmp for 10 minutes and serum was separated and then stored at -20°C till analysis. Detection of Anti H. pylori IgG in serum by ELISA was done by commercial test kit (Monobind Inc. Lake Forest, CA 92630, USA, AccuBind, ELISA Microwells).

2.5 Data Analysis

Survey data and laboratory data were analyzed using SPSS v. 26. Mean along with standard error of the mean, percentages were calculated. Odds ratio (OR) were calculated where the distribution of H. pylori IgG seronegative vs seropositive were dependent variables. Took P<0.05 as significant.

3. RESULTS

Eighty blood samples (59 male and 21 female) were collected from 32 Bangladeshi students and 48 Somali students (Table 1) and the average age of participant’s was 24.90±0.477 years. Among 80 students, more than half (55%) were diagnosed with H. pylori Compare to Somali (33 out of 48) students, Bangladeshi (11 out of 32) students found less positive in H. pylori IgG analysis and it has been found significant (p<0.002). The age and gender distribution pattern of their samples showed that most of the samples were obtained from age between 20–24 years old (56.3%). H. pylori IgG was predominating in males (38 out of 59) rather than females (6 out of 21) and it was significant (p=0.006). Within 44 seropositive most of them were from undergraduate level (29 participants). But there was no significant association with regards to age group, level of education distribution of participants, and presence of H. pylori IgG.

Total numbers of participants were subjected to analyze their food habits and lifestyle to know whether the bacterial infections were related to their food sources, lifestyles. Students were asked whether their foods were homemade/self-made or purchased from a restaurant. The results are summarized in Table 2. Where most of them 59 (73.3%) had restaurant-made food, however, food sources showed no statistical association to be seropositive (presence of IgG
antibody). We further enquired about their food habits particularly the meal and breakfast skipping pattern and physical activity level. It is noteworthy that maximum entrant 22 (27.5%) had their meals 2 hours delay where only 7 had a meal on time. Among 80 participants 19 (23.8%) deviated their meal for more than 4 days per week. Significant associations were found in the case of breakfast ($p<0.001$) and physical activity ($p=0.007$). Around 51 (63.7%) students skipped their breakfast which is shocking. Physically inactive or less active students were prone to seropositive compared to moderately and highly active students.

A multivariate logistic regression analysis was conducted to find the association between microbial infections and a number of variables (food consumption timing, lifestyle, age, gender, education, and ethnic origin). In Table-3 the associations are summarized. With 95% confidence interval, gender (OR: 4.524, CI: 1.526-13.407, $p=0.006$), ethnic origin (OR: 4.200, CI: 1.622-10.872, $p=0.002$), skipping of meals (OR: 8.600, CI: 0.984-75.151, $p=0.023$), skipping of breakfast (OR: 11.205, CI: 3.740-33.568 $p<0.001$) and physical activity levels (OR: 0.286, CI: 0.113-0.721, $p=0.007$) were found significantly associated with $H. \text{ pylori}$ infections. Seropositivity of $H. \text{ pylori}$ IgG was not linked with age, education level, and sources of food.

While analyzing the data of Table-1, we have found that foreign students possessed much more infections than local students. To know the reason within our data, we have further compared food habits and lifestyles between them (Table-4). One-third of Bangladeshi students were infected with $H. \text{ pylori}$, however, for the Somalian students (68.7%) the results were just the opposite. More than 95% of Somalian students skipped at least one of the daily meals. Half of the Bangladeshi student skipped breakfast, on the other hand the rate in Somalian students was 72.9%. More than half of the Somalian students (56.3%) were either inactive or less active, the results in Bangladeshi students (40.6%) were found contrary.

### Table 1. Demographic Information among participants

| Parameter                        | Participants, N (%) | Distribution of participants on basis of $H. \text{ pylori}$ IgG | P-value |
|----------------------------------|---------------------|---------------------------------------------------------------|---------|
|                                  |                     | Seronegative | Seropositive |                     |
|                                  |                     | Number | % of N | Number | % of N |        |
| Total Participants               | 80 (100%)           | 36     | 45%     | 44     | 55%     |        |
| Ethnic Origin (Nationality)      |                     |          |         |        |        |         |
| Bangladeshi Student              | 32 (40.0%)          | 21     | 26.3%   | 11     | 13.8%   | 0.002  |
| Somali Student                   | 48 (60.0%)          | 15     | 18.8%   | 33     | 41.3%   |        |
| Age                              |                     |          |         |        |        |         |
| Mean±SEM: 24.90±0.477            |                     |          |         |        |        |         |
| Age Group                        |                     |          |         |        |        |         |
| 20 to 24 Years Old               | 45 (56.3%)          | 22     | 27.5%   | 23     | 28.7%   | 0.790  |
| 25-29 Years Old                  | 26 (32.5%)          | 11     | 13.8%   | 15     | 18.8%   |        |
| 30-34 Years Old                  | 4 (5.0%)            | 1      | 1.3%    | 3      | 3.8%    |        |
| 34+ Years Old                    | 5 (6.3%)            | 2      | 2.5%    | 3      | 3.8%    |        |
| Gender                           |                     |          |         |        |        |         |
| Female                           | 21 (26.3%)          | 15     | 18.8%   | 6      | 7.5%    | 0.006  |
| Male                             | 59 (73.8%)          | 21     | 26.3%   | 38     | 47.5%   |        |
| Education                        |                     |          |         |        |        |         |
| Postgraduate                     | 25 (31.3%)          | 10     | 12.5%   | 15     | 18.8%   | 0.545  |
| Undergraduate                    | 55 (68.8%)          | 26     | 32.5%   | 29     | 36.3%   |        |

$SEM$=standard error of the mean. $p<0.05$ considered statistically significant
Table 2. Lifestyle and food habits of participants

| Parameter                        | Participants, N (%) | Distribution of participants on basis of H. pylori IgG | P-value |
|----------------------------------|---------------------|-------------------------------------------------------|---------|
|                                  |                     | Seronegative Seropositive                               |         |
|                                  |                     | Number % of N Number % of N                             |         |
| **Food Sources**                 |                     |                                                       |         |
| Homemade/Self-made Foods         | 21 (16.3%)          | 9 11.3% 12 15.0%                                       | 0.818   |
| Restaurant Made Foods           | 59 (73.3%)          | 27 33.8% 32 40.0%                                     |         |
| **Regular meals taken habits**   |                     |                                                       |         |
| Meal deviation (meals have been taken within hour of regular time) | 7 (8.8%) | 6 7.5% 1 1.3%                                        | 0.022   |
| 1 hour late of regular time     | 21 (26.3%)          | 13 16.3% 8 10.0%                                     |         |
| 2 hours late of regular time    | 22 (27.5%)          | 6 7.5% 16 20.0%                                     |         |
| 3 hours late of regular time    | 16 (20.0%)          | 7 8.8% 9 11.3%                                     |         |
| 3+ hours late of regular time   | 14 (17.5%)          | 4 5.0% 10 12.5%                                     |         |
| **Frequency of meal deviation per week** |             |                                                       |         |
| Not skipped                      | 15 (18.8%)          | 12 15.0% 3 3.8%                                     | 0.021   |
| 1 to 2 days per week            | 13 (16.3%)          | 7 8.8% 6 7.5%                                     |         |
| 2 to 3 days per week            | 16 (20.0%)          | 6 7.5% 10 12.5%                                     |         |
| 3 to 4 days per week            | 17 (21.3%)          | 6 7.5% 11 13.8%                                     |         |
| 4+ days per week                | 19 (23.8%)          | 5 6.3% 14 17.5%                                     |         |
| **Breakfast**                    |                     |                                                       |         |
| Not Skipped                      | 29 (36.3%)          | 23 28.7% 6 7.5%                                     | 0.000   |
| Skipped                          | 51 (63.7%)          | 13 16.3% 38 47.5%                                    |         |
| **Physical activity level**      |                     |                                                       |         |
| Not active                       | 13 (16.3%)          | 2 2.5% 11 13.8%                                     | 0.007   |
| Less active                      | 27 (33.8%)          | 10 12.5% 17 21.3%                                    |         |
| Moderately active                | 22 (27.5%)          | 16 20.0% 6 7.5%                                     |         |
| Highly active                    | 18 (22.5%)          | 8 10.0% 10 12.5%                                     |         |

SEM=standard error of the mean. p≤ 0.05 considered statistically significant

Table 3. Factor Associated with H. pylori infection

| Factors                                              | Odd Ratio | 95% Confidence Interval | P-Value |
|------------------------------------------------------|-----------|-------------------------|---------|
| Age (20 to 24 years old vs 24+ years old)            | 1.435     | .587 3.507               | 0.428   |
| Gender (Female vs Male)                              | 4.524     | 1.526 13.407             | 0.006   |
| Education (Postgraduate vs Undergraduate)            | 0.744     | 0.285 1.941              | 0.545   |
| Ethnic Origin (Bangladeshi vs Somalian Students)     | 4.200     | 1.622 10.872             | 0.002   |
| Food Sources (Home/Self made foods vs Restaurant Made Foods) | 0.889 | 0.325 2.427               | 0.818   |
| Skips Meals (Not skipped vs skipped)                 | 8.600     | 0.984 75.151             | 0.023   |
| Breakfast (Not skipped vs skipped)                   | 11.205    | 3.740 33.568             | 0.000   |
| Physical activity (Not active/Less active vs Moderately/Highly active) | 0.286 | 0.113 0.721               | 0.007   |

p≤ 0.05 considered statistically significant
Table 4. Comparison of Lifestyle and Food habits between Bangladeshi and Somalian Students

| Parameters | Bangladeshi Students (n=32) | Somali Students (n=48) |
|------------|-----------------------------|------------------------|
|            | Number | % of within ethnic origin | Number | % of within ethnic origin |
| Distribution of participants on basis of *H. pylori* IgG | | | |
| Seronegative | 21 | 65.6% | 15 | 31.3% |
| Seropositive | 11 | 34.4% | 33 | 68.7% |
| Meals | | | |
| Not Skipped | 5 | 15.6% | 2 | 4.2% |
| Skipped | 27 | 84.4% | 46 | 95.8% |
| Breakfast | | | |
| Not skipped | 16 | 50.0% | 13 | 27.1% |
| Skipped | 16 | 50.0% | 35 | 72.9% |
| Physical Activity | | | |
| Not or Less active | 13 | 40.6% | 27 | 56.3% |
| Moderately or Highly active | 19 | 59.4% | 21 | 43.7% |

4. DISCUSSION

*H. pylori* infection is one of the major public health issues and approximately 4.4 billion individuals were estimated to be positive for *H. pylori* infection worldwide [35]. The infection is prominent in developing countries. Particularly poor cleanliness and swarmed environment have been found as risk factors [14]. *H. pylori* is frequent and was acquired in childhood, however, it bypasses both immune response and becomes a carrier of *H. pylori* [15,16]. Most of the people with *H. pylori* are found asymptomatic [18,19]. *Helicobacter pylori* infection is coupled with several factors including races, environments, microbial factors, etc. *H. pylori* infections are predominant reasons for peptic ulcers disease, gastritis, and gastritis cancer [1-4].

The present study aimed to determine the prevalence of *H. pylori* infections and their relation with food sources, food consumption habits, and lifestyles. Among 80 students were surveyed and diagnosed. Around 55% were found seropositive which confirms the higher prevalence in developing countries [14, 24,25]. The result is almost similar to the two studies [36,37]. The prevalence of *H. pylori* IgG antibody was higher in African (Somalian) students compared to Bangladeshi students. This result was similar to the study conducted in the USA [27] where it was found that *H. pylori* infections were more prevalent in African American population. Regardless of age and education, bacterial infection can be observed in most of the country [18,37]. However, a study conducted in New Zealand found that age along with socioeconomic status and lower household income are significantly associated with infection [38]. Our study demonstrated that males are more ubiquitous than females. This observation supports some studies [26, 38]. In 2019 Ahmed et. al. showed the prevalence of *H. pylori* infection was among 23% of hospital patients [25]. The deflection from our study was probably we are working with university students. A study conducted in 2018 concluded that the risk of *H. pylori* infection was higher in university students [27]. The USA [27] study showed that lower educated people are more susceptible. In this study, undergraduate students are found seropositive than postgraduate study and signify the USA [27] study results. The probable causes might be the youngster’s indifference towards food consumption habits and lifestyle. Lack of knowledge on hygiene and sanitation also might play a significant role in this regard.

The prevalence of *H. pylori* infection was shown at 55%, which is lower than in neighboring countries e.g. India at 79%, Pakistan at 84% [25]. Probably because very few Bangladeshi people (1.15%) live without improved sanitation compared to India (4.53%) and Pakistan (6.03%) [39]. Moreover, no Bangladeshis paretic open defecation whereas Indians (14.93%) and Pakistanis (7.3%) people go for it [39]. As a result, among 179 countries in the sanitation and drinking water index 2020, Bangladesh (129) remains better than that India (139) and Pakistan (144) [40]. An article published in the Bulletin of
the World Health Organization reported that *H. pylori* is mostly transmitted through water [41].

Somalian students (68.7% among Somalians) were found to be more prevalent compared to Bangladeshi students (34.4% among Bangladeshis). There could be many reasons as *H. pylori* infections show composite factors. One of the factors could be Somalian students were infected earlier in Somalia and remain asymptomatic. Due to socioeconomic conditions, 15.82% of Somalians do not have access to improved sanitation and 23.12% practices open defecation [39]. These could be a major reason for being infected with *H. pylori*. Other factors might include the language barrier in Bangladesh and native food habits that probably held back them to get proper and on-time meals. Similarly, lack of proficiency in common language thwarts them to be friendly with local students which made them engage in their room. Thus, they became less active compared to Bangladeshi students. Race-related connections were discussed above.

Multivariate analysis of current studies demonstrated that skipping of meals (OR: 8.600, CI: 0.984–75.151, \( p=0.023 \)) and breakfast (OR: 11.205, CI: 3.740–33.568 \( p<0.001 \)) are significantly associated with *H. pylori* infection. A similar pattern was also reported in a 2013 study [28] and concluded that prolonged meal skipping and deviation emerge augmented the possibility of rising gastritis and *H. pylori* infection [42]. Skipping or irregular timing of meals including breakfast perhaps changes the mucosal membrane that could raise susceptibility *H. pylori* infection. The mucosa membrane can be then disturbed and facilitate bacterial infection [43]. Nevertheless, there was no association between food sources and *H. pylori* infection in this study which is in line with others [44]. A recent study [45] found that physical activity levels are linked with *H. pylori* infection as we have found so. The active human body activates several biochemical pathways as well as defense systems that might prevent bacterial infections.

**5. CONCLUSION**

*Helicobacter pylori* infections become a prime concern for human wellbeing at present. Several factors including the human race, socioeconomic conditions, environments, personal hygiene, and sanitation as well as microbial factors are responsible for the prevalence and progression of the disease. Prolonged infections are a risk factor for peptic ulcer diseases as well as stomach cancer. To prevent this infection, we need to follow a healthy lifestyle. As this bacterial infection occurs mostly in childhood with unwariness and carefree lifestyle of youngsters might create problems in late stages of life. Cleanliness can prevent these bacteria as well as on-time meals and adequate physical activity could be major protective measures. Somali students perhaps carry *H. pylori* from their native; however, staying in Bangladesh with some obstacles including communication and having foods of their choice enhances the risks. Universities as well and authorities responsible for foreign students need to be cautious about their health. Authority should motivate students to take their meals on time and to exercise regularly as well.

**6. LIMITATIONS OF THE STUDY**

The major limitation of the study was the sample size. Due to the COVID-19 pandemic, we had to limit data and blood sample collection. Cluster-based equal number of samples could be solidified our results. As the youngsters were the subject and for the time constrain, we could not have many demographic, physiological, health, habit, and lifestyle related questions in our questionnaire. A bigger sample size and more variables could strengthen our findings. There are also limitations, in fund accusation. However, despite all limitations we are thankful to all who helped and supported us to complete the experiments.

**DISCLAIMER**

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

**CONSENT**

Each participant was informed about the aim and objectives of the research and written consent was taken from all participants.

**ETHICAL APPROVAL**

It is not applicable.
COMPEting Interests

Authors have declared that no competing interests exist.

References

1. Tsuda M, Asaka M, Kato M, Matsushima R, Fujimori K, Akino K, Kikuchi S, Lin Y, Sakamoto N. Effect on Helicobacter pylori eradication therapy against gastric cancer in Japan. Helicobacter. 2017;22(5):e12415.

2. Fashner J, Gitu AC. Diagnosis and treatment of peptic ulcer disease and H. pylori infection. American family physician. 2015;91(4):236-42.

3. Seo M, Okada M, Shirotani T, Nishimura H, Maeda K, Aoyagi K, Sakisaka S. Recurrence of Helicobacter pylori infection and the long-term outcome of peptic ulcer after successful eradication in Japan. Journal of clinical gastroenterology. 2002;34(2):129-34.

4. Shiotani, A. and D.Y. Graham, Pathogenesis and therapy of gastric and duodenal ulcer disease. Med Clin North Am. 2002;86(6):1447-66, viii.

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

6. Hosking SW, et al. Duodenal ulcer healing by eradication of Helicobacter pylori without anti-acid treatment: randomised controlled trial. Lancet. 1994;343(8896):508-10.

7. Khamraev AA, Rustamova MT, Khairullaeva SS. [State of mucosal barrier of the stomach after Helicobacter pylori eradication and ulcer healing in patients with duodenal ulcer disease]. Eksp Klin Gastroenterol. 2013;(12):24-6.

8. Suriani R, et al. Type III intestinal metaplasia, Helicobacter pylori infection and gastric carcinoma risk index in an Italian series of 1750 patients. Hepatogastroenterology. 2005;52(61):285-8.

9. Zhu Y, et al. Risk Factors and Prevalence of Helicobacter pylori Infection in Persistent High Incidence Area of Gastric Carcinoma in Yangzhang City. Gastroenterol Res Pract. 2014; 2014:481385.

10. Cheng Y, et al. Prognostic significance of helicobacter pylori-infection in gastric diffuse large B-cell lymphoma. BMC Cancer. 2019;19(1):842.

11. Ishikura N. et al. Helicobacter pylori (HP) infection alone, but not HP-induced atrophic gastritis, increases the risk of gastric lymphoma: a case-control study in Japan. Ann Hematol. 2019;98(8):1981-1987.

12. Kalin-Hajdu E, et al. Helicobacter pylori Infection of the Gastric Mucosa and Ocular Adnexa-Lack of Association With Ocular Adnexal Lymphoma. Ophthalimic Plast Reconstr Surg. 2021;37(3S):S1-S5.

13. Zhang J. et al. Transcriptome hallmarks in Helicobacter pylori infection influence gastric cancer and MALT lymphoma. Epigenomics. 2020;12(8):661-671.

14. Aziz RK. water as a source of H. pylori infection: A review. Journal of Advanced Research. 2015;6(4):539-547.

15. Lacy BE, Rosemore J. Helicobacter pylori: ulcers and more: the beginning of an era. J Nutr. 2001;131(10):2789S-2793S.

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

17. Perez-Perez GI, Rothenbacher D, Brenner H. Epidemiology of Helicobacter pylori infection. Helicobacter. 2004;9 Suppl 1:1-6.

18. Sjomina O. et al. Epidemiology of Helicobacter pylori infection. Helicobacter. 2018;23 Suppl 1:e12514.

19. Kotilea K, Bontems P, Touati E. Epidemiology, Diagnosis and Risk Factors of Helicobacter pylori Infection. Adv Exp Med Biol. 2019;1149:17-33.

20. Leja M, et al. Review: Epidemiology of Helicobacter pylori infection. Helicobacter. 2019;24 Suppl 1:e12635.

21. Tseng FC, et al. Polymorphisms in cytokine genes and risk of Helicobacter pylori infection among Jamaican children. Helicobacter. 2006;11(5):425-30.

22. Brown LM, et al. Helicobacter pylori infection in rural China: demographic, lifestyle and environmental factors. Int J Epidemiol. 2002;31(3):638-45.

23. Fox JG, et al. High prevalence and persistence of cytotoxin-positive Helicobacter pylori strains in a population with high prevalence of atrophic gastritis. Am J Gastroenterol. 1992;87(11):1554-60.

24. Ahmad MM, et al. Prevalence of Helicobacter pylori in asymptomatic population—a pilot serological study in Bangladesh. J Epidemiol, 1997;7(4):251-4.
25. Ahmed MMS, Masum A, M AS. Mohiuddin HA, Rahman M, A Declining Prevalence of Helicobacter Pylori Infection- A 13C Urea Breath Test (UBT) Based Study in Symptomatic. Anwer Khan Modern Medical College Journal. 2019;10(2): 121-124.

26. Naja F, Kreiger N, Sullivan T. Helicobacter pylori infection in Ontario: prevalence and risk factors. Can J Gastroenterol. 2007;21(8):501-6.

27. Graham DY, et al. Epidemiology of Helicobacter pylori in an asymptomatic population in the United States. Effect of age, race, and socioeconomic status. Gastroenterology. 1991;100(6):1495-501.

28. Lim SL, et al. Irregular Meal Timing Is Associated with Helicobacter pylori Infection and Gastritis. ISRN Nutr, 2013. 2013:714970.

29. Yoon H, Kim N. Diagnosis and management of high risk group for gastric cancer. Gut Liver. 2015;9(1):5-17.

30. Fock KM, et al. Second Asia-Pacific Consensus Guidelines for Helicobacter pylori infection. J Gastroenterol Hepatol. 2009;24(10):1587-600.

31. Jemal A, et al. Global cancer statistics. CA Cancer J Clin. 2011;61(2): 69-90.

32. Cheng Y, et al. Physical activity and peptic ulcers. Does physical activity reduce the risk of developing peptic ulcers? West J Med. 2000;173(2):101-7.

33. Huerta JM, et al. Prospective study of physical activity and risk of primary adenocarcinomas of the oesophagus and stomach in the EPIC (European Prospective Investigation into Cancer and nutrition) cohort. Cancer Causes Control. 2010;21(5):657-69.

34. Campbell PT, Sloan M, Kreiger N, Physical activity and stomach cancer risk: the influence of intensity and timing during the lifetime. Eur J Cancer. 2007;43(3):593-600.

35. Hooi JKY, et al. Global Prevalence of Helicobacter pylori Infection: Systematic Review and Meta-Analysis. Gastroenterology. 2017;153(2):420-429.

36. Assaad S. et al. Dietary habits and Helicobacter pylori infection: a cross sectional study at a Lebanese hospital. BMC Gastroenterol. 2018;18(1): 48.

37. Zhang F. et al. Prevalence and associated risk factors of Helicobacter pylori infection in the Wuwei cohort of north-western China. Trop Med Int Health. 2021;26(3):290-300.

38. Fraser, A.G., et al., Prevalence of Helicobacter pylori infection in different ethnic groups in New Zealand children and adults. Aust N Z J Med. 1996;26(5): 646-51.

39. Ritchie H, Roser M. Sanitation. 2021 [Cited 2021 04 July]; Available:https://ourworldindata.org/sanitati on.

40. EPI. Sanitation & Drinking Water (Environment Performance Index). 2020 [Cited 2021 04 July]; Available: https://epi.yale.edu/epi-results/2020/component/h2o.

41. van Duynhoven, Y.T. and R. de Jonge, Transmission of Helicobacter pylori: a role for food? Bull World Health Organ. 2001;79(5):455-60.

42. Verdalet-Olmedo M. et al. Omission of breakfast and risk of gastric cancer in Mexico. World J Gastrointest Oncol. 2012;4(11):223-9.

43. Mukojima K. et al. Protective effects of free radical scavenger edible batanin against xanthine oxidase-mediated increase in epidermal permeability increases in human intestinal epithelial cell monolayer. J Burn Care Res. 2009;30(2):335-40.

44. Hussen BM, et al. The prevalence of Helicobacter pylori among university students in Iraq. Indian Journal of Science and Technology. 2009;1(6): 5019-23.

45. Feyisa ZT, Woldeamanuel BT. Prevalence and associated risk factors of gastritis among patients visiting Saint Paul Hospital Millennium Medical College, Addis Ababa, Ethiopia. PLoS One. 2021;16(2): e0246619.

© 2022 Ferdous et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/84335