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Science**



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Dietary Habits and *Helicobacter pylori* Infection among Bahraini Adults

**A Thesis Submitted in Partial Fulfilment of the Requirements
for the Degree of M.Sc. in Nutrition and Dietetics**

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Abstract

Helicobacter pylori (*H. Pylori*) infection is the main bacterial cause of several gastrointestinal disorders. Studies on the prevalence and predisposing factors of *H. pylori* infection on different populations and geographical areas are reporting conflicting results. This study aims to estimate the prevalence of *H. pylori* infection in a population of symptomatic adults seeking care at tertiary level in the Kingdom of Bahrain and examine the association between dietary habits and other factors with *H. pylori* infection. The study is a hospital-based retrospective, cross-sectional analytical study combining data from medical records for *H. pylori* status, other comorbidities, and biochemical parameters with sociodemographic, lifestyle and dietary habits information using a telephone interview. The study was conducted on 200 patients between January and September 2021. A validated food frequency questionnaire was used to collect information about dietary habits. Binary logistic regression was applied to test the association between *H. pylori* infection with sociodemographic, lifestyle, dietary habits, and other health-related factors. The prevalence of *H. pylori* infection among the studied group was 55.5%. *H. pylori* infection was significantly higher among participants with a high school education or less (44.1%). Among dietary habits, the mean of frequency of green tea, coffee and honey intake was significantly lower among the *H. pylori* infected participants compared to their non-infected counterparts. Vitamin D level was significantly lower among participants with *H. pylori* infection and each unit decrease in serum vitamin D was associated with an increased risk of *H. pylori* infection by 1.1 time (OR = 1.1; 95% CI:1.05, 1.18; $p < 0.001$). The study concluded that educational level, consumption of honey, green tea and coffee, and serum vitamin D level were significantly associated with *H. pylori* infection. Additional studies are needed to estimate the prevalence and predisposing factors of *H. pylori* infection in the general population.

Dedication

This thesis is dedicated to my parents, for their unconditional care, love, support and believing in me.

To my loving and supporting husband, who always sees the unseen potentials in me. To my son and daughter, who were highly understanding that beside being their mother, I have other roles in life including being a continuous learner and a researcher.

To my siblings, who are supportive and see me as a role model.

Finally, this work is dedicated to my beloved country Bahrain, for empowering and enabling women to achieve their dreams.

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List of Abbreviations:

BMI	Body Mass Index
BP	Blood Pressure
CagA	Gene A
CVD	Cardiovascular Vascular Disease
FBS	Fasting Blood Sugar
FFQ	Food Frequency Questionnaire
GE	Gastroenterology
GI	Gastrointestinal
<i>H. pylori</i>	<i>Helicobacter pylori</i>
HbA1c	Glycated hemoglobin
HDL	High Density Lipoprotein
LDL	Low Density Lipoprotein
MALT	Mucosa-associated lymphoid tissue
MENA	Middle East and North Africa
Tele-interview	Telephone Interview
TG	Triglycerides
T2D	Type 2 Diabetes

Chapter One

Introduction to the Study

- 1.1 Introduction
- 1.2 Research Problem
- 1.3 Research Questions
- 1.4 Research Objectives
- 1.5 Research Significance
- 1.6 The Study's Setting
- 1.7 Research Terminologies

1.1 Introduction

Helicobacter pylori (*H. pylori*) is a gram-negative spiral shaped bacterium, which colonize and grow in human gastric epithelial tissue and mucosa (Hooi et al., 2017). More than 50% of the global population are infected by *H. pylori* especially in developing countries and among populations with low socioeconomic status (Mitchell & Katelaris, 2016). Studies suggest that transmissions occur mainly during childhood through direct contact with family members. *H. pylori* is usually transmitted through the feco-oral route due to ingestion of contaminated water or food, but it can be transmitted through direct contact with saliva and vomitus (Amaral et al., 2017; Diaconu, Predescu, Moldoveanu, Pop, & Fierbințeanu-Braticevici, 2017). The microorganism was classified as group 1 carcinogen (International Agency for Research on Cancer, 1994) and it causes various upper gastrointestinal (GI) disorders including gastritis, gastroduodenal ulcer diseases and gastric adenocarcinoma (Moss, 2017). The later was recognized to be the fourth-leading cause of cancer-related deaths worldwide in 2020 (Sung et al., 2021).

Acquisition and various disease outcomes of *H. pylori* infection are intermediated by complex interactions between bacterial virulence factors, host, and environmental factors (Kao, Sheu, & Wu, 2016). There is a high level of disparity in *H. pylori* genetic recombination and these genetic differences might exist even in *H. pylori* colonizing the same patient. Host genetic background

might contribute to protect from infection with *H. pylori* infection (Capparelli & Iannelli, 2021). Some of the factors that were associated with *H. pylori* infection include age, gender, ethnicity, educational level, and household income (Assaad, Chaaban, Tannous, & Costanian, 2018). Furthermore, crowding index, living standards which includes sanitation and hygiene, and source of drinking water have all been shown to be associated with *H. pylori* infection (Krueger, Hilborn, Converse, & Wade, 2015). Results of the relationship between smoking and alcohol consumption and *H. pylori* infection in previous studies are conflicting (Mhaskar et al., 2013; Murray, McCRUM, Evans, & Bamford, 1997; Ogiyara et al., 2000; Ozaydin, Turkeyilmaz, & Cali, 2013).

Over the past years, epidemiological studies have found that diet plays a significant role in the development of *H. pylori* infection and investigated the association between the intake of certain foods and /or nutrients and the development of such infection (Eslami, Shahraki, Shahraki, & Ansari, 2017; Monno et al., 2019; Shu, Zheng, Zhang, & Feng, 2019). However, in reality people do not consume food groups or nutrients in isolation, but rather in combination. For this reason, examining dietary pattern has emerged as a complementary approach to assess the relationship between diet and health outcomes in nutritional epidemiological studies (Shu et al., 2019). Some studies have reported that salty, pickled, fermented, or smoked foods increased the risk of *H. pylori* infection (Fox et al., 1999;

Tsugane, Tei, Takahashi, Watanabe, & Sugano, 1994). On the other hand, other studies have shown that antioxidant-rich fruits and vegetables were protective against *H. pylori* infection (Hwang, Dwyer, & Russell, 1994; Jarosz et al., 2009; Shinchii, Ishii, Imanishi, & Kono, 1997). Moreover, it was reported that lower intakes of raw vegetables were significantly associated with a higher risk of *H. pylori* infection (Eslami et al., 2017). Similarly, meat consumption and consumption of restaurant food were associated with increased risk of *H. pylori* infection, while chili pepper intake was shown to have a protective effect (Eslami et al., 2017; Mhaskar et al., 2013).

Risk factors associated with *H. pylori* infection, especially lifestyle and dietary habits, have not been thoroughly investigated in Bahrain. Given the high burden of *H. pylori* infection in developing countries and the high prevalence of modifiable cardio-metabolic risk factors in the Middle East and North Africa (MENA) region, including the Kingdom of Bahrain specifically, a study investigating the relationship between dietary habits and *H. pylori* infection is warranted.

1.2 Research Problem

H. pylori infection is the most prevalent chronic gastric infection worldwide especially in developing countries. The microorganism is the first identified bacterial carcinogen which is responsible for various upper GI disorders including gastritis,

gastro-duodenal ulcer diseases and gastric cancer. The latter is known to be the fourth cause of cancer related deaths worldwide. Epidemiological studies have reported an association between sociodemographic factors and lifestyle factors, dietary habits, anthropometric measurements, and biochemical markers with *H. pylori* infection in various contexts. However, to date there are no studies in the Kingdom of Bahrain regarding the association between these factors and *H. pylori* infection.

1.3 Research Questions

The following questions have arisen when reviewing the literature and examining the previous studies.

1. What is the prevalence of *H. pylori* infection in a population of Bahraini adults?
2. What are the sociodemographic characteristics associated with *H. Pylori* infection?
3. What are the lifestyle factors associated with *H. Pylori* infection?
4. What are the dietary habits associated with *H. pylori* infection?
5. What is the relationship between specific medical conditions, blood pressure (BP), body mass index (BMI) and biochemical markers (lipid profile, fasting blood sugar (FBS), glycated hemoglobin (HbA1c), and vitamin D levels) with *H. pylori* infection?

1.4 Research Objectives

This study was conducted to fulfill the following objectives:

1. To estimate the prevalence of *H. pylori* infection in a population of symptomatic Bahraini adults seeking care at tertiary level.
2. To investigate the relationship between several sociodemographic characteristics and *H. pylori* infection.
3. To assess the relationship between several lifestyle factors (smoking, alcohol consumption, physical activity, sleeping hours and perceived stress) and *H. pylori* infection.
4. To investigate the association between dietary habits and *H. pylori* infection.
5. To evaluate the relationship between *H. pylori* infection and several medical conditions, BP, BMI and biochemical measurements.

1.5 Research Significance

H. Pylori infection is the main bacterial cause of several preventable GI disorders. Infection with *H. pylori* was established to be a risk factor for gastric cancer, the fourth-leading cause of cancer-related deaths worldwide in 2020 (Sung et al., 2021). Eradication of *H. pylori* using the traditional method is increasingly difficult due to antibiotic-resistant strains and poor patient compliance. In addition, the cost associated with *H. pylori* eradication might limit the access to treatment especially

in settings with low socioeconomic status and might create a financial burden on health care systems. Results of previous studies conducted in different cultural backgrounds have revealed an association between some of the sociodemographic characteristics, lifestyle factors and dietary habits with of *H. pylori* infection (Altheeb AlKalbani et al., 2016; Assaad et al., 2018; Eslami et al., 2017; Fox et al., 1999; Hwang et al., 1994; Shinchu et al., 1997; Tsugane et al., 1994). Therefore, data acquisition on *H. pylori* infection prevalence and identification of the subpopulation groups most at risk will support the establishment of national health policies, guidelines, and dietary recommendations to prevent *H. pylori* infection and its related problems. Integrating diet as part of the prevention and management plan of *H. pylori* infection might be convenient in terms of cost, tolerability, and cultural acceptability.

Until now and to the best of our knowledge, no studies in the Kingdom of Bahrain have investigated the correlation between predisposing factors including dietary patterns and *H. pylori* infection.

1.6 The Study's Setting

Participants were recruited from follow-up patients at the gastroenterology (GE) unit in King Hamad University Hospital (KHUH) in Muharaq, Kingdom of Bahrain. The GI unit provides outpatient, inpatient and endoscopy services as elective and emergency for patients with a range of GI conditions.

1.7 Research Terminologies

- **Dietary habits:** The habitual decisions of individuals or group of people regarding what foods they eat (Preedy & Watson, 2010)
- ***Helicobacter Pylori (H. pylori)*:** A gram negative, spiral shaped bacterium which has two to six flagella that enable it to move and resist gastric contractions and penetrate gastric mucosa (Brown, 2000). *H. pylori* is transmitted from person-to-person either by the oral-oral route (through vomitus and saliva) or the fecal-oral route (through consumption of contaminated food or water). *H. pylori* express a variety of virulence factors that enables it to survive the hostile acidic gastric conditions (Kao et al., 2016). It is the first formally recognized bacterial carcinogen that is linked with gastritis, gastroduodenal ulcer disease, gastric adenocarcinoma and low-grade gastric mucosa associated lymphoid tissue (MALT) lymphoma (Ahn & Lee, 2015).

- **Sociodemographic factors:** Includes independent variables as age, sex, educational level, marital status, occupation, monthly income, and number of people living in the household and the number of rooms to estimate the crowding index.
- **Lifestyle factors:** Includes independent variables such as smoking status, alcohol consumption, self-perception of level of stress, total number of hours slept per day and physical activity.
- **Food frequency questionnaire (FFQ):** Food frequency questionnaire (FFQ) is a type of dietary assessment tool that consists of a context specific foods and beverages list with response categories to indicate usual frequency of consumption over a specific period. To assess the dietary patterns, the number of foods and beverages in such a tool typically ranges from 80 to 120 (INDDEX project, 2018). The FFQ is an acceptable valid and reliable tool for assessing dietary intake to understand the relationship between consumption patterns and health outcomes in large epidemiological studies (Collins et al., 2014; Gosadi et al., 2017; Marventano et al., 2016; Zang et al., 2019; Zang et al., 2019).
- **Body Mass Index (BMI):** A value obtained from the weight (mass) and height of a person. The BMI is defined as the body weight in kilograms divided by the square of the body height in meters, and it is expressed in units of kg/m^2 . It is used as a reliable indicator of body

fatness for most people and to screen for weight categories that could lead to health problems (Bipembi, Panford, J. K., & Appiah, 2015).

- **Biochemical measurements:** Any biochemical compound in the body such as an antigen, antibody, enzyme, or hormone or others that is altered in disease condition and used in diagnosis or in evaluation of predisposition to the disease or its outcome (Debnath, Prasad, & Bisen, 2010).

Chapter Two

Theoretical Framework and Literature Review

2.1 Microbiological Characteristics of *H. pylori*

2.2 Transmission of *H. pylori* Infection

2.3 Clinical Impact of *H. pylori* Infection

2.4 *H. pylori* Diagnosis and Treatment

2.5 Prevalence of *H. pylori* Infection

2.6 Association between *H. pylori* and Sociodemographic Factors

2.7 Association between *H. pylori* and Lifestyle Factors

2.8 Food Frequency Questionnaire

2.9. Association between *H. pylori* and Dietary Habits

2.10 Association between *H. pylori* infection and Some Medical Conditions and Anthropometric Measurements and Biochemical Markers

2.11 Hypothesis

H. pylori infection is a public health problem responsible for various upper GI disorders including gastritis, gastro-duodenal ulcer diseases and gastric cancer. The latter is known to be the fourth-leading cause of cancer-related deaths worldwide in 2020 (Sung et al., 2021). Treatment of *H. pylori* infection using the traditional method is increasingly difficult due to antibiotic-resistant strains and poor patient compliance (Chey et al., 2017; Fallone et al., 2016). The prevalence of *H. pylori* infection varies between different countries due to several contributing factors including cultural variation and differences in lifestyle, living standards and dietary patterns (Mitchell & Katelaris, 2016).

This chapter provides a theoretical overview about *H. pylori* infection, the prevalence of *H. pylori* infection and other possible factors investigated in previous studies for their possible association with *H. pylori* infection. The emphasis will largely be on sociodemographic factors, lifestyle, and dietary habits and their relationship with *H. pylori* infection. Finally, findings from recent studies on biochemical markers and their relationship with *H. pylori* infection will be highlighted in this review.

2.1 Microbiological Characteristics of *H. pylori*

H. pylori was first isolated and described by Warren and Marshall in 1983 (Warren & Marshall, 1983). It is a spiral shaped, gram-negative bacterium which has two to six flagella that enable it to move and resist gastric contractions and penetrate gastric mucosa (Brown, 2000). *H. pylori* express a variety of virulence factors that enables it to survive in the hostile acidic gastric conditions partly owing to its high urease activity which converts the urea present in gastric juice to alkaline ammonia and carbon dioxide thereby neutralizing the acidic gastric environment to colonize and persist in the gastric lumen (Kao et al., 2016). *H. pylori* exhibits flagella-mediated motility to move toward gastric epithelium cells and releases several proteins/toxins that cause gastric host tissue damage, including cytotoxin-associated gene A (CagA), and vacuolating cytotoxin A. The host immune response is activated through the secretion of cytokines by the gastric epithelial cells, which all play a role in the clinical outcome of gastric and extragastric diseases (Kao et al., 2016). There are 20 different strains of *H. pylori* that have been identified and implicated in many human diseases (Agbor et al., 2018; Gunaletchumy et al., 2014).

2.2 Transmission of *H. pylori* Infection

Epidemiological studies of *H. pylori* indicate that the bacteria is predominantly transmitted from person-to-person by the fecal–oral and the oral–oral routes. However, the results are conflicting with regards to understanding pathogen transmission and the influence of environmental factors (Krueger et al., 2015). Acquisition rates during early childhood (under the of age 10 years) was reported to be high in developing countries, which may be attributed to low socioeconomic status, overcrowding and poor sanitation (Hooi et al., 2017).

2.3 Clinical Impact of *H. pylori* Infection

H. pylori infection is strongly associated with a group of gastric diseases such as chronic gastritis, peptic ulcer, mucosa-associated lymphoid tissue (MALT) lymphoma, non-Hodgkin's lymphoma, and gastric adenocarcinoma (Shiota et al., 2012; Watari et al., 2014). Majority of infected individuals remain asymptomatic, with only about 20% of those infected developing severe disease outcomes (Shiota et al., 2012). Most infected individuals will develop gastric chronic inflammation (gastritis) to some extent (Tohidpour, 2016). *H. pylori* gastritis is usually associated with upper GI symptoms, mainly dyspepsia. Peptic ulcer is defined as a break in the mucosa lining of the stomach or proximal intestine (Graham, 2014). It is characterized by chronic, periodic epigastric abdominal pain that is usually

relieved by eating food or taking antacids, but might be complicated with hemorrhage and perforation (Graham, 2014). Although around 10% of *H. pylori* infected individuals will develop peptic ulcer disease, 40%-75% of peptic ulcer disease cases were attributed to *H. pylori* infection (Zhang, R., Duan, Fan, & Chen, 2016; Watari et al., 2014). Similarly, while only 1-3% of *H. pylori* infected individuals will develop gastric cancer, more than 90% of gastric cancer patients have existing or past *H. pylori* infection (Gunathilake et al., 2018; Uemura et al., 2001; Watari et al., 2014; Zhang et al., 2016). An estimated 952,000 new cases of gastric cancer diagnosed annually with 780,000 cases of cancer being attributed to *H. pylori* infection, thus corresponding to 6.2% of the total cancer cases worldwide (Ferlay et al., 2015; Plummer, Franceschi, Vignat, Forman, & de Martel, 2015). Several interacting factors are involved in the risk of developing gastric adenocarcinoma, including bacterial virulence and genetic stereotype, host genetics, dietary factors, and the GI microbiota (Mitchell & Katelaris, 2016). *H. pylori* infection is strongly associated with the initiation and progression of gastric cancer and gastric lymphoma (Nagai & Kim, 2017). Yassibas et al. (2012) reported that *H. pylori* infection prevalence was 81.3% in patients with gastric adenocarcinoma. A meta-analysis of seven randomized studies, indicated that the treatment of *H. pylori* could reduce the risk of gastric cancer [from 1.7% to 1.1%; relative risk (RR): 0.65; 95% CI: 0.43–0.98] (Fuccio et al., 2009). *H. pylori* infection related morbidities and mortalities including gastric adenocarcinoma

requires public health attention and intervention (Tohidpour, 2016).

2.4 *H. pylori* Diagnosis and Treatment

Several methods are available to detect *H. pylori* infection, but the gold standard for epidemiological studies remains controversial (Miftahussurur & Yamaoka, 2016). Fiber optic upper GI endoscopy is a direct method for testing *H. pylori* infection, which involves obtaining gastric biopsies taken from the stomach (Miftahussurur & Yamaoka, 2016; Mitchell & Katelaris, 2016). Diagnostic methods used to detect *H. pylori* using biopsies specimen, includes histopathology and/or immunohistochemistry, rapid urease test and culture (Atkinson & Braden, 2016). On the other hand, indirect methods to detect *H. pylori* include antibody-based tests (serology and urine test), urea breath test (UBT), and stool antigen test (SAT) (Atkinson & Braden, 2016). Both UBT and SAT are preferred to determine active infection with a diagnostic accuracy of more than 95% (Stenström, Mendis, & Marshall, 2008). Several antibody-based serology tests are widely available, characterized by a sensitivity ranging between 76-84% and specificity between 79-90%. A serology positive test may indicate previous rather than current infection (Lee, J. Y. & Kim, 2015). The choice of diagnostic method of *H. pylori* infection mainly depends on the clinical context. For patients younger than 45 years old with uncomplicated upper GI symptoms, the non-invasive method of

UBT or SAT, is appropriate (Stenström et al., 2008). Non-invasive tests involve less cost and resources and provide excellent accuracy. Nonetheless, endoscopy with testing of gastric biopsy specimens is preferred where alarming symptoms are present, or failure of eradication therapy exist (Atkinson & Braden, 2016).

Treatment is offered to all patients with active infection and a positive test of *H. pylori*. Eradication of *H. pylori* usually implies the use of different combinations of antibiotics and proton pump inhibitor that inhibit gastric parietal cells acid secretion (Chey, Leontiadis, Howden, & Moss, 2017). The decision of therapy option is based on local antibiotic usage and availability, documented antibiotic resistance and previous modality of treatment in previous attempts of eradication (Chey et al., 2017). First line therapy that is mostly used is proton pump inhibitor (PPI) triple therapies (a PPI plus two of the following antibiotics: clarithromycin, amoxicillin, or metronidazole) for 7 to 10 days. This modality is becoming increasingly ineffective, with some studies reporting eradication in less than 50% of cases (Fallon et al., 2016). Other regimens for *H. pylori* eradication involve concomitant, sequential or hybrid regimens combine these three drugs with a nitroimidazole or other agents with the increase in duration of therapy to 10-14 days (Gasparetto, Pescarin, & Guariso, 2012). Nevertheless, the increasing prevalence of antibiotic-resistant strains of *H. pylori* and suboptimal patient compliance has led to reduced success with traditional *H. pylori*

treatment regimens. In a systematic review and metanalysis, Zhang et al. (2016) showed that adding probiotics to the standard *H. pylori* eradication therapy was associated with an increase in *H. pylori* eradication rate, and a reduction in side effects, but did not improve patient compliance.

2.5 Prevalence of *H. pylori* Infection

2.5.1 *H. pylori* Prevalence in General Population Worldwide

H. pylori infection is estimated to affect more than 50% of the worldwide population (Zabala Torres et al., 2017). The prevalence of *H. pylori* infection might reach more than 90 % in developing countries, compared to 35% percent or less in developed countries (Zabala Torres et al., 2017). Furthermore, there is a marked variation in the prevalence of *H. pylori* infection in different geographic areas, age groups, ethnicities, and socioeconomic levels (Brown, 2000; Khalifa, Mohammed Mahdy, Sharaf, & Aziz, 2010) with rates increasing as the socioeconomic status of the region decreases (Nagy et al., 2016). According to a recent systematic review and meta-analysis, *H. pylori* infection prevalence among the general population in different regions around the world was as follows: Northern America 28.5%, Europe 35.3%, Asia 44.7 %, Oceania 47.7 %, Africa 56.7% and Latin America and the Caribbean 59.3% (Zamani et al., 2018).

The highest prevalence was reported in Latin America countries (79.4%) (Porras et al., 2013), whereas the lowest prevalence was reported in the US (30.7%) (Grad, Lipsitch, & Aiello, 2012). In Australia the prevalence was also low (32%) (Robertson, Cade, Savoia, & Clancy, 2003). In Europe, there was a wide variation in the prevalence of *H. pylori*, where it was lower in Northern countries compared to Southern and Eastern countries (Eusebi et al., 2014). While in Yogyakarta in Indonesia, one of the lowest incidences worldwide for gastric cancer, *H. pylori* prevalence reported to be only 4.5% among participants recruited from the general population (Tokudome et al., 2005). A decreasing trend of *H. pylori* infection was observed in a cross-sectional nationwide multi-center study conducted in Korea. *H. pylori* seroprevalence was estimated to be 54.4% in 2011, which is significantly lower than the seroprevalence of 59.6% in 2005 and that of 66.9% in 1998 (Lim et al., 2013). Lim et al. (2013) suggested changes in human host factors as well as socioeconomic and hygienic factors as possible causes. In South Africa, one of the regions with high *H. pylori* infection, the prevalence was 86.6% (Dube et al., 2009). The prevalence of *H. pylori* infection was 51% in India in a case control study that was conducted to explore the association between peptic ulcer and *H. pylori* infection among adults (Mhaskar et al., 2013).

2.5.2 *H. pylori* Prevalence in Symptomatic Patients

In Oman, a pilot cross-sectional study was conducted on 100 dyspeptic adult patients revealed *H. pylori* prevalence of 41% (Altheeb AlKalbani, FT, Al-Hinai, & AlMuniri, 2016). In a cross-sectional study conducted in Lebanon on 294 patients who were recruited from GE unit in a tertiary hospital in which *H. pylori* status was determined after histopathological assessment of gastric biopsies, *H. pylori* infection prevalence was 52.4% (Assaad et al., 2018). A study conducted in Jazan Province in Saudi Arabia on 404 dyspeptic patients who were evaluated with gastric biopsies obtained through upper GI endoscopy found that *H. pylori* prevalence was 46.5% (Akeel et al., 2018).

Some studies conducted in symptomatic patients in the MENA region including Iran, Egypt, and Turkey reported infection rates that reached to 86.8% in Iran (Khedmat et al., 2013). The prevalence of *H. pylori* among subjects with dyspepsia in United States, Brazil and China was 28.9%, 57%, and 84% respectively (Akeel et al., 2018).

In a recent retrospective study involving 942 patients to evaluate the prevalence of *H. pylori* infection in Bahrain, it was revealed that the overall prevalence of *H. pylori* in patients with dyspepsia diagnosed with gastric biopsies histology and UBT was 59.4% (Alshaikh, Ahmed Al Sharakhat, Toorani, Farid, & Abdulla, 2021).

2.5.3 *H. pylori* Prevalence Trend over Time

H. Pylori infection is acquired in developed countries at a constant rate of 2-6% per year with a prevalence ranging from 20-40% in adults. While in developing countries, where the infection is acquired mainly during early childhood, higher rates are observed, with 70-90% of the population estimated to be infected by the age of 20 (Thong-Ngam, Mahachai, & Kullavanijaya, 2007). In a systematic review by Nagy et al. (2016), a significant decrease in the prevalence of *H. pylori* infection in China was reported which is most likely due to increasing urbanization and improvement in life standards. Similarly, in Japan Ueda et al. (2014) indicated that the prevalence of *H. pylori* infection tends to increase with age and exhibits geographic variation with a significant decrease in the prevalence of *H. Pylori* infection among younger Japanese adults. In Rwanda Walker et al. (2014) found that the overall prevalence of *H. pylori* infection was 75.3%, which is similar to what was previously reported in the same country by Rouvroy et al. (1987).

2.6 Association between *H. pylori* and Sociodemographic Factors

2.6.1 Age and Gender

Sociodemographic factors reported as risk factors for *H. pylori* infection included age, gender, educational level, and income (Abebaw et al. 2014; Lee, Y. Y. et al., 2012; Lim et al., 2013; Ozaydin et al., 2013; Shu et al., 2019; Xia et al., 2016; Zaterka et al., 2007). In a study conducted on 993 blood donors in Brazil, the prevalence of *H. pylori* infection was slightly higher in males blood donors (66.5% in males vs 63.2% in females) and the prevalence increased with advanced age, regardless of gender (Zaterka, Eisig, Chinzon, & Rothstein, 2007). In a case control study conducted on 161 participants in Malaysia, the percentage of men was slightly higher among cases in comparison to control group (65 vs 49%, $P = 0.056$) (Lee, Y. Y. et al., 2012). In a cross-sectional study that included 209 dyspeptic patients in Ethiopia, *H. pylori* infection prevalence increased with age (Abebaw et al. 2014). Similarly, male gender and advanced age were significantly related to *H. pylori* infection in China, Korea, and Turkey (Lim et al., 2013; Ozaydin et al., 2013; Shu et al., 2019; Xia et al., 2016). On the contrary, gender and age were not related to the risk of infection in other studies conducted from India, Oman, and Lebanon (Altheeb AlKalbani et al., 2016; Assaad et al., 2018; Mhaskar et al., 2013).

2.6.2 Employment and Household Income

A retrospective cohort study conducted in Italy to evaluate the association between *H. pylori* with dietary habits and socioeconomic conditions, found no association between *H. pylori* infection and type of employment (Monno et al., 2019). Moreover, Lower income was associated with a higher risk of *H. pylori* infection in several studies (Lim et al., 2013; Mhaskar et al., 2013; Shu et al., 2019; Yassibas et al., 2012; Zaterka et al., 2007). A prospective study Korean on 970 patients to evaluate reinfection rate of *H. pylori*, revealed that low income is one of the factors that determined the reinfection (Kim, M. S. et al., 2013). There was no association between *H. pylori* infection and income in other studies (Altheeb AlKalbani et al., 2016)

2.6.3 Educational Level

Participants with higher educational level were less likely to have *H. pylori* infection in studies conducted in Korea and Turkey (Lim et al., 2013; Ozaydin et al., 2013). Similarly, a cross-sectional study conducted on 10407 participants in China, reported that participants with *H. pylori* infection tend to have a lower educational level (Xia et al., 2016). In contrast Assaad et al. (2018), found that *H. pylori* infection risk was higher among Lebanese participants with a university degree or higher (OR=2.74). There was no clear correlation between income and

educational level with *H. pylori* infection in Oman (Altheeb AlKalbani et al., 2016). Similarly, a prospective study conducted on 516 participants in Pakistan revealed no association between *H. pylori* infection and educational level and family income (Faisal, Tanvir, & Rakhshanda, 2012).

2.6.4 Household Crowding

Overcrowding may facilitate transmission of *H. pylori* infection among family members and those sharing the household (Brown, 2000). In a randomized clinical trial conducted to investigate the potential determinants of *H. pylori* infection among adults in six Latin American countries, crowding (more than two persons sharing a bedroom) (OR 1.8: 1.3–2.3) was associated with *H. pylori* infection (Porrás et al., 2013). Similarly, Ali et al. (2017) in a study conducted in Pakistan have identified that participants who shared a room with three or more occupants were nearly 3 times more at risk of *H. pylori* infection compared to participants who share the room with less than three persons.

2.7 Association between *H. pylori* and Lifestyle Factors

2.7.1 Smoking and Alcohol Intake

Although the association between *H. pylori* infection and lifestyle is unclear, economic conditions might contribute strongly in the individual populations (Valliani et al., 2013). Prolonged exposure to nicotine, might contribute to gastric

mucosal chronic inflammation which facilitate the colonization of *H. pylori* (Li et al., 2014). Smoking has been associated with increased risk and persistence of *H. pylori* infection and lower eradication rates (Ferro et al., 2019). Studies on the relationship between *H. pylori* infection and smoking resulted in conflicted findings. In a cross-sectional study conducted by Murry et al. (1997) on 4742 randomly selected individuals in Northern Ireland aged between 12-64 years, revealed that *H. pylori* infection is significantly more common among current smokers of 20 or more cigarettes per day (OR=1.33) and ex-smokers (OR=1.22) compared with non-smokers. Similarly, Mhaskar et al. (2013) reported that tobacco smokers were more likely to be infected with *H. pylori* compared to non-tobacco smokers. In addition, Ozaydin et al. (2013) reported that regular Turkish male smokers were at higher risk of *H. pylori* infection than non-smokers, but there was no association between smoking and the risk of infection among females. Moreover, Shu et al. (2019) revealed that the percentage of current smokers and ex-smokers was higher among Chinese participants with *H. pylori* infection (19.6% and 5.9%) compared to the non-infected participants (16.6% and 4.7%). In contrast, a study conducted on 540 healthy participants aged 18-82 years in Turkey, reported that *H. pylori* infection was detected more in non-smokers (54.3%), compared to smoker participants (41.6%) (Kanbay, Gür, Arslan, Yilmaz, & Boyacioğlu, 2005). While a recent pooled analysis study aimed to evaluate the relationship between *H. pylori* infection and smoking comprising 14, 244 cases and 33, 932 controls,

revealed no association between smoking and *H. pylori* infection (Ferro et al., 2019). Furthermore, other studies reported no significant association between smoking and *H. pylori* infection (Altheeb AlKalbani et al., 2016; Assaad et al., 2018; Khalifa et al., 2014; Valliani et al., 2013). Despite several studies indicating a positive association between smoking and *H. pylori* infection, findings regarding such association are still inconsistent.

When it comes to alcohol consumption and *H. pylori* infection, the results are inconsistent. A study conducted in Germany between 1997 and 1999 on 6545 subjects, revealed that *H. pylori* infection was lower among subjects consuming 25–50 g alcohol/day (35.2%) compared to those who reported drinking no alcohol (49.3%). This association was recognized for different alcoholic beverages and there was an inverse relationship between the frequency of alcohol consumption and *H. pylori* infection (Kuepper-Nybelin, Thefeld, Rothenbacher, & Brenner, 2005). Similarly, in another German study, there was a statistically significant inverse association between participants who consumed either moderate (OR= 0.73) or high (OR= 0.72) amounts of alcohol and the risk of *H. pylori* infection (Wawro et al., 2019). In Turkey, Ozaydin et al. (2013) reported that participants who never drink alcohol, those who used to drink in the past and the occasional drinkers had a higher risk for *H. pylori* infection compared to regular alcohol consumers and concluded that regular alcohol consumption was protective for *H. pylori* infection. On the other hand, a study conducted in Australia on

328 participants between 2001-2004 revealed that participants who consume alcohol were at almost 9-times at risk (OR = 9.05, 95% CI: 1.05–77.98) of *H. pylori* infection compared to those who did not consume alcohol. The type of alcohol beverage and amount were also associated with *H. pylori* infection. *H. pylori* infection risk increase with consumption of wine and spirits compared to beer and with the amount of alcohol consumed ($P = 0.014$) (Zhang, L. et al., 2010). Similarly, in a cross-sectional study conducted in Ethiopia, alcohol consumers had a 2.72 (95% CI = 1.3-5.6) higher chance of *H. pylori* infection compared to those who did not consume alcohol (Abebaw, Kibret, & Abera, 2014). Xia et al. (2016) in a study conducted in China reported also that *H. pylori* infection was more prevalent among participants who drink alcohol everyday ($P < 0.01$). Another study conducted in China by Wang et al. (2019) reported that the prevalence of active *H. pylori* infection was higher among participants who consumed alcohol compared to non-drinkers ($P = 0.0207$). Several studies reported that there is no clear association between alcohol consumption and *H. pylori* infection (Altheeb AlKalbani et al., 2016; Assaad et al., 2018; Mhaskar et al., 2013; Zaterka et al., 2007).

2.7.2 Physical Activity

Although physical activity has several health benefits, evidence for the protective role of physical activity against the *H. pylori* infection and gastric cancer is not yet well established. In a meta-analysis that pooled 1,535,006 individuals and 7944 cases of

gastric cancer, found a modest protective association between sufficient physical activity and gastric cancer, which was not affected by *H. pylori* status (Abioye, Odesanya, Abioye, & Ibrahim, 2015). In Korea, Gunathilake et al. (2018) conducted a cross-sectional study to evaluate the associations between physical activity and gastric cancer risk by *H. pylori* infection status, which included 415 gastric cancer patients and 830 controls. It was found that *H. pylori* infected subjects who participated in regular exercise had significantly a lower risk of gastric cancer (OR = 0.52). Xia et al. (2016) in China reported that, participants with *H. pylori* infection had higher BMI ($P < 0.0001$) and higher physical activity ($P = 0.01$).

2.7.3 Sleep and Psychological Factors

H. pylori infection might be the underlying factor involved in some sleep disturbances, cognitive impairment, and perceived stress. Some studies reported an association between obstructive sleep apnea and *H. pylori* infection (Gültepe, Günbatar, & Dülger, 2014; Kountouras, C. et al., 2017; Kountouras, J., Polyzos, & Deretzi, 2015). Bacterial infections including *H. pylori* might affect sleep process, which may result in higher arousal index, sleep fragmentation, and decrease in sleep efficiency. Patients might be affected by having chronic fatigue, daytime sleepiness, narcolepsy, and insomnia (Ibarra-Coronado et al., 2015). Emotional factors and psychological stress induce alteration in gastric acid secretion and changes in gastric motility. Mental stress is associated with an increased prevalence of peptic

ulcer in patients with or without *H. pylori* infection (Deding et al., 2016). In a prospective population-based Danish study involving 3379 individuals to assess the relationship between psychological stress and peptic ulcers, ulcer incidence was significantly higher among subjects with highest stress scores compared to those with lower stress score (adjusted OR 2.2; 95% confidence interval [CI], 1.2–3.9; $P < .01$). Stress effect was similar on ulcers associated with *H. pylori* infection and those unrelated to *H. pylori* (Levenstein, Rosenstock, Jacobsen, & Jorgensen, 2015). On the other hand, in an observational cross-sectional study conducted on 975 Japanese adults, *H. pylori* infected subjects with atrophic gastritis showed a higher risk of psychological distress (OR, 16.4; 95% CI, 3.45-94.9) and depression (OR, 2.86; 95% CI, 1.31-6.05), compared to subjects who were not diagnosed of *H. pylori* infection and atrophic gastritis (Takeoka et al., 2017).

2.8 Association between *H. pylori* and Dietary Habits

Several studies worldwide have investigated the relationship between diet and *H. pylori* infection. Diet contains many substances that might exhibit potent antibacterial activity against *H. pylori*. In addition, diet may constitute of harmful agents that contribute to *H. pylori* pathogenicity and outcome (Hołubiuk & Imiela, 2016).

2.8.1 Consumption of Fruits and Vegetables

Several studies have reported a significant relationship between the consumption of fruits and vegetables and *H. pylori* infection (Akyön, 2002; Eslami et al., 2017; Jarosz et al., 2009; Mard et al., 2014; Mhaskar et al., 2013; Shu et al., 2019; Yassibas et al., 2012). Jarosz et al. (2009) in a study conducted in Poland found that consumption of vegetables, and fruits was significantly lower in subjects with *H. pylori* infection compared to controls. In a study conducted by Yassibas et al. (2012) in Turkey to evaluate the effect of dietary habits and lifestyle factors on the risk of gastric cancer, found that factors associated with lower risk of gastric cancer were consumption of green vegetables (ORs = 0.569), onion (ORs = 0.092), garlic (ORs = 0.795) and dried fruits (ORs = 0.041) (Yassibas et al., 2012). In India, Mhaskar et al. (2013) have revealed that chili peppers consumption (OR: 0.20) was protective against *H. pylori* infection. In another study that evaluated the difference in dietary habits among Iranian patients infected with *H. pylori* (n= 160)

and subjects without the infection (n= 214), found that *H. pylori* infected participants had significantly lower weekly consumption of tomatoes, onions, green pepper, apple, and citrus fruits (Mard et al., 2014). Another study in Iran conducted by Eslami et al. (2017) to evaluate the association between *H. Pylori* infection with metabolic syndrome and dietary habits among medical undergraduate students, found that low consumption of raw vegetables was significantly associated with higher odds of *H. pylori* infection (OR=3.74). In a cross-sectional study that evaluated the relationship between dietary patterns and *H. pylori* infection among Chinese adult who were between 45 and 59 years, Shu et al. (2019) reported that “grains-vegetables” dietary pattern was associated with a decreased risk of *H. pylori* infection (OR=0.82). Fruit and vegetables a rich source of antioxidant nutrients, especially vitamin C, vitamin E and carotenoids which play role in decreasing susceptibility to infections (Akyön, 2002). *In vivo* and *in vitro* experimental studies have shown that vitamin C and astaxanthin, a carotenoid, does not only have an antioxidant effect by scavenging free radicals, but also antimicrobial activity against *H. pylori* (Akyön, 2002).

2.8.2 Salt Intake

The effects of high-salt diet on *H. pylori* infection and gastric cancer have been investigated in several studies (Caston et al., 2019; Gaddy et al., 2013; Voss et al., 2015). Yassibas *et al.* in a study conducted in Turkey, reported that frequent consumption

of salty dishes (ORs = 3.686), very salty foods like pickles (ORs=7.784), soup mixes (ORs=5.264), sausages (ORs= 3.148) and adding salt without tasting (OR = 4.198) were associated with increased risk of gastric cancer (Yassibas et al., 2012). Similarly, in Iran Mard *et al.* reported that food rich in salt, sugar, and saturated fat, which includes sausages, hamburgers and mayonnaise, were associated with an increased risk of *H. pylori* infection (Mard et al., 2014). Xia et al. (2016), found that Chinese participants who were infected with *H. pylori* had higher intake of salt. Similarly, Shu et al. reported that “high-salt” pattern was associated with an increased risk of *H. pylori* infection (Shu et al., 2019).

2.8.3 Consumption of Meat and Fish

Red and processed meat consumption usually result in an oxidative stress (Van Hecke, Van Camp, & De Smet, 2017). *H. pylori*-infected individuals have alterations in the gastric secretions, characterized by a decreased level of important antioxidants including vitamin C and mucins (glycosylated proteins), and increased levels of inflammatory markers (Van Hecke et al., 2017). Mhaskar *et al.* has identified meat consumption (OR: 2.35) to be one of the risk factors for *H. pylori* infection (Mhaskar et al., 2013). While in China, Xia *et al.* reported that diet rich in animal foods and seafood was associated with a lower prevalence of *H. pylori* infection (Xia et al., 2016). On the other hand, in an Iranian study, fish consumption was significantly negatively correlated with risk of *H. pylori*

infection (Mard et al., 2014). Lee et al. (2012) revealed that consumption of local anchovy sauce was protective against *H. pylori* infection in Malaysia (OR: 0.09). A retrospective case control study conducted in Italy that included 201 *H. pylori* positive patients and 259 *H. pylori* negative subjects, found no significant association between meat and fish consumption with *H. pylori* infection (Monno et al., 2019).

2.8.4 Consumption of Carbohydrate and Grains

It has been postulated that high consumption of carbohydrate will lead to an elevation in blood sugar levels and lowers gastric pH (Sohouli et al., 2021). It will also alter the secretion of mucus and the gastric mucosa, which are protective factors against pathogenic microorganisms including *H. pylori*, this might result in facilitating the colonization of *H. pylori* (Sohouli et al., 2021).

A cross-sectional study was conducted. to evaluate dietary habits and *H. pylori* infection in Khuzestan province in Iran, found that *H. pylori* infection was positively associated with excessive carbohydrate intake ($P=0.02$) (Mard et al., 2014). In China Xia et al. (2016) revealed that there is a positive association between the dietary pattern rich in carbohydrates and sweets characterized with high consumption of candied fruits, cakes, and sugared beverages and the prevalence of *H. pylori* infection. Another cross-sectional study conducted in China to evaluate the relationship between dietary patterns and *H. pylori* infection concluded that the “grains-vegetables” dietary pattern, which is rich in whole-grains, roots and tubers, vegetables, mushrooms,

bean, vegetable oils, nuts, and seeds, was significantly associated with a lower risk for *H. pylori* infection (Shu et al., 2019). A case-control study was conducted in Iran investigated the relationships between carbohydrate consumption, glycemic load, glycemic index, and the risk of *H. pylori* infection, revealed that high consumption of dietary carbohydrates, a high glycemic load and a high glycemic index, significantly elevates the risk of *H. pylori* infection. In addition, the quantity of refined-grain products and bread consumed had a significant positive relationship with *H. pylori* infection (Sohouli et al., 2021).

2.8.5 Consumption of Honey, Tea, and Probiotics

Some dietary substances have anti-*H. pylori* activities and can alter the rate of the infection as well as the infection outcome. Favorable dietary substances include probiotics, green/black tea, and honey. Green tea has been shown to exhibit antibacterial activity to inhibit the growth of *H. pylori* and gastric mucosal inflammation if consumed before being infected with *H. pylori* (Stoicov, Saffari, & Houghton, 2009). Similarly, honey with its low pH, high osmolarity and hydrogen peroxide content is considered to exhibit a potent antibacterial activity. Some types of honeys, such as Manuka, Mountain, South African and oak tree honeys, exhibit anti-*H. pylori* effect *in vitro* by suppressing urease activity (Hołubiuk & Imiela, 2016; Ndip et al., 2007). Lactobacilli are a major component in yoghurt, which was found to have anti-bacterial activity by blocking colonization and inhibiting the adhesion of *H. pylori* to the gastric epithelial cells

(Vuyst et al., 2004). In Malaysia, Lee et al. (2012) found that frequent consumption of tea was inversely associated with *H. pylori* infection risk (OR: 0.023). In a study conducted in Bulgaria to assess dietary habits of 150 dyspeptic patients, honey intake at least once a week (OR: 0.38) and green/black tea consumption for at least a day or more a week (OR: 0.45) were significantly associated with lower prevalence of *H. pylori* infection (Boyanova et al., 2015). A study conducted to investigate the relationship between fermented and unfermented dairy product intake and *H. pylori* infection in a Mexican population, revealed that eating one serving or more of yogurt per week had a protective effect against *H. pylori* (OR: 0.57, 95% CI: 0.35–0.94) (Ornelas, Galvan-Potrillo, & López-Carrillo, 2007). In a case control study from Poland that evaluated the relationship between some dietary factors and *H. pylori* infection, found that *H. pylori* infected individuals were consuming less frequently fermented dairy products compared to non-infected group (Jarosz et al., 2009). Similarly, Mard *et al.* revealed a significant negative correlation between a daily intake of honey and *H. pylori* infection (Mard et al., 2014). In a study conducted to assess the relationship between some dietary factors and *H. pylori* infection and strains virulence, revealed a reverse association between intake of honey and yogurt for 5 days or more a week and the prevalence and virulence of the *H. pylori* infection (Honey OR: 0.68, yogurt OR: 0.56) (Yordanov et al., 2017). While other studies did not reveal any association between honey, fermented dairy products and tea with *H. pylori*

infection (Altheeb AlKalbani et al., 2016; Assaad et al., 2018; Monno et al., 2019).

2.8.6 Consumption of Oils

Several studies have evaluated the antibacterial activity of olive oil (Castro et al., 2012; Mard et al., 2014). Phenolic compounds in virgin olive oil have shown antibacterial activity *in vitro* specifically against *H. pylori* (Medina, Brenes, Garcia, Romero, & de Castro, 2009). For example, Castro et al. (2012) revealed that administration of virgin olive oil showed moderate effectiveness in eradicating *H. pylori*. Mard et al. found a significant negative correlation between daily olive oil consumption and *H. pylori* infection (Mard et al., 2014).

2.8.7 Consumption of Coffee

Findings on the relationship of coffee consumption and *H. pylori* infection are inconsistent. For instance, coffee consumption was found to exacerbate *H. pylori* related gastritis symptoms among Ethiopian students (Alebie & Kaba, 2016). A retrospective study conducted in Italy to evaluate the association between dietary factors and *H. pylori* infection showed that the frequent consumption of coffee increases the *H. pylori* infection rate (Monno et al., 2019). In contrast, other studies did not find an association between coffee consumption and *H. pylori* infection

risk (Ali et al., 2017; Altheeb AlKalbani et al., 2016; Assaad et al., 2018).

2.8.8 Consumption of Soft Drinks

The association between soft drink consumption and *H. pylori* infection remains controversial. While the mechanism remains unclear, high soft drink consumption may prolong periods of gastric acidification, which accelerates *H. pylori* infection, colonization, and invasion (Shu et al., 2019). Mard et al., reported that there is a positive significant correlation between soft drink consumption and *H. pylori* infection (Mard et al., 2014). Similarly, AlKalbani et al. from Oman revealed in their study to evaluate relationship between diet and *H. pylori* infection that 71% of those who consume soft drinks in daily basis or nearly daily basis had *H. pylori* positive (Altheeb AlKalbani et al., 2016). In Portugal, Amaral et al. (2017) conducted a study to investigate factors related to the prevalence of *H. pylori* infection, it was found that the prevalence of *H. pylori* was higher in individuals who reported consuming soft drinks (OR = 1.33). On the other hand, other studies did not reveal this association (Alsaimary et al., 2014; Assaad et al., 2018; Shu et al., 2019).

2.8.9 Consumption of Food Not Prepared at Home

Contaminated foods and water have an important role in transmission of *H. pylori* to humans. *H. pylori* transmission through feco-oral routes was suggested to be one of the methods of *H. pylori* transmission (Krueger et al., 2015). It was also hypothesized that water plays a role as an environmental reservoir and as a medium in the fecal-oral transmission of *H. pylori* infection (Stefano et al., 2018). Mhaskar et al. (2013) identified frequent consumption of restaurant food to be a risk factor for *H. pylori* infection (OR: 3.77). In a case control study conducted in Pakistan to identify factors associated with *H. pylori* infection, participants who ate from restaurants had 9.596 higher risk of infection compared to subjects who ate homemade food (Ali et al., 2017).

The relationship of other dietary habits was evaluated in relation to *H. pylori* infection. Yassibis *et al.*, in a case control study to evaluate the effect of dietary habits and lifestyle factors on the risk of gastric cancer reported that frequent consumption of foods at hot temperature (OR:3.273), eating fast (OR: 5.399) and adding salt without tasting (OR: 4.198) were associated significantly with increased gastric cancer risk (Yassibas et al., 2012). While Assaad *et al.* in their study to evaluate dietary habits association with *H. pylori* infection, revealed no relationship was found between meal temperature and food consumption speed with *H. pylori* infection (Assaad et al., 2018).

2.8.10 Source of Drinking Water in Childhood

Source of drinking water in childhood was evaluated as potential risk factors of *H. pylori* infection. An increased risk of *H. pylori* infection is associated with non-treated water consumption such as well water and tap water in some countries (Sjomina, Pavlova, Niv, & Leja, 2018). Mhaskar et al. reported that individuals drinking nonfiltered or nonboiled water were at higher risk of *H. pylori* infection (OR: 1.05) (Mhaskar et al., 2013). In Brazil, a cross-sectional study revealed that city drinking water (OR: 2.6) was a risk factor for *H. pylori* infection (Basílio et al., 2018). Some studies postulated a possible effect of the drinking water pH on human health and suggested that alkaline-reduced water could have a therapeutic effect on GI diseases including *H. pylori* induced gastritis. However, there is only limited scientific evidence to support this assumption ((Bajgai et al., 2022; Chaves et al., 2020).

2.9 Association between *H. pylori* infection and Medical Conditions

In addition to *H. pylori* being associated with GI disorders, it has also been linked to various extra-gastric disorders, such as cardiovascular diseases (CVD), metabolic diseases, autoimmune thyroid disease, hepatobiliary disease, and blood disorders (He, Yang, & Lu, 2014). *H. pylori* infection triggers immune response and provokes systemic inflammation by producing inflammatory markers, including C-reactive protein (CRP), interleukin-1(IL-1), interleukin-6 (IL-6), interleukin-8 (IL-8) and tumor necrosis factor- α (TNF- α) (Buzás, 2014). *H. pylori* induced gastritis can possibly affect the secretion of gastric related hormones such as gastrin, somatostatin, as well as ghrelin and leptin, which may have an influence in the predisposition to diabetes (He et al., 2014). There is growing evidence between the *H. pylori* related chronic inflammation, immune response, the alteration in secretion of gastric-related hormones, and insulin resistance and deficiency implicated in the predisposition to diabetes and other metabolic related abnormalities (He et al., 2014).

2.9.1 Association between *H. pylori* and Diabetes Mellitus

Type 2 diabetes (T2D) is a metabolic disorder characterized by high levels of blood glucose levels resulting from insulin resistance and partial insulin deficiency (Leahy, 2005). It is a serious emerging public health pandemic that results in

significant number of morbidities and mortalities annually (Bhutani & Bhutani, 2014). The pathophysiology of T2D is complex and many factors might contribute, such as genetic predisposition and lifestyle factors (Leahy, 2005). Emerging data indicates a strong relationship between *H. pylori* infection and the incidence of T2D. Diabetic patients were identified to be susceptible to infections. Owing to several factors such as impaired immunity, reduced gastric motility and acid secretion and changes in the gastric mucosa due to alteration in glucose metabolism, all of which facilitate pathogen colonization (Borody, Ren, Pang, & Clancy, 2002; Jeon et al., 2012). The relationship between *H. pylori* infection and diabetes continues to be controversial, some studies revealed a higher prevalence of infection in diabetic patients (Bener et al., 2007; Devrajani, Shah, Soomro, & Devrajani, 2010), others report no difference (Anastasios et al., 2002). In a case-control study, *H. pylori* was identified in 73% of the diabetic patients compared to only 51.4% of non-diabetic controls (Devrajani et al., 2010). On the other hand, *H. pylori* infection was associated with an increased rate of diabetes in a prospective cohort study of individuals aged 60 years or older. *H. pylori* seropositive participants were 2.7 times more likely at any given time to develop diabetes than seronegative participants (Jeon et al., 2012). A meta-analysis conducted by Chen *et al.* which involved 4401 diabetic participants, revealed that HbA1c levels were elevated in type 1 and type 2 diabetic patients with *H. pylori* infection compared to

diabetic patients without the infection (Chen, J., Xing, Zhao, & Ma, 2019).

2.9.2 Association between *H. pylori* and Lipid Profile

It is hypothesized that chronic *H. pylori* infection activates proinflammatory cytokines, which results in an atherogenic lipid profile through various ways such as increasing hepatic fatty acid synthesis, stimulating lipoprotein lipase activity in adipose tissue, and affecting lipolysis (Eslami et al., 2017).

Epidemiological studies have indicated an association between chronic *H. pylori* infection and lipid abnormality (Kim, H. et al., 2011; Nam, Ryu, Park, & Park, 2015). Individuals who tested positive for *H. pylori* have been reported to have higher risk of cardiovascular disease, higher low-density lipoprotein (LDL) and triglycerides (TG) and lower high-density lipoprotein (HDL) concentrations (Sato, Saijo, Yoshioka, & Tsutsui, 2010; Sayilar, Çelik, & Dumlu, 2015). A study conducted in Japan to investigate the relationship between *H. pylori* infection and lipid profile, found that *H. pylori* infection is significantly associated with high LDL cholesterol and low HDL cholesterol in Japanese male subjects (Sato et al., 2010). Kim et al. revealed that *H. pylori* infection was significantly associated with elevation of serum levels of LDL, but no association was found with triglyceride and HDL levels (Kim et al., 2011). In a prospective cohort study on 13,383 healthy participants, Nam *et al.* have reported that current *H. pylori* infection had a positive

association with high LDL, low HDL, and CVD (Nam et al., 2015).

2.9.3 Association between *H. pylori* and Blood Pressure and BMI

The relationship between *H. pylori* infection and BP and BMI is controversial in literature. A multi-centric prospective study conducted by Kopacova et al. (2014), concluded that chronic *H. pylori* infection did not affect BP, body weight and BMI. In Bahrain, a study was conducted to evaluate *H. pylori* prevalence in obese and non-obese patients. The study included 100 non-obese and 100 obese subjects and *H. pylori* status was determined after UGI gastric biopsies testing. *H. pylori* prevalence was 62% in obese subjects, while in non-obese subjects it was only 36% (Hashim, Abualsel, Mostafa, & Obaid, 2015). Zhang et al. revealed that *H. pylori* infection was significantly positively associated with overweight/obesity in a Chinese population in a cross-sectional study conducted on 2,050 healthy participants (Zhang, Y. et al., 2015). In another Chinese retrospective study that 3,039 subjects, *H. pylori* infection was found to be associated with with overweight/ obesity (Xu, Liu, Yuan, Yin, & Lu, 2017). While in a study conducted on 2604 participants in Taiwan, revealed that *H. pylori* infected participants aged less than 50 years, had an odd of nearly 2 time of being obese (OR=1.836) and higher mean BMI values compared to participants without the infection (Chen, L. et al., 2018). Similarly, in a cross-sectional study conducted in Pakistan on 698 participants to

determine *H. pylori* prevalence in relation to BMI, *H. pylori* infection was present in 76% obese participants compared to only 24% of participants with normal BMI ($P < 0.001$) (Siddiqui et al., 2018). There were no significant differences in physical activity level or BMI between the *H. pylori* infected group and non-infected participants in other studies (Assaad et al., 2018; Lim et al., 2013; Murray et al., 1997; Naja, Kreiger, & Sullivan, 2007).

2.9.4 Association between *H. pylori* and Vitamin D

Vitamin D is an immunoregulatory agent, which plays a role in maintaining the level of serum calcium and phosphorus in normal range to maintain variety of metabolic functions, transcription regulation, and bone metabolism (Hosseini-nezhad & Holick, 2013). Vitamin D deficiency is defined as a 25-hydroxyvitamin D (major circulating form of vitamin D) below 20 ng/mL and vitamin D insufficiency as a 25-hydroxyvitamin D of 21–29 ng/mL (Holick et al., 2011). Adequate intake for vitamin D can be met by sufficient sunlight exposure, a vitamin D-rich diet and supplementation (Wacker & Holick, 2013). Evidence from recent literature suggest that vitamin D is essential not only for bone health, but also in reducing several diseases risk including type 1 diabetes, CVD, certain cancers, cognitive decline, and depression (Hosseini-nezhad & Holick, 2013). A meta-analysis conducted by Yang et al. (2019) evaluated the effect of vitamin D on *H. pylori* infection and eradication, reported that vitamin D had a protective effect

against *H. pylori* infection and improved the success rate of *H. pylori* eradication (Yang, He, Li, & Lu, 2019). Moreover, Antico et al. (2012) reported that participants with *H. pylori* autoimmune gastritis had lower vitamin D concentration compared to healthy participants and those with non-specific gastritis. A similar finding was reported by Assaad et al. (2018), where *H. pylori* infection risk was significantly higher among Lebanese participants with vitamin D deficiency (OR=29.14) compared to participants with normal levels of vitamin D. Furthermore, a cross-sectional study conducted in Turkey to evaluate the association between vitamin D deficiency and *H. pylori* infection, revealed that vitamin D deficiency was associated with 3-fold increased odds of *H. pylori* infection (Surmeli et al., 2019). The concentrations of vitamin D in the serum of *H. pylori* infected Chinese participants were similarly significantly lower compared to the non-infected controls (Han et al., 2019).

In conclusion, *H. pylori* is the main bacterial cause of several GI disorders including gastric adenocarcinoma and was linked to a group of extra-gastric disorders including T2D and vitamin D deficiency. Diet and other factors might play a role in acquisition of *H. pylori* infection. Studying *H. pylori* prevalence and investigating predisposing factors that includes dietary habits in our context is crucial to establish national health policies and dietary recommendations to prevent *H. pylori* related problems.

2.10 Hypothesis

The study Hypothesis aims to test the following:

H. pylori infection is determined by the interaction of multiple factors including agent related ones, environmental and host related factors (socio-demographic, lifestyle, dietary habits, and comorbidities) and genetics (Figure 1). The present study mainly focuses on the host related parameters. The hypothesis of this study is that dietary habits are important predictors of *H. pylori* infection.

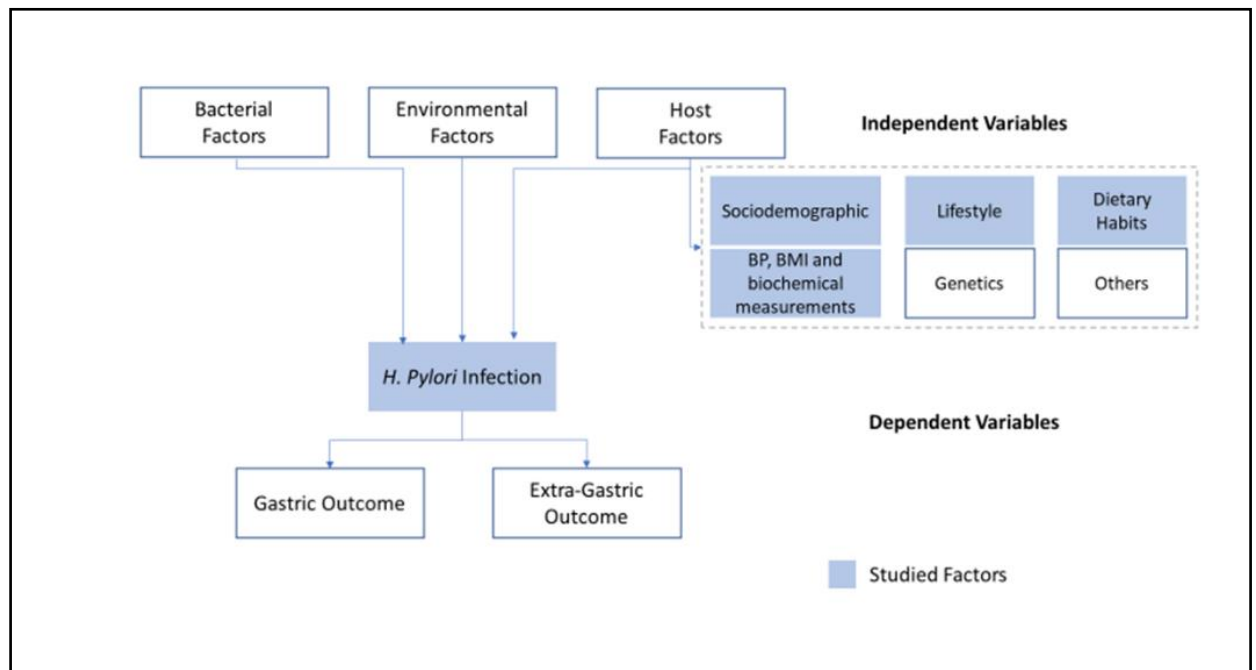


Figure 1: *H. Pylori* Infection Predisposing Factors and Outcomes

Chapter Three

Methodology and Procedures

- 3.1 Methodology
- 3.2 Research Tools
- 3.3 Data Collection/Procedures
- 3.4 Data Entry
- 3.5 Statistical Analysis
- 3.6 Ethical Considerations
- 3.7 The Pilot Study

3.1 Methodology

3.1.1 Study Setting and Duration

This study was conducted at the GE unit in King Hamad University Hospital (KHUH) in Muharraq, Kingdom of Bahrain between the period of January and September 2021. The GE unit in KHUH provides outpatient, inpatient and endoscopy services as elective and emergency for patients with a range of GI conditions.

3.1.2 Study population

Bahraini patients aged 18 years or older who visited the Gastroenterology Unit of KHUH for different GI related problems, in which their *H. pylori* status (positive or negative) was determined by either testing of a gastric biopsy specimens obtained during upper GI tract endoscopy or UBT or both within the past 18 months.

3.1.3 Study Design

This study is a hospital-based retrospective cross-sectional, analytical study combining data from medical records for *H. pylori* status, other comorbidities and biochemical parameters with sociodemographic, lifestyle and dietary habits information using a tele-interview.

3.1.4 Sample size

Sample size was calculated assuming the following parameters: alpha error=0.05, power=80%, expected effect size: odds ratio (OR) =1.4 (for the diet as a risk factor), prevalence of *H. pylori* (outcome) =0.50. A total of 200 patients were included in the study.

3.1.5 Inclusion Criteria

Participants were recruited if they were 18 years or above, Bahraini, following in gastroenterology unit in KHUH and have done *H. pylori* testing within the past 18 months with either upper GI tract endoscopy biopsy testing or UBT, or both. Only asymptomatic patients or who presented with GI symptoms as dyspepsia, heartburn and gastritis related symptoms were included. Patients with an updated medical record within the past 18 months were eligible. The data was retrieved for the past 18 months to ensure reaching the target number of participants, since it was conducted during the COVID-19 pandemic, during which the flow of patients to the hospitals for non-urgent medical problems and investigations was lesser than the pre-pandemic period,.

3.1.6 Exclusion Criteria

Patients were excluded if they had a history and/or documentation of *H. pylori* eradication therapy prior to *H. pylori* testing, or had a previous diagnosis of cancer, CVD, inflammatory diseases such as coeliac disease, inflammatory bowel disease or certain food allergies, or had a history of gastric or intestinal surgery or previous gastric perforation or hemorrhage. Patients who were tested for *H. pylori* status by methods other than upper GI tract endoscopy biopsy testing or UBT were not

included. Women who were currently pregnant or previously pregnant within the past 18 months were excluded, since the dietary habits might be changed during pregnancy.

3.2 Research Tools

A validated structured questionnaire was used as the instrument for data collection, which was structured based on findings in the literature review with cultural adaptation. The questionnaire was developed in English and translated into Arabic and back translated to English by a different person. Both the English and Arabic versions of the questionnaire were finalized and revised by a registered dietician and a public health physician. A piloting phase was conducted with a smaller sample of 10 participants prior to the final use of the instrument.

The questionnaire contains five sections. The sociodemographic section, which includes questions about age, gender, educational level, marital status, employment status, monthly household income, number of household members and number of household rooms; the lifestyle factors to gather information about smoking status, number of cigarettes smoked per day, alcohol consumption, frequency of alcohol consumption, degree of perceived stress on a scale of 1-10, total number of hours slept per night and frequency and duration of physical activity and a medical history section that includes history of any digestive symptom that lasted for more than one month during the past three years which includes indigestion, bloating, epigastric pain, regurgitation, heart burn and others. Assessment of dietary habits and the frequency of consumption of food and beverages items was assessed combining a validated short version FFQ that was used in

previous studies (Assaad et al., 2018; Yassibas et al., 2012), the Bahraini FFQ which is in process of validation, some food and beverages were included based on finding from the literature (honey, green tea, and soft drinks). The frequency of consumption for the past 18 months was assessed through selecting one of five categories “less than once per month/None”, “1-2 times /month”, “1–2 times/week”, “3-4times/week” and “Everyday”. Examples were provided in front of some of the food items to make illustration easier to the interviewer.

The Food frequency questionnaires (FFQ) is a scientific valid tool to provide description of dietary intake and nutritional status as determinants of health in large epidemiological studies (Steinemann et al., 2017). The FFQ is a method used for obtaining dietary data in which a context-specific food list is used to assess the usual diet and recognize the relationship between intake patterns and health outcomes (INDDEX Project, 2018). FFQs are not accurate as other quantitative dietary assessment methods such as 24-hour dietary recalls and weighed food records, because the food quantity is not quantified by using scales or household utensils (INDDEX Project, 2018). The short FFFQ has been shown to be a useful method of evaluating diet and determining variations in diet quality within and across different populations (Cleghorn et al., 2016; Mannato et al., 2015). FFQ was the frequently chosen method to assess dietary habits in majority of studies targeted to assess diet and its association with *H. pylori* infection (Altheeb AlKalbani et al., 2016; Assaad et al., 2018; Eslami et al., 2017; Lee et al., 2012; Mhaskar et al., 2013; Shu et al., 2019; Xia et al., 2016).

Dietary habits questions were also adapted such as type of drinking water during childhood, salt status of the dishes, and consumption of chili pepper and frequency of having meals not prepared at home. The last section involved data collected from the participants' medical records which included documentation of comorbidities as T2D, hypertension and hyperlipidemia, Systolic and diastolic BPs (mmHg), height (cm) and Weight (kg), FBS (mmol/L), HbA1c as a percentage (DCCT unit), Total cholesterol in (mmol/L), LDL (mmol/L), HDL (mmol/L), TG (mmol/L) and vitamin D level (ng/mL). *H. pylori* status (positive vs. negative) was determined upon the result of either UBT, upper GI tract biopsy testing or both, which has been done within the past 18 months. The method used for diagnosis was recorded.

3.3 Data Collection/Procedures

The study is a questionnaire-based telephone interview (tele-interview). A team of five interviewers (physicians) were trained in how to run the interview and ask the questions.

1. An electronic list of potential participants was generated. The electronic list included potential participants' Central Population Registry (CPR) numbers, contact numbers and data retrieved from the medical records including *H. pylori* status. If the biochemical and anthropometric measurements was more than 18 months old or not available, it was recorded as missing.
2. The interviewers referred to the electronic list of patients, prior to the tele-interview. Each participant was interviewed by one interviewer. The interviewer first introduced him/herself,

explained the purpose of the call and the aim of the study, took a verbal consent, and used an electronic semi-structured questionnaire form (google form) to document the consent and collect the required data.

3. After completing the interview by filling all required information, the interviewer would electronically submit the questionnaire (google form).
4. The interviewer would indicate in the electronic list of potential participants whether each patient was contacted and tele-interviewed or not, by highlighting it with a certain color code.
5. All data were collected centrally by the main investigator to ensure confidentiality of information disclosed by the participants.

3.4 Data Entry

Completed questionnaires were submitted electronically immediately following the tele-interviews and documenting medical data obtained from the medical records. The main investigator reviewed the collected data on a weekly basis. After obtaining the required sample, all questionnaires submitted were revised by the main investigator and two of the interviewers to check for any missing data, duplication in entry and any information that need to be verified. The participants were linked to an identifier, CPR number for monitoring purpose only; these identifiers were not used for any other purpose. Each participant was given a code number; the CPR numbers of the participants were not included. Information obtained on anthropometric and biochemical

measurements were recoded as binary (normal level versus not) based on widely known cutoff levels for each parameter. The term above normal BP was defined as having either, a systolic BP ≥ 120 mmHg or a diastolic BP ≥ 80 mmHg, or both. BMI was calculated by dividing the weight (kg) by the square of height (m) and was classified according to the World Health Organization's definition into four categories: underweight (<18.5), normal weight ($18.5\text{--}24.9$), overweight ($25.0\text{--}29.9$) and obese (≥ 30.0). For the biochemical measurements FBS level (above normal ≥ 5.6 mmol/L), HbA1c (above normal $> 5.7\%$), in diabetic patients level of control (uncontrolled if HbA1c $> 7\%$), HDL (below normal <1.5 mmol/L), LDL (above normal >2.6 mmol/L), total cholesterol (above normal > 5.6 mmol/L), TG (above normal >1.7 mmol/L), and vitamin D level (below normal ≤ 30 ng/mL). These cut point values were based on international and national recommendations and were revised by the head of primary healthcare diabetes clinics in the Kingdom of Bahrain (American Diabetes Association, 2021; Arnett et al., 2019; Bakris, Ali, & Parati, 2019; Holick et al., 2011; Jensen et al., 2014). Participants were categorized as having the diagnosis of T2D, hypertension and hyperlipidemia based on the participants responses in the questionnaire and was verified from the medical records. The BP and biochemical measurement values were not used to categorize participants as hypertensive, diabetic or having hyperlipidemia since there is a diagnostic criterion which might include further information or measurements.

3.5 Statistical Analysis

All data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 26 (Chicago, IL, USA) software. Categorical variables were computed as frequencies and percentages, and continuous (numerical) variables were computed as mean and standard deviation. For analysis purpose, some categories in the categorical variables in sociodemographic and lifestyle factors were merged to reduce the low frequencies effect on the power of statistic tests. T-test was used to determine whether there is a significant difference in means between two independent groups if the sample size is greater than 30 in each group. Mann-Whitney test was used to determine whether there is a significant difference in means between two independent groups if the sample size is less than 30 in at least one group. Chi-Square test was used to compare frequency distributions of categorical variables and to determine whether there is a significant relationship. Fisher's exact test was used in 2×2 contingency table to test whether there is a significant relationship between two categorical variables if at least one of the expected values is less than 5. Frequency of food and beverages consumption per week was converted into a numerical scale (less than once per month/None=0, 1-2 times/month=1, 1–2 times/week=2, 3-4times/week=4 and everyday=7). The mean for each item was calculated for *H. pylori* positive and negative groups. Univariate logistic regression was employed to evaluate the crude association between dietary factors and *H. pylori* status. Univariate logistic regression was employed to evaluate the crude association between dietary factors and *H. pylori* status. Binary logistic

regression was used to explore the risk factors that affect the presence of *H. pylori*. Odds ratio (OR) was calculated using 95% confidence interval (CI) and a P-value of ≤ 0.05 was statistically significant in all statistical tests used. The internal consistency reliability using Cronbach's alpha coefficient was used to verify the reliability of the food frequency questionnaire.

3.6 Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Institutional Research Board at KHUH and the Ethics Committee of the Department of Biology, University of Bahrain. A verbal consent was obtained from the participants, and they were informed that the participation is voluntary and refusal to participate would not affect them in any way. Furthermore, all data collected were kept under confidentiality and anonymity and not used for purposes other than those of the present study.

3.7 The Pilot Study

A pilot study was carried out with randomly selected participants to identify problematic questions that might be misleading or does not make sense to participants, or problems within the questionnaire or the process of interview that might lead to biased answers and modify it accordingly. The results of the pilot study are excluded from the final analysis.

Chapter Four

Results, Discussion and Recommendation

4.1 Results

4.2 Discussion

4.3 Strengths and Limitations

4.4 Conclusion

4.5 Recommendations

4.1 Results

4.1.1 *H. pylori* Hospital Based Prevalence

In the present study, 200 participants were recruited. The prevalence of *H. pylori* infection among the study population was 55.5% with (95% CI: 48.7%, 62.3%) (Figure 2: **Prevalence of *H. pylori* Infection among Study Population (n=200)**). *H. pylori* status was determined in majority of the participants by gastric biopsy testing as demonstrated in Table (1).

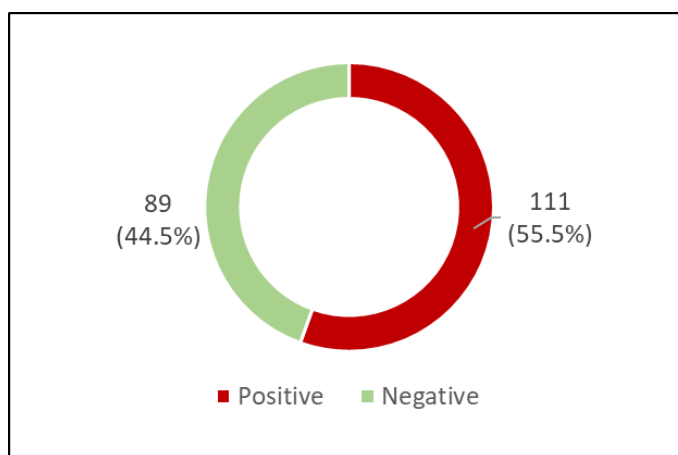


Figure 2: Prevalence of *H. pylori* Infection among Study Population (n=200)

Table (1)

Frequencies and Distribution of *H. pylori* Diagnostic Methods Used

Parameter	n	%
Diagnostic method used		
Urea breath test	71	35.5
Gastric biopsy testing	102	51.0
Both	27	13.5

4.1.2 Sociodemographic Characteristics

Table (2) provides details of the participants' sociodemographic data. The age range was between 18 to 79 years and the mean age of the participants was 51.4 years (95% CI: 49.5-53.3). The predominant age group of the participants was 46 - 60 years old (41.5%) and 29% of the participants were above 60 years. The proportion of females was larger than males (57% vs 43%). Majority of participants were married (80%) with a high school education or less (70.5%). Regarding employment status, nearly a quarter were employed, 35% were retired and 33.5% were homework/housewife, 2% were students and 5% were unemployed. More than half of the participants (60%) had monthly household income between BHD 301 and BHD 900. Participants with monthly household income of less than BHD 300 represented only 13.5% of the total participants, while just over a quarter had a household monthly income over BHD 900 (26.5%). Majority of the participants were living in a household with 4-6 rooms (48.7%) and the mean number of rooms per household for the study sample was 4.5 (standard deviation; SD $\pm$ 2.1). Most of the participants reported that the number of household members living in the same house was between 5-8 members (45%), with the mean number of household members living in the same household for the sample being 5.8 (standard deviation; SD $\pm$ 3.2) members.

Table (2)
Percent Distribution of sociodemographic characteristics of the
participants (n=200)

Sociodemographic characteristics	n	%
Age		
18 - 30 years	17	8.5
31 - 45 years	42	21.0
46 - 60 years	83	41.5
>60 years	58	29.0
Gender		
Male	86	43.0
Female	114	57.0
Marital status		
Single	17	8.5
Married	160	80.0
Divorced	11	5.5
Widowed	12	6.0
Educational level		
Primary school	32	16.0
Intermediate school	23	11.5
High school	86	43.0
College/University	59	29.5
Employment status		
Student	4	2.0
Homemaker/housewife	67	33.5
Employed	49	24.5
Unemployed	10	5.0
Retired	70	35.0
Household income		
BHD 300 or less	27	13.5
BHD 301 - 600	61	30.5
BHD 601 - 900	59	29.5
BHD 900 or more	53	26.5
Number of household members		
1 – 4	79	39.5
5 – 8	90	45.0
8 or more	31	15.5
Number of household rooms		
1 – 3	69	35.0
4 – 6	96	48.7
6 or more	32	16.2

4.1.3 Lifestyle Characteristics

Details about lifestyle characteristics of the participants are presented in Table (3). Most of the participants were non-smokers during the time of the study with 77% having never smoked and 11.5% ex-smokers having quit smoking at least 15 years prior to the study of whom 154 (77%) have not smoked before and 23 (11.5%) were ex-smokers, with the majority of them (66.7%) having smoked for over 15 years. In terms of number of cigarettes smoked per day among the smokers, 17 (37%) of the current smokers smoked around 11-20 cigarettes per day. Only 7 (3.5%) participants reported that they consume alcohol. The mean level of perceived stress for the participants on a scale of one to ten was 5.6 (SD $\pm$ 2.8). The number of participants who perceived low stress (Score <3) was 30 (15%), while 44.5% and 40.5% of the participants had a moderate and high perception of stress, respectively. The mean hours night sleep for the sample was 6.0 (SD $\pm$ 1.6) hours and more than half of the participants (61.5%) slept between 5-7 hours per night for most of the days. Regarding physical activity 82 (41%) of the participants exercise for more than 2 times/week and the majority 104 (83.2%) were exercising for 20 minutes or more per occasion.

Table (3)
Percent Distribution of Lifestyle Characteristics of the
Participants (n= 200)

Lifestyle characteristics	n	%
Smoking status		
Non-smoker	154	77.0
Ex-smoker	23	11.5
Current smoker	23	11.5
Duration since stopping smoking¹		
15 years or less	12	57.1
More than 15 years	9	42.9
Duration of smoking		
15 years or less	7	33.3
More than 15 years	14	66.7
Number of cigarettes smoked/day		
Less than 1 (occasional smoker)	5	10.9
1 – 10	12	26.1
11 – 20	17	37.0
More than 20	12	26.1
Drinking alcohol status		
Yes	7	3.5
No	193	96.5
Frequency of drinking alcohol		
1 time or less monthly	3	42.9
2 - 4 times/month	3	42.9
2 - 3 times/week	1	14.3
Level of perceived stress		
Less than 3 (Low)	30	15.0
3 - 6 (Moderate)	89	44.5
7 - 10 (High)	81	40.5
Number of hours of sleep per night		
Less than 5	39	19.5
5 – 7	123	61.5
More than 7	38	19.0
Number of times/week of being physically active		
None	75	37.5
Less than 1 time per week	22	11.0
1 - 3 times per week	21	10.5
More than 3 times per week	82	41.0
Duration of physical activity		
Less than 20 minutes	21	16.8
20 minutes or more	104	83.2

4.1.4 Dietary Habits

Data related to the participants' frequency of food and beverage consumption is presented in

Table (4). Daily consumption of grains was reported by majority of participants (80%), whereas daily consumption of green vegetables and fruits were reported by more than half the participants (57% and 56.5%, respectively). Similarly, over half of the participants (55.5%) reported to consume fish 1-2 times/week. Red meat consumption was reported to be once or twice a week by half of the participants (50%). Chicken was reported to be consumed for 3-4 times/week by 85 (42.5%) of the participants. Majority of the participants reported the consumption of processed meats including sausage, hot dog and salami to be less than once per month or none (85.5%, 89.5% and 89%, respectively). Hamburger consumption was reported to be less than once per month or never by half of the participants (50.5%). Milk, yogurt and cheese were reported to be consumed everyday by more than 30% of the participants (37.5%, 30.5% and 37%, respectively). Over two-thirds (68%) of the participants reported daily consumption of vegetable oils, while nearly half (49%) of the participants reported butter and ghee consumption as never or rarely. Tea was reported to be consumed daily by 120 (60%) of the participants. On the other hand, green tea was reported to be consumed less than once/month or never by two-thirds (67.5%) of the participants. Coffee was reported to be consumed daily by 34% of the participants and 30% reported that they never consume coffee or consume it less than once per month. Consumption of soft drinks was less than once per month or never in 58.5% of the participants. Honey consumption was reported to be less than once per

month or never by 38% of the participants with only 19% reported consuming honey daily.

Table (4)
Percent Distribution of Frequency of Consumption of Food and Beverage Items

Food	<1 time per month/None	1 - 2 times /month	1 - 2 times /week	3 - 4 times /week	Every Day
	n (%)	n (%)	n (%)	n (%)	n (%)
Grains	4 (2.0)	1 (0.5)	12 (6.0)	23 (11.5)	160 (80.0)
Green vegetable	9 (4.5)	14 (7.0)	33 (16.5)	30 (15.0)	114 (57.0)
Tuberous vegetables	6 (3.0)	18 (9.0)	41 (20.5)	43 (21.5)	92 (46.0)
Fish	16 (8.0)	30 (15.0)	111 (55.5)	39 (19.5)	4 (2.0)
Chicken	8 (4.0)	6 (3.0)	49 (24.5)	85 (42.5)	52 (26.0)
Red meat	34 (17.0)	45 (22.5)	100 (50.0)	19 (9.5)	2 (1.0)
Sausage	171 (85.5)	18 (9.0)	7 (3.5)	4 (2.0)	0 (0.0)
Hot dog	179 (89.5)	16 (8.0)	4 (2.0)	1 (0.5)	0 (0.0)
Salami or ham	178 (89.0)	15 (7.5)	4 (2.0)	2 (1.0)	1 (0.5)
Hamburger	101 (50.5)	56 (28.0)	35 (17.5)	6 (3.0)	2 (1.0)
Milk	50 (25.0)	22 (11.0)	27 (13.5)	26 (13.0)	75 (37.5)
Yogurt	30 (15.0)	24 (12.0)	48 (24.0)	37 (18.5)	61 (30.5)
Salty Cheese	29 (14.5)	18 (9.0)	42 (21.0)	37 (18.5)	74 (37.0)
Fresh Fruits	6 (3.0)	15 (7.5)	36 (18.0)	30 (15.0)	113 (56.5)
Legumes	43 (21.5)	49 (24.5)	76 (38.0)	23 (11.5)	9 (4.5)
Eggs	18 (9.0)	19 (9.5)	82 (41.0)	40 (20.0)	41 (20.5)
Nuts and dried fruits	41 (20.5)	35 (17.5)	51 (25.5)	31 (15.5)	42 (21.0)
Salted fish	151 (75.5)	29 (14.5)	15 (7.5)	4 (2.0)	1 (0.5)
Pickled vegetables	127 (63.5)	28 (14.0)	31 (15.5)	4 (2.0)	10 (5.0)
Onion	28 (14.0)	11 (5.5)	36 (18.0)	29 (14.5)	96 (48.0)
Garlic	43 (21.5)	12 (6.0)	28 (14.0)	30 (15.0)	87 (43.5)
Tomato	20 (10.0)	13 (6.5)	28 (14.0)	30 (15.0)	109 (54.5)
Butter and ghee	98 (49.0)	30 (15.0)	38 (19.0)	17 (8.5)	17 (8.5)
Vegetable oils	7 (3.5)	13 (6.5)	21 (10.5)	23 (11.5)	136 (68.0)
Deserts	40 (20.0)	36 (18.0)	67 (33.5)	12 (6.0)	45 (22.5)
Tea	28 (14.0)	14 (7.0)	24 (12.0)	14 (7.0)	120 (60.0)
Green tea	135 (67.5)	21 (10.5)	22 (11.0)	7 (3.5)	15 (7.5)
Coffee	60 (30.0)	22 (11.0)	37 (18.5)	13 (6.5)	68 (34.0)
Soft drinks	117 (58.5)	24 (12.0)	30 (15.0)	12 (6.0)	17 (8.5)
Honey	76 (38.0)	38 (19.0)	28 (14.0)	20 (10.0)	38 (19.0)

Table (5) shows the percent distribution of other dietary habits. Tap water was the main source of drinking water during childhood for the majority of participants (57.5%). Consumption of chili pepper was reported by 51% of the participants, while 46% reported to consume salty meals and 3.5% reported consumption of highly salty meals. Participants reported consuming their meals very fast and fast were 12.0% and 18.5% respectively. Participants indicating a preference for hot temperature meals were 48%, while 10.5% reported to consume very hot meals. A small percentage of participants (19.5%) reported to consume meals prepared outside home around 3-7 times/week.

Table (5)
Percent Distribution of Participants' Dietary Habits

Dietary factors	n	%
Source of drinking water during childhood		
Tap water	115	57.5
Well water	53	26.5
Filtered or mineral water	32	16.0
Consumption of chili pepper		
Yes	102	51.0
No	98	49.0
Salt status of consumed dishes		
Very salty	7	3.5
Salty	92	46.0
Less salty	92	46.0
Salt free	9	4.5
Speed of meal consumption		
Very fast	24	12.0
Fast	37	18.5
Normal	78	39.0
Slow	61	30.5
Preference of meal temperature		
Cool/warm	83	41.5
Hot	96	48.0
Very hot	21	10.5
Frequency of consuming meals prepared outside home		
<1 time per month/Never	54	27.0
1 - 3 times/month	60	30.0
1 - 2 times per week	47	23.5
3 - 7 times per week	39	19.5

4.1.5 Medical Characteristics of the Participants

The medical characteristics of the participants are shown in Table (6). Upper GI symptoms were reported by two-thirds of the participants (68.5%). Over half of the participants reported having epigastric abdominal pain and regurgitation, (54.7% and 54%, respectively), whereas indigestion, bloating and regurgitations were reported by 13.1%, 44.5% and 40.9%, of the participants respectively. Nearly a quarter (24.1%) reported having other symptoms including anorexia, nausea, diarrhea, constipation, and dysphagia. Three participants (1.5%) self-reported a diagnosis of gastric cancer. Previous history and/or documentation of hypertension, T2D, hyperlipidemia among participants were recorded in 33.5%, 31% and 30% of cases, respectively. There were some missing data related to anthropometric and biochemical measurements retrieved from the medical records. The number of cases with missing data were as follows: weight and height measurements (23), BP (2), cholesterol (102), LDL (103), HDL (103), TG (103), FBS (160), HbA1c (105) and vitamin D (83). Results are presented according to available data for each variable. Just over half of the participants with available anthropometric measurements were obese (52.5%) and 31.6% were overweight. More than three quarter of the participants had above normal BP (76.8%), but only 26.4% had a systolic BP ≥ 140 mmHg or a diastolic pressure ≥ 90 mmHg. Participants with normal cholesterol were 68.4%, while 72.2% had normal TG. On the other hand, more than half of the participants (53.6%) had abnormal LDL and 73.2% had undesirable HDL levels. In

addition, over half the participants had abnormal FBS (55%) and three-quarters (75.8%) had abnormal HbA1c level. Of the participants who were diagnosed to have T2D, 50% had uncontrolled diabetes according to HbA1c levels (Figure 3). Vitamin D was abnormally low in most of the participants (92.3%).

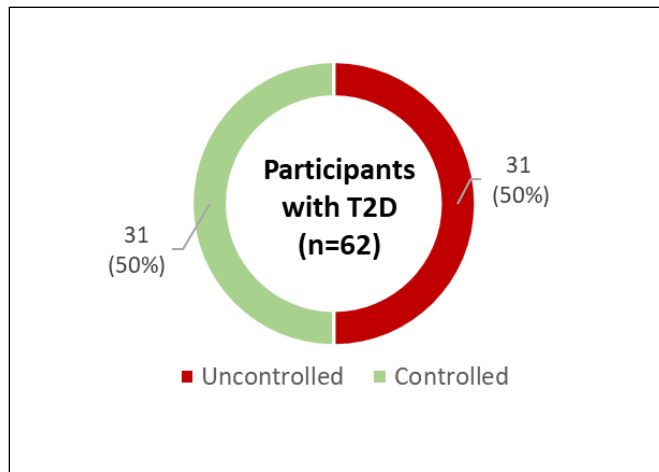


Figure 3: Frequency and percentage of T2D participants according to the level of control (n=62)

Table (6)
Percent Distribution of Medical Characteristics of the
Participants

Medical characteristics	n	%
Upper GI symptoms		
Yes	137	68.5
No	63	31.5
Symptoms		
Indigestion		
Yes	18	13.1
No	119	86.9
Bloating		
Yes	61	44.5
No	76	55.5
Epigastric pain		
Yes	75	54.7
No	62	45.3
Regurgitation		
Yes	74	54.0
No	63	46.0
Heart burn		
Yes	56	40.9
No	81	59.1
Other symptoms		
Yes	33	24.1
No	104	75.9
Self-reported gastric cancer		
Yes	3	1.5
No	197	98.5
Self-reported <i>H. Pylori</i> infection		
Yes	132	66.0
No	68	34.0
History or Documentation of Hypertension		
Yes	67	33.5
No	133	66.5
History or Documentation of Diabetes		
Yes	62	31.0
No	138	69.0
History or documentation of Hyperlipidemia		
Yes	60	30.0
No	140	70.0
BMI¹		
Underweight (< 18.5)	1	0.6

Normal weight (18.5–24.9)	27	15.3
Overweight (25.0–29.9)	56	31.6
Obese (≥ 30.0).	93	52.5
BP²		
Normal	46	23.2
Above normal	152	76.8
Cholesterol³		
Normal (< 5.6 mmol/L)	67	68.4
Above normal (≥ 5.6 mmol/L)	31	31.6
TG⁴		
Normal (< 1.7 mmol/L)	70	72.2
Above normal (≥ 1.7 mmol/L)	27	27.8
LDL⁴		
Normal (<2.6 mmol/L)	45	46.4
Above normal (≥ 2.6 mmol/L)	52	53.6
HDL⁴		
Normal (> 1.5 mmol/L)	26	26.8
Below normal (≤ 1.5 mmol/L)	71	73.2
FBS⁵		
Normal (< 5.6 mmol/L)	18	45.0
Above normal (≥ 5.6 mmol/L)	22	55.0
HbA1c⁶		
Normal (< 5.7%)	23	24.2
Above normal ($\geq 5.7\%$)	72	75.8
Vitamin D⁷		
Normal (> 30 nmol/L)	9	7.7
Below normal (≤ 30 nmol/L)	108	92.3

BMI: Body Mass Index, **TG:** Triglycerides, **HDL:** High Density Lipoprotein., **LDL:** Low Density Lipoprotein, **FBS:** Fasting Blood Sugar, **HbA1:** Glycated hemoglobin

- 1.Number of missing is 23. 2. Number of missing is 3. 3.Number of missing is 102.
4. Number of missing is 103. 5.Number of missing is 160. 6. Number of missing is 105.
7. Number of missing is 83.

4.1.6 Association between Sociodemographic Characteristics and *H. pylori* Status

Table (7) shows the detail regarding the association between sociodemographic characteristics and *H. pylori* status.

H. pylori infection was significantly higher among participants with a high school education or less (60.3% positivity rate) compared to subjects with a college/university degree (44.1% positivity rate) ($P=0.035$) (Figure 4).

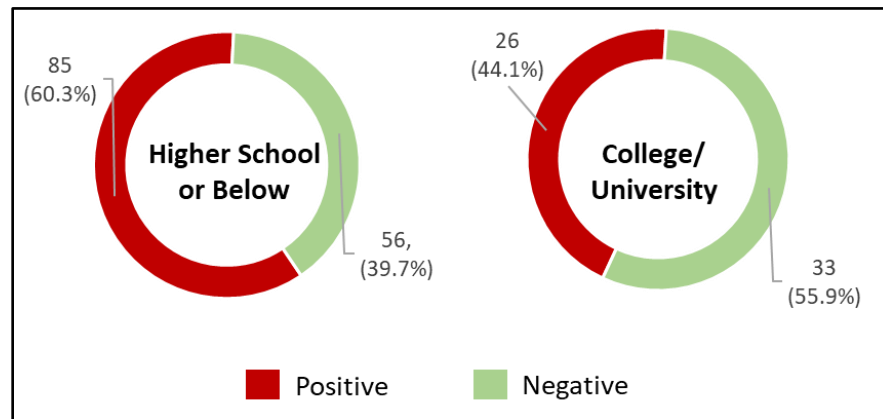


Figure 4: *H. pylori* Positivity Rate in Relation to Educational Level

The prevalence of infection among the retired participants (62.9%) was higher compared to employed (49%) or unemployed (53.1%) participants; however, it was not statically significant. No significant statistical difference was found between *H. pylori* infection and other sociodemographic factors such as gender, age, employment status and household monthly income. *H. pylori* infection rate was higher among participants who shared their household with eight or more other persons (20 out of 31, 64.5% positivity rate) compared to those who shared the household with fewer than 8 members; however the finding was not statistically significant ($p=0.493$).

Table (7)
Association between Sociodemographic Characteristics and *H. pylori* Status

Sociodemographic characteristics	H. pylori status		Chi-Square P-value
	Positive	Negative	
	n (%)	n (%)	
Age			
18 - 30 years	10 (58.8)	7 (41.2)	0.980
31 - 45 years	23 (54.8)	19 (45.2)	
46 - 60 years	45 (54.2)	38 (45.8)	
Older than 60 years	33 (56.9)	25 (43.1)	
Gender			
Male	48 (55.8)	38 (44.2)	0.938
Female	63 (55.3)	51 (44.7)	
Marital status			
Married	88 (55)	72 (45)	0.776
Unmarried	23 (57.5)	17 (42.5)	
Educational level			
High school or below	85 (60.3)	56 (39.7)	0.035
College/University	26 (44.1)	33 (55.9)	
Employment status			
Employed	24 (49)	25 (51)	0.277
Unemployed	43 (53.1)	38 (46.9)	
Retired	44 (62.9)	26 (37.1)	
Household income			
BHD 300 or less	16 (59.3)	11 (40.7)	0.201
BHD 301 – 600	35 (57.4)	26 (42.6)	
BHD 601 – 900	37 (62.7)	22 (37.3)	
BHD 900 or more	23 (43.4)	30 (56.6)	
Number of household members			
1 – 4	44 (55.7)	35 (44.3)	0.493
5 – 8	47 (52.2)	43 (47.8)	
8 or greater	20 (64.5)	11 (35.5)	

Number of household rooms			
1 – 3	37 (53.6)	32 (46.4)	
4 – 6	54 (56.3)	42 (43.8)	0.858
6 or more	19 (59.4)	13 (40.6)	

Data in bold are statistically significant

4.1.7 Association between Lifestyle Factors and *H. pylori* Status

Table (8) shows the differences and association in lifestyle factors between *H. pylori* positive and negative subjects. *H. pylori* infection was more prevalent among smokers (73.9%) compared to non-smokers (53.1%) however the difference was not statistically significant. There was no significant association between *H. pylori* infection with any of the lifestyle factors investigated in this study including alcohol consumption, level of perceived stress, number of hours of sleep per night and frequency and duration of physical activity.

Table (8)
Association between Lifestyle Factors and *H. pylori* Status

Lifestyle characteristics	H. pylori status		Chi-Square P-value
	Positive	Negative	
	n (%)	n (%)	
Smoking status			
Non-smoker	94 (53.1)	83 (46.9)	0.059
Smoker	17 (73.9)	6 (26.1)	
Number of cigarettes smoked/day			
10 or less	8 (47.1)	9 (52.9)	0.560
11 – 20	10 (58.8)	7 (41.2)	
20 or more	8 (66.7)	4 (33.3)	
Level of perceived stress			
Less than 3 (Low)	18 (60)	12 (40)	0.861
3 - 6 (Moderate)	49 (55.1)	40 (44.9)	
7 - 10 (High)	44 (54.3)	37 (45.7)	
Number of hours of sleep per night			
Less than 5 hours	25 (64.1)	14 (35.9)	0.186
5 – 7 hours	62 (50.4)	61 (49.6)	
More than 7 hours	24 (63.2)	14 (36.8)	
Number of times/week of being physically active			
None	42 (56)	33 (44)	0.427
Less than 1 time per week	12 (54.5)	10 (45.5)	
1 - 3 times per week	15 (71.4)	6 (28.6)	
More than 3 times per week	42 (51.2)	40 (48.8)	
Duration of physical activity			
Less than 20 minutes	11 (52.4)	10 (47.6)	0.776
20 minutes or more	58 (55.8)	46 (44.2)	

4.1.8 Association between Frequency of Consumption of Food and Beverage Items and *H. pylori* Status

Table (9) demonstrates the differences and level of association between frequency of consumption of food and beverages in *H. pylori* positive and negative participants. There was a negative relationship between the mean level of green tea ($p=0.012$), honey ($p=0.018$) and coffee consumption ($p=0.007$) with *H. pylori* infection. The mean of frequency of green tea, coffee and honey intake was significantly lower among the *H. pylori* infected participants compared to their non-infected counterparts. There was no significant association between the mean level of frequency of consumption of other food and beverage items and *H. pylori* infection.

Table (9)
Association between the Mean Level of Frequency of
Consumption of Food and Beverage Items and *H. pylori* Status

Food	H. pylori status		Mann-Whitney P-value
	Positive	Negative	
	Mean $\pm$ SD	Mean $\pm$ SD	
Grains	6.3 $\pm$ 1.6	6.0 $\pm$ 1.9	0.374
Green vegetable	4.7 $\pm$ 2.6	5.4 $\pm$ 2.3	0.057
Tuberous vegetables	4.4 $\pm$ 2.5	4.9 $\pm$ 2.3	0.153
Fish	2.2 $\pm$ 1.4	2.2 $\pm$ 1.2	0.746
Chicken	3.9 $\pm$ 2.1	4.3 $\pm$ 2.0	0.166
Red meat	1.6 $\pm$ 1.2	1.8 $\pm$ 1.1	0.139
Sausage	0.3 $\pm$ 0.8	0.2 $\pm$ 0.5	0.740
Hot dog	0.1 $\pm$ 0.5	0.2 $\pm$ 0.5	0.220
Salami or ham	0.1 $\pm$ 0.5	0.3 $\pm$ 0.9	0.134
Hamburger	0.8 $\pm$ 1.1	0.8 $\pm$ 1.2	0.922
Milk	3.3 $\pm$ 2.9	3.8 $\pm$ 3.0	0.263
Yogurt	3.4 $\pm$ 2.7	3.6 $\pm$ 2.6	0.374
Salty Cheese	3.6 $\pm$ 2.7	4.1 $\pm$ 2.7	0.182
Fresh Fruits	4.9 $\pm$ 2.5	5.1 $\pm$ 2.4	0.651
Legumes	1.8 $\pm$ 1.5	1.7 $\pm$ 1.8	0.215
Eggs	3.1 $\pm$ 2.3	3.2 $\pm$ 2.2	0.571
Nuts and dried fruits	2.5 $\pm$ 2.3	3.2 $\pm$ 2.7	0.154
Salted fish	0.3 $\pm$ 0.7	0.6 $\pm$ 1.1	0.130
Pickled vegetables	1.0 $\pm$ 1.9	0.7 $\pm$ 1.3	0.508
Onion	4.4 $\pm$ 2.8	4.4 $\pm$ 2.8	1.000
Garlic	4.0 $\pm$ 2.9	4.0 $\pm$ 3.0	0.926
Tomato	4.8 $\pm$ 2.6	4.7 $\pm$ 2.8	0.828
Butter and ghee	1.4 $\pm$ 2.0	1.6 $\pm$ 2.2	0.377
Vegetable oils	5.4 $\pm$ 2.4	5.6 $\pm$ 2.3	0.561
Deserts	2.7 $\pm$ 2.6	2.7 $\pm$ 2.5	0.835
Tea	4.6 $\pm$ 3.0	5.1 $\pm$ 2.7	0.214
Green tea	0.8 $\pm$ 1.8	1.3 $\pm$ 2.1	0.012
Coffee	2.7 $\pm$ 2.9	3.7 $\pm$ 3.0	0.007
Soft drinks	1.4 $\pm$ 2.2	1.1 $\pm$ 1.8	0.350
Honey	1.8 $\pm$ 2.3	2.8 $\pm$ 2.9	0.018

Data in bold are statistically significant

Table (10) shows that *H. pylori* positivity rate was significantly lower (38.6 %) in green tea consumers ≥ 1 day/week compared with their counterparts (60.3%) ($p=0.0011$). Logistic regression analysis showed a lower risk of *H. pylori* positivity rate in participants who consume green tea ≥ 1 day/week (OR, 0.011; 95% confidence interval [CI], 0.23–0.92). *H. pylori* positivity rate was lower (50%) in coffee consumers ≥ 1 day/week compared with their counterparts (63.4%) and in honey consumers ≥ 1 day/week (48.8%) compared with the other participants (60.5%), but this difference was not statistically significant.

Table (10)
Association between *H. pylori* status and each of Green Tea, Coffee, and Honey Consumption

	H. pylori status		Chi-Square P-value	OR	P-value	95% CI for OR
	Positive	Negative				
	n (%)	n (%)				
Green tea						
<1 day weekly	94 (60.3)	62 (39.7)	0.011	0.46	0.029	(0.23 , 0.92)
≥ 1 day weekly	17 (38.6)	27 (61.4)				
Coffee						
<1 day weekly	52 (63.4)	30 (36.6)	0.060	0.62	0.107	(0.34 , 1.11)
≥ 1 day weekly	59 (50)	59 (50)				
Honey						
<1 day weekly	69 (60.5)	45 (39.5)	0.100	0.65	0.149	(0.37 , 1.17)
≥ 1 day weekly	42 (48.8)	44 (51.2)				

Data in bold are statistically significant

4.1.9 Association between Dietary Habits and *H. pylori* Status

As shown in

Table (11), *H. pylori* infection was more prevalent among participants who consumed well water during childhood as the main source of drinking water (66%), chili peppers (58.8%), salty foods (60.6%) and restaurant meals more than three times a week (59%), however the differences were not statistically significant.

Table (11)
Association between Dietary Habits and *H. pylori* Status

Dietary factors	H. pylori status		Chi-Square P-value
	Positive	Negative	
	n (%)	n (%)	
Source of drinking water during childhood			
Tap water	62 (53.9)	53 (46.1)	0.117
Well water	35 (66)	18 (34)	
Filtered or mineral water	14 (43.8)	18 (56.3)	
Consumption of chili pepper			
Yes	60 (58.8)	42 (41.2)	0.335
No	51 (52)	47 (48)	
Salt status of consumed dishes			
Salty	60 (60.6)	39 (39.4)	0.150
Less salty/Salt free	51 (50.5)	50 (49.5)	
Speed of meals consumption			
Fast	33 (54.1)	28 (45.9)	0.883
Normal	45 (57.7)	33 (42.3)	
Slow	33 (54.1)	28 (45.9)	
Temperature status of meals consumed			
Cool/warm	45 (54.2)	38 (45.8)	0.758
Hot	66 (56.4)	51 (43.6)	
Frequency of consuming meals prepared outside home			
<1 time per month/Never	30 (55.6)	24 (44.4)	0.897
1 - 3 times/month	34 (56.7)	26 (43.3)	

1 - 2 times per week	24 (51.1)	23 (48.9)
3 - 7 times per week	23 (59)	16 (41)

4.1.10 Association between Medical Conditions and *H. pylori* Status

Table (12) shows the association between *H. pylori* with medical conditions and biochemical markers. *H. pylori* positivity rate among participants who are overweight (58.9%) or obese (50.50.5%) is higher compared to participants with normal BMI (48.1%), however this difference was not statistically significant. The proportion of *H. pylori* was higher among participants with hyperlipidemia (61.7%), and abnormal high levels of LDL (57.7%) as compared to their counterparts without this diagnosis. *H. pylori* infection was more prevalent among participants with subnormal vitamin D levels (54.6%) compared to participants with normal levels of vitamin D (22.2%). Nevertheless, there was no statistically significant association between *H. pylori* with any of the medical conditions and biochemical markers (Table (12)).

Table (12)
Association between Medical Conditions and *H. pylori* Status

Medical characteristics	H. pylori status		Chi-Square P-value
	Positive	Negative	
	n (%)	n (%)	
History or Documentation of Hypertension			
Yes	38 (56.7)	29 (43.3)	0.806
No	73 (54.9)	60 (45.1)	
History or Documentation of Diabetes			
Yes	35 (56.5)	27 (43.5)	0.856
No	76 (55.1)	62 (44.9)	
History or documentation of Hyperlipidemia			
Yes	37 (61.7)	23 (38.3)	0.251
No	74 (52.9)	66 (47.1)	
BMI			
Normal weight (18.5–24.9)	13 (48.1)	14 (51.9)	0.530
Overweight (25.0–29.9)	33 (58.9)	23 (41.1)	
Obese (≥30.0)	47 (50.5)	46 (49.5)	
Blood pressure			
Normal	25 (54.3)	66 (45.5)	0.851
Above normal	85 (55.9)	67 (44.1)	
Cholesterol			
Normal (< 5.6 mmol/L)	35 (52.2)	32 (47.8)	0.402
Above normal (≥5.6 mmol/L)	19 (61.3)	12 (38.7)	
TG			
Normal (< 1.7 mmol/L)	38 (54.3)	32 (45.7)	0.829
Above normal (≥1.7 mmol/L)	14 (51.9)	13 (48.1)	
LDL			
Normal (<2.6 mmol/L)	22 (48.9)	23 (51.1)	0.386
Above normal (≥ 2.6 mmol/L)	30 (57.7)	22 (42.3)	
HDL			
Normal (> 1.5 mmol/L)	17 (65.4)	9 (34.6)	0.159
Below normal (≤1.5 mmol/L)	35 (49.3)	36 (50.7)	
FBS			
Normal (< 5.6 mmol/L)	10 (55.6)	8 (44.4)	0.525
Above normal (≥ 5.6 mmol/L)	10 (45.5)	12 (54.5)	
HbA1c			
Normal (< 5.7%)	12 (52.2)	11 (47.8)	0.688
Above normal (≥ 5.7%)	41 (56.9)	31 (43.1)	

Vitamin D			
Normal (> 30 nmol/L)	2 (22.2)	7 (77.8)	0.085
Below normal ($\leq$ 30 nmol/L)	59 (54.6)	49(45.4)	

BMI:Body Mass Index, **TG:** Triglycerides, **HDL:** High Density Lipoprotein, **LDL:** Low Density

Lipoprotein, **FBS:** Fasting Blood Sugar, **HbA1:** Glycated hemoglobin

a.Fisher's Exact Test.

Table (13) shows the differences and relationship between the mean of age, BMI, systolic and diastolic BP, and biochemical measurements with *H. pylori* status. There were no statistically significant differences in the means of age, BMI, systolic and diastolic BP, FBS, HbA1c and lipid profile between *H. pylori* positive and *H. pylori* negative participants. The mean of serum vitamin D level was significantly lower in *H. pylori* infected participants (Mean =15.46, 95% CI of $\pm$ 6.3) compared their non-infected counterparts (Mean =21.04, 95% CI of $\pm$ 8.15) (p =<0.001).

Table (13)

Association between the Mean Level of Anthropometric Measurements and Biochemical Markers and *H. pylori* Status

	H. pylori status		T-test P-value
	Positive	Negative	
	Mean $\pm$ SD	Mean $\pm$ SD	
Age	51.4 $\pm$ 13.7	51.5 $\pm$ 13.4	0.948
BMI	30.87 $\pm$ 6.18	31.18 $\pm$ 6.43	0.742
Systolic BP	129.69 $\pm$ 16.39	128.7 $\pm$ 15.43	0.666
Diastolic BP	76 $\pm$ 10.11	74.58 $\pm$ 10.23	0.331
Cholesterol	6.12 $\pm$ 10.17	4.47 $\pm$ 0.99	0.288
Triglyceride	1.44 $\pm$ 1.16	1.49 $\pm$ 1.4	0.867
LDL	2.82 $\pm$ 1	2.63 $\pm$ 0.82	0.316
HDL	1.36 $\pm$ 0.53	1.25 $\pm$ 0.3	0.216
FBS	5.76 $\pm$ 1.77	6.73 $\pm$ 2.4	0.113
HbA1c	7.08 $\pm$ 2.16	6.78 $\pm$ 1.78	0.474
Vitamin D	15.46 $\pm$ 6.35	21.04 $\pm$ 8.15	<0.001

Data in bold is statistically significant

Error! Reference source not found. shows that among T2D participants, *H. pylori* infection rate was more among those who had controlled diabetes (63.2%) according to HbA1c level compared to those who were uncontrolled (51.6%), but it was not statistically significant ($p=0.425$).

Table (14)

Association between level of Control According HbA1c Level and *H. pylori* Status among Diabetic Participants

HbA1c	H. pylori status		Chi-Square P-value
	Positive	Negative	
	n (%)	n (%)	
Normal	12 (63.2)	7 (36.8)	0.425
Abnormal	16 (51.6)	15 (48.4)	

Table (15) gives an overview of the results of the bivariate logistic regression analysis. Participants with high school degree or below were 1.38 times more likely to develop *H. pylori* infection compared to participants with a college/University degree, but the difference is not statistically significant ($p=0.474$). In addition, smokers were 3.58 times more likely to develop *H. pylori* compared to non-smoker participants, but the difference is not statistically significant ($p=0.129$). Finally, the risk of *H. pylori* infection increases by 1.11 per one unit decrease of vitamin D (OR: 1.11, 95% CI of 1.05, 1.18, $p<0.001$).

Table (15)
**Binary Logistic Regression of Educational level, Smoking Status,
and Vitamin D Level on *H. pylori* Status**

	Odd Ratio	P-value	95% CI for Odd Ratio
Educational level			
High school or below	1.38	0.474	(0.57, 3.35)
College/University	Reference		
Smoking status			
Smoker	3.58	0.129	(0.69, 18.51)
Non-smoker	Reference		
Vitamin D	1.11	<0.001	(1.05, 1.18)

Data in bold is statistically significant

4.2 Discussion

Prevalence of *H. pylori* infection in this study was found to be 55.5%. The risk of infection was significantly higher among participants with lower educational level (high school degree or less) compared to those with university degree. The mean of frequency of consumption of green tea, coffee and honey was significantly lower among participants with *H. pylori* infection compared to non-infected participants. The mean serum vitamin D level was significantly lower in *H. pylori* infected participants compared to *H. pylori* non-infected participants. The decrease in serum vitamin D level was significantly associated with increased risk of *H. pylori* infection. No association was detected between *H. pylori* status and other sociodemographic and lifestyle factors, dietary habits, medical conditions, BP, BMI, and biochemical measurements.

The overall prevalence of *H. pylori* infection found in this study was 55.5%. This is comparable to the prevalence of 59.4% reported by Alshaikh et al. (2021) in a recent retrospective study conducted in the Kingdom of Bahrain. Interestingly, previous studies conducted on samples of dyspeptic adult patients who underwent gastroscopy in a tertiary care hospital in Bahrain revealed prevalence ranges between 75% and 79.4% (Fakhro et al., 1999, Kamath et al., 1995). These finding could hypothesize a decreasing trend of *H. pylori* infection among symptomatic patients in specific, which raises a question if that decreasing trend of *H. pylori* infection observed in symptomatic patients applies on the general population of Bahrain.

The prevalence found in this study is near to the prevalence of 52.4% reported by Assaad et al. (2018) in a study conducted in Lebanese patients referred for upper GI endoscopy. However, lower prevalence was reported in studies conducted in dyspeptic patients in Oman (41%) and in Jazan Province in Saudi Arabia (46.5%) (Akeel et al., 2018, Altheeb AlKalbani et al., 2016). In Many studies conducted in the Middle East/North Africa (MENA) region including Iran, Egypt, and Turkey reported higher infection rates which reached to 86.8% in Iran (Khedmat et al., 2013). The prevalence of *H. pylori* among subjects with dyspepsia in United States, Brazil and China was 28.9%, 57%, and 84% respectively (Akeel et al., 2018).

H. pylori infection might be a contributing factor in the GI problems of the included participants. The difference in the prevalence of *H. pylori* infection observed in different studies might be due to variation in the study design, sample size, study setting, the period in which the study was conducted, participants characteristics, ethnicities of the sample, and testing methods used to determine *H. pylori* status. Also, variation in bacterial virulence and stereotypes, antibiotic resistance, environment, living standards, socioeconomic and lifestyle factors and dietary habits in different context could affect this prevalence. The prevalence reported in this study cannot be generalized to reflect *H. pylori* prevalence in the Kingdom of Bahrain, since it represents only the rate of the infection in a relatively small cohort of patients who were following in one of the tertiary hospitals in the country.

In terms of *H. Pylori* infection and sociodemographic factors, findings of this study revealed no association between *H. pylori* infection and sociodemographic factors except educational level.

There was no significant relationship between *H. pylori* infection with age or gender.

H. pylori infection was significantly higher among participants with lower educational levels (high school degree or below) (60.3% positivity rate) compared to subjects with higher educational levels (college/university degree) (44.1% positivity rate). Participants with high school degree or below had 1.38 times increased risk of *H. pylori* infection compared to participants with college or university degree, but this was not statistically significant in the bivariate logistic regressing (OR=1.38; 95% CI: 0.57-3.35). Participants with higher educational level (university degree) could be of younger age and might have better life standards and health care coverage since childhood which made them at a lesser risk of *H. pylori* infection.

Also, participants with university degree might be more knowledgeable/aware of health-related issues and have better healthy lifestyle compared to those with lesser educational levels. In agreement with this study finding, participants with higher educational level were less likely to have *H. pylori* infection in studies conducted in Turkey, Korea, and China (Lim et al., 2013; Ozaydin et al., 2013).

The prevalence of infection among participants who were retired (62.9%) was higher compared to those who were employed (49%) or unemployed (53.1%); however, it was not statistically significant. Retired participants might be of older age and might have lower life-standards during childhood which will increase their risk of acquiring the infection. Similarly, Monno et al. (2019) in a retrospective study conducted in Italy revealed no association between *H. pylori* infection and type of employment.

In the present study, there was no association between household income and the risk of *H. pylori* infection. Although lower income was associated with a higher risk of *H. pylori* infection in other studies (Kim et al., 2013; Lim et al., 2013; Mhaskar et al., 2013; Shu et al., 2019; Yassibas et al., 2012; Zaterka et al., 2007), access to health care and education are available for free for all Bahrainis, this might contribute to diseases prevention including *H. pylori* infection even for those with lower household incomes. Comparable to this finding, Altheeb et al. (2016) in Oman, a country in the region with similar culture and health care system, finds no association between *H. pylori* status and monthly income.

No association was identified in this study between the number of rooms of the household and number of people sharing the household and the risk of *H. pylori* infection. Overcrowding was reported to facilitate transmission of *H. pylori* infection among family members and those sharing the household (Brown, 2000). Household crowding might be comparatively not common in Bahrain which might explain this finding. However, assessing crowding index might provide more accurate results regarding this association which was beyond the scope of this study. Similarly, Faisal et al. (2012) reported no association between number of rooms and the risk of *H. pylori* infection.

None of the lifestyle factors studied was associated with *H. pylori* infection. The relationship between *H. pylori* infection and different lifestyle factors remains unclear. In the present study, *H. pylori* infection was more prevalent among current smokers and those who smoke more than 20 cigarettes per day, but was not statistically

significant. Smoking has been associated with an increased risk and persistence of *H. pylori* infection and lower eradication rates (Ferro et al., 2019). The prolonged exposure to nicotine might contribute to a permanent status of inflammation in gastric mucosa, which facilitates *H. pylori* colonization (Li et al., 2014). Consistent with this study finding, a recent pooled meta-analysis study aimed to evaluate the relationship between *H. pylori* infection and smoking comprising 14, 244 cases and 33, 932 controls, revealed no association between smoking and *H. pylori* infection (Ferro et al., 2019). Also, studies conducted in Oman, Lebanon, Egypt, and Pakistan found no association between smoking and *H. pylori* infection (Altheeb AlKalbani et al., 2016; Assaad et al., 2018; Khalifa, Mohie Aldeen Abd Alzaher & Abd Almaksoud, 2014; Valliani et al., 2013). While studies conducted in Ireland, India, Turkey, and China, revealed that smoking is associated with increased risk of *H. pylori* infection (Mhaskar et al., 2013; Murray et al., 1997; Ozaydin et al., 2013). Although, some studies revealed a positive association between smoking and *H. pylori* infection, findings are still inconclusive.

Since the participants were patients with different GI problems, they might be exposed to health education in smoking cessation in which they either quit smoking or changed their smoking habits. It might be helpful to conduct future studies to assess the relationship between *H. pylori* infection and different types of smoking (cigarettes, nargila/shisha, vape and others) on asymptomatic participants.

It could be due to cultural and religious factors, that only 7 participants (3.5%) reported drinking alcohol. It was not possible to conclude any association between drinking alcohol and *H. pylori* infection due to the very small number of respondents. Nonetheless, studies reported a positive association between alcohol consumption and *H. pylori* infection (Abebaw et al., 2014; Wang et al., 2019; Xia et al., 2016; Zhang et al. 2010). Since majority of the participants were non-alcohol consumer, it could reflect in reducing *H. pylori* infection rate among the studied sample. Few studies reported a protective effect of alcohol consumption on the risk of *H. pylori* infection (Kuepper-Nybelen et al., 2005; Ozaydin et al., 2013; Wawro et al., 2019). Whereas some studies found no clear association between alcohol consumption and *H. pylori* infection (Altheeb AlKalbani et al., 2016; Assaad et al., 2018; Mhaskar et al., 2013; Zaterka et al., 2007). Assessing relationship between drinking alcohol and *H. pylori* infection, might not be viable within the context of Bahrain due to religious and cultural reasons.

There was no significant association between *H. pylori* infection with other lifestyle factors investigated in this study such as level of perceived stress, number of hours of sleep per night, frequency, and duration of physical activity. This is inconsistent with the study

hypothesis that presume host related factors including lifestyle are associated with the risk of *H. pylori* infection. This finding could be due to small sample size, participants characteristics as patients with certain health seeking behavior and the study design which is prone to recall bias. Furthermore, the data was collected during the COVID-19 pandemic in which lifestyle of majority of the population have been changed due to the quarantine and social distancing precautions (Lim et al., 2021). Consistent with this finding, Assaad et al. (2018) in Lebanon found no association between *H. pylori* infection and any of lifestyle factors studied which include smoking, alcohol consumption, physical activity, and number of sleep hours per night and perceived level of stress.

This study found an inverse relationship between green tea, and honey consumption and *H. pylori* infection. Green tea and honey have been shown to exhibit antibacterial activity to inhibit the growth of *H. pylori* and gastric mucosal inflammation (Hołubiuk & Imiela, 2016; Stoicov et al., 2009). Honey has a potent antibacterial activity due certain characteristics as low pH, high osmolarity and hydrogen peroxide content (Hołubiuk & Imiela, 2016; Ndip et al., 2007). Findings in this study revealed that honey and green tea were not frequently consumed (daily consumption of green tea and honey was reported by 7.5% and 19% of the participants, respectively). However, *H. pylori* infection rate was lesser in those with higher consumption due to the anti-inflammatory and antibacterial properties of green tea and honey. Also, *H. pylori* infection rate was significantly lesser among participants who

consume green tea one time or more per week. Consistent with this finding, a study conducted in Bulgaria to assess dietary habits of 150 patients with dyspepsia revealed that honey intake at least once a week (OR: 0.38) and green/black tea consumption for at least one day or more a week (OR: 0.45) were significantly associated with lower prevalence of *H. pylori* infection (Boyanova et al., 2015). Similarly, Mard et al. (2014) found a significant negative correlation between daily intake of honey and *H. pylori* infection. Yordanov et al. (2017) reported a reverse association between the intake of honey for five days or more a week and the prevalence and virulence of the *H. pylori* infection (OR: 0.68).

This study also showed that the frequency of coffee consumption was lower among *H. pylori* infected participants compared to non-infected. Coffee consumption has been linked to several health benefits as lowering the risk of some diseases such as CVD, T2D, obesity and some types of cancers (Gokcen & Sanlıer et al., 2017). Coffee is rich in polyphenols which are known to affect the immune function and chronic inflammation (Loftfield et al., 2015). It also contains arabinogalactan proteins which are type of polysaccharide that exhibit prebiotic and immunomodulatory properties (Gokcen & Sanlıer et al., 2017). Loftfield et al. (2015) found an inverse association between coffee consumption and the systemic levels of some inflammatory markers. All of the mentioned properties of coffee might provide an explanation to the association between *H. pylori* and coffee consumption observed in this study. However, findings from the literature on the relationship between coffee consumption and *H. pylori* infection are inconsistent. Alebie et al. (2016) in a study that included

145 Ethiopian students with gastritis found that consumption of coffee exacerbates *H. pylori* related gastritis symptoms. Monno et al. (2019) in a retrospective study conducted in Italy revealed that the frequent consumption of coffee increases *H. pylori* infection rate. While other studies did not find any association between coffee consumption and *H. pylori* infection (Ali et al., 2017; Altheeb AlKalbani et al., 2016; Assaad et al., 2018). The relationship between coffee consumption and *H. pylori* infection might be attributed to differences in the type of coffee consumed, preparation methods, combining coffee with different beverages as milk or consuming it alone or in combination with meals. Another reason for the observed finding could be an intentional reduction of coffee consumption among *H. pylori* infected participants due to their personal beliefs or health care workers instructions. It might be important in future studies to include data about type and amount of coffee consumed, preparation methods and if the participant intentionally alter consumption for any reason.

This study did not find any association between *H. pylori* infection and any of other food and beverage items and dietary habits studied. Similarly, Assaad et al. (2018) in a study conducted in Lebanon found no correlation between the intakes of any of the food item studied with *H. pylori* infection. In addition, a study conducted in Oman showed that none of the food items studied was associated with *H. pylori* infection except for soft drinks (Altheeb AlKalbani et al., 2016).

Contrary to this study finding, salt intake and frequent consumption of salty food items such as pickles, sausages, salami, hotdogs, hamburger and adding salt without tasting were associated with an increased risk of *H. pylori* infection in other studies (Mard et al., 2014; Shu et al.,

2019; Xia et al., 2016) and were associated to an increased risk of gastric cancer (Yassibas et al., 2012). Consumption of processed meats is not common within the context of Bahrain which is reflected in the low frequency of consumption of these food items in the FFQ, no association could be found between the consumption of these food items and *H. pylori* infection.

It is essential to study details about dietary patterns, since evaluating food items in isolation might not provide a full view of nutrients interaction. Moreover, dietary habits were assessed during the COVID-19 pandemic, during which some dietary habits might be altered (Lim et al., 2021). The COVID-19 pandemic had impacted eating behaviors and limited the access to fresh food due to quarantine precautions and lockdown which led to increased consumption of processed and fast foods that are rich in salt, sugar, and saturated fat (Papazisis et al., 2021).

There was no association between *H. pylori* infection and BP, BMI, FBS, HbA1c and lipid profile. In addition, the difference in *H. pylori* infection rate among participants with the diagnosis of diabetes, hypertension, hyperlipidemia, and participants without these diagnosis was not significant. The relationship between *H. pylori* infection and diabetes, blood pressure, BMI and lipid profile is controversial in the literature. Although some studies revealed an association between *H. pylori* infection and some medical conditions or biomarkers (Bener et al., 2007; Devrajani et al., 2010; Chen et al., 2018; Zhang et al., 2015),

others concluded no association (Assad et al., 2018; Anastasios et al., 2002; Kopacova et al., 2014).

Assessing the relationship between *H. pylori* infection and medical conditions and biochemical markers was a secondary objective of this study. The number of diagnosed participants with T2D, Hyperlipidemia and hypertension in this study were small. Moreover, a lot of data of the BP, BMI and biochemical measurements was missing. It is recommended to conduct further detailed studies targeted on assessing the relationship between *H. pylori* infection and these medical conditions and biochemical measurements with bigger sample size from the general population with possibly different study design (case-control, cross-sectional or prospective studies) and acquiring detailed information about the condition (which includes duration of the medical problem and type of management used) to minimize any confounding effect. The participants included in this study were follow-up patients visiting the GE unit in a tertiary hospital and most of them have experienced GI related symptoms that might require changing their lifestyle and diet which might affect their weight and other health related parameters.

In addition, this study finding in regard the relationship of *H. pylori* and medical conditions and biochemical measurements could be attributable to variation in *H. pylori* strain and host genetic that might affect the inflammatory response, which was hypothesized to play a role in lipid and blood sugar metabolism (Gravina et al., 2018).

In the present study, vitamin D level was assessed in more than half of the participants (58.5%). This finding could reflect that the physicians were aware regarding the role of vitamin D in *H. pylori* infection, or patients who were tested might present with certain health problems that required vitamin D testing. Majority of those tested for vitamin D had below normal levels (92.3%). There are several risk factors known for vitamin D deficiency which include suboptimal exposure to sunlight, inadequate intake of vitamin D containing foods and malabsorption of vitamin D in the intestine (Parva et al., 2018). The high percentage of vitamin D deficiency among the study population could be due to numerous factors. Vitamin D deficiency was linked to GI disorders by Ahmad et al. (2020), all those included in this study were follow up patients in the GE unit and some of them might have GI disorders which affect the absorption of vitamin D. These patients might also have altered dietary patterns due to their GI related symptoms which could affect their intake of vitamin D rich dietary sources. Another possible cause is low exposure to sunlight, despite sufficient sunshine all through the year studies found that one-third of individuals living in Sub-Saharan Africa and the Middle East have serum vitamin D <25 nmol/L (Arabi et al., 2010). Golbahar et al. (2013) in a study that included 500 healthy Bahraini adults reported that 49.4% of the participants had vitamin D deficiency. Findings related to vitamin D deficiency found in this study is specific for the study population only and cannot be generalized to the general population due to the special characteristics of the studied group.

This study showed that the decrease in vitamin D level is significantly associated with increased risk of *H. pylori* infection. In addition, participants who were infected with *H. pylori* had lower mean level of vitamin D compared to participants without the infection. Evidence from recent literatures indicate that vitamin D poses an immunoregulatory functions that exhibit an effect on susceptibility to infections in general and to *H. pylori* in specific (Yang et al., 2019). Vitamin D might decrease the risk of infection by various mechanisms; vitamin D improves innate immunity by modulating the production of antimicrobial peptides and cytokine response (Yang et al., 2019). Furthermore, Vitamin D helps in enhancing the activity of monocytes and macrophages and contributes in enhancing systemic antimicrobial effect (El Shahawy et al., 2018). Therefore, *H. pylori* infection rate was more among participants with vitamin D deficiency compared to participants with normal vitamin D levels due to the previously mentioned reasons. In consistent with this finding, a multi-centric study conducted in China, reported that *H. pylori* infected participants had significantly lower serum vitamin D levels compared to the non-infected group (Han et al., 2019). Assaad et al. (2018) in Lebanon, reported that *H. pylori* infection risk was significantly higher among participants with vitamin D deficiency (OR=29.14) compared to participants with normal vitamin D levels. A recent study conducted in Turkey revealed that vitamin D deficiency was associated with increased odds of *H. pylori* infection by almost 3 times (Surmeli et al., 2019). Yang et al. (2019) in a metanalysis study revealed that vitamin D had a protective effect against *H. pylori* infection and improved the success rate of *H. pylori* eradication.

The relationship between vitamin D and *H. pylori* infection worth more investigation in the context of Bahrain, as many factors might be involved including diet and comorbidities. Considering vitamin D supplementation as part of prevention and treatment plans of *H. pylori* infection to certain groups in the population might be effective.

4.3 Strengths and limitations

This study had several strengths and limitations. First, to the best of my knowledge, this is the first study in the Kingdom of Bahrain and one of few in the region to evaluate the association between sociodemographic, lifestyle, dietary habits, and some medical conditions with *H. pylori* infection. Second, a short version-13 item-FFQ previously validated by Yassibas (Yassibas et al., 2012) was used to assess dietary intake, FFQ is considered one of the best dietary tools to assess the relationship between diet and disease. Furthermore, the internal consistency and reliability of this tool was improved by adding items from the Bahraini FFQ that is in process of validation and other food items and beverages that were related to *H. pylori* infection in previous studies. The 30-items structured FFQ seems to be acceptable reliable tool to assess dietary habits in relation to *H. pylori* infection in similar context in future studies. Third, the data were collected through tele-interview and not self-administered, by that, the interviewer might contribute to clarify any misunderstandings if needed and minimize missing information. Fourth, *H. pylori* status was determined upon upper GI endoscopy biopsy testing and/or UBT, both

have high diagnostic accuracy. Finally, anthropometric, and biochemical measurements, BP and some medical conditions were retrieved from the patients' medical records, minimizing any self-reporting bias.

Some limitations regarding this study should be considered when interpreting the results. The data collection was conducted during the COVID-19 pandemic, within this period some lifestyle and dietary habits might be affected. In addition, due to the regulations related to that period, some non-urgent investigations/procedures were rescheduled, which affected our reach to the targeted population. Due to that reason, we included any patient who has done the *H. pylori* testing within the past 18 months by either UBT or upper GI endoscopy biopsy testing. Although, our initial plan was including only patients who have done *H. pylori* testing by upper GI endoscopy biopsy, due to the constraints mentioned earlier, patients who were evaluated by UBT were included. The convenience sampling method used to select the participants and this subgroup characteristics might limit the ability to generalize the results to the general population. Potential misclassification bias of the main outcome although minimal is possible. Moreover, the use of FFQ might represent some limitations. Food intake in the previous 18 months of the interview was self-reported by participants with no measure for verification, which might lead to possible recall and information bias. In addition, intake of food and beverages items was assessed without specifying quantities or portion size. However, variation in portion size between participants is smaller than variation of frequency of consumption, which will have

limited effect on the finding. Some medical data were missing or not updated for a group of participants. This could contribute to the final findings. Finally, an inference of causality cannot be generated due to the cross-sectional study design.

4.4 Conclusion

H. pylori infection is a major public health problem that affects more than half of the world population leading to a range of GI and extra-gastric problems. This study is the first in Bahrain and one of few in the region to investigate the relationship between diet and *H. pylori* infection. *H. pylori* infection was significantly higher among participants with lower educational level (high school degree or below) compared to those with higher educational level (university degree). Intake of honey, green tea and coffee was found to be protective against *H. pylori* infection. While other food items and beverages and dietary habits were not associated with *H. pylori* infection. However, subnormal level of vitamin D was a risk factor for *H. pylori* infection. It is crucial to evaluate dietary substances that exhibit a protective effect against *H. pylori*. Including diet in the prevention and treatment options of *H. pylori* infection will provide an acceptable convenient approach to control *H. pylori* with reasonable cost, high availability, and lesser side effects compared to medications.

4.5 Recommendations

1. To increase community awareness about *H. pylori* infection through public campaigns tailored to different subgroups in the community.
2. To design health awareness and education programs that encourages healthy lifestyle including healthy eating patterns as a measure of prevention of *H. pylori* infection.
3. To encourage health care workers and decision makers to include dietary approaches in the prevention and management plans of *H. pylori* infection.

4. Vitamin D assessment and supplementation might play a role in *H. pylori* prevention and management, future longitudinal studies are needed to evaluate its effectiveness.
5. Most studies conducted in the Kingdom of Bahrain and in the region included symptomatic patients, further studies are needed to investigate *H. pylori* prevalence and its predisposing factors including dietary habits in asymptomatic volunteers from the general population. Estimating *H. pylori* infection prevalence, trends and predisposing factors is essential in planning appropriate strategies for the prevention, diagnosis and treatment of this infection.
6. To evaluate the prevalence of gastric cancer and investigate its predisposing factors including *H. pylori* infection and diet within the context of Bahrain.

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Appendix 1

Summary of Some Studies on the Relationship between *H. pylori* and Dietary Patterns

Reference	Country	Age	Study Population	Number of subjects	Methodology	<i>H. pylori</i> Prevalence (%)	Main Results
Jarosz et al., 2009	Poland	17 - 88 years	Subjects who had successful treatment of <i>H. pylori</i> infection had	- Cases (111 persons with <i>H. pylori</i> re-infection) -Control group (175 persons who had not been re-infected)	- Case-Control - Interview using questionnaire composed of 3 sections: dietary habits, lifestyle, and socio-economic factors.	Not Applicable	Lower frequency of consumption of fermented dairy products ($P < 0.0001$), vegetables ($P = 0.02$), and fruit ($P = 0.008$) among cases compared to control group.
Lee et al., 2012	Malaysia	-Mean age <i>H. pylori</i> positives 55.0 ± 16 -Mean age <i>H. pylori</i> negatives 57.5 ± 27	Malays who underwent upper GI endoscopy between 2000 and 2008	161 participants, (cases: 79 <i>H. pylori</i> positive and 82 controls)	- Case- Control - Interview by two trained interviewers. - Researchers validated, structured questionnaire composed of 3 sections: 1. Socio-demographic 2. Sanitary and sociocultural practices 3. Dietary practices.	Not Applicable	Sociodemographic Factors: 1. The percentage of men was slightly higher among participants with <i>H. pylori</i> infection compared to those without (65 vs 49%, $p = .056$). 2. Educational status was inversely associated with the risk of infection ($p = .007$). - Subjects with <i>H. pylori</i> infection also had higher BMI - sanitary practices were associated with an increased prevalence of <i>H. pylori</i> infection: 1. Use of well water (OR = 3.38) 2. Use of pit latrine (OR = 2.76) 3. Infrequent washing hand practice after toilet use (OR = 3.49) and before meals (OR = 10.41). -Dietary factors inversely associated with <i>H. pylori</i> infection: 1. frequent consumption of tea (OR: 0.023) 2. Frequent use of “budu” or local anchovy sauce (OR: 0.09) 3. Frequent use of “pegaga” or centenella asiatica (OR: 0.25)

Yassibas, Arslan, & Yalcin, 2012	Turkey	Mean age 57.4±13.0 years	Patients with gastric adenocarcinoma (106) - Controls (106) without cancer matched for age (range 28-85 years) and gender	212	- Case-Control Study. - Interview by dietitian using a questionnaire composed of three sections: 1. Demographic information, 2. Dietary habits and frequency of food and drinks consumption 3. Smoking and alcohol consumption (duration, frequency and amount)	- 81.3% in patients with gastric cancer - Not available for control group	- Factors associated with increased risk: gastric cancer: 1. Frequent consumption of salty dishes (ORs = 3.686) 2. Very salty foods like pickles (ORs=7.784), soup mixes (ORs=5.264) , sausages (ORs= 3.148) 3. Foods at hot temperature (ORs= 3.273) 4. Adding salt without tasting (OR = 4.198) 5. Frequent consumption of colas (OR = 3.397) other soft drinks (OR = 6.146) 6. Heavy smoking and high amount of alcohol consumption (p = 0.000) -Factors associated with lower risk (but not significantly): frequent consumption of green vegetables (ORs = 0.569), onion (ORs = 0.092), garlic (ORs = 0.795 and dried fruits (ORs = 0.041).
Mhaskar et al., 2013	India (Pune)	More than 18 years	-Participants identified via the hospital database. -Criteria of selection of the cases and controls were pre-defined.	Total=451 (1) patients diagnosed with peptic ulcer (190), (2) patients diagnosed with stomach cancer (n=35), and (3)	- Case control study. - Semi-structured questionnaire was used to collect data on <i>H. Pylori</i> risk factors including diet. - Data collected through a face-face interview by 2 physicians.	51%.	- Risk factors for <i>H. pylori</i> infection were: 1. Low socioeconomic status [OR: 1.10] 2. Smoking (OR: 2.23] 3. Drinking nonfiltered or nonboiled water (OR: 1.05] 4. Meat consumption (OR: 2.35] 5. Frequent consumption of restaurant food (OR: 3.77] - While chili peppers consumption was protective (OR: 0.20]. - Gender, age, educational level, consumption of alcohol, fish and eating food while it is hot were not associated with <i>H. pylori</i> infection

				controls (n=125).	- <i>H. pylori</i> status was assessed from stool by monoclonal antigen detection		
Mard et al. 2014	Iran (Khuzestan province)	Not Mentioned	Patients with functional dyspepsia who were referred for upper gastrointestinal endoscopy.	Total= 374 - <i>H. pylori</i> positive =160, - <i>H. pylori</i> negative= 214	- Retrospective cross-sectional study. - Data was collected through face to- face interviews using a validated food frequency questionnaire (FFQ) to assess dietary habits during the past year. - <i>H. pylori</i> status was determined after upper GI endoscopy and histopathological assessment of a gastric sample.	43%	- Positive significant correlation: 1. Energy intake ($P = 0.01$). 2. Carbohydrate intake ($P=0.02$). 3. Foods rich in salt, sugar and saturated fat , which includes: sausages ($P=0.001$), hamburgers ($P=0.002$), fat mayonnaise ($P=0.002$), and soft drinks ($P=0.001$). 4. <i>H. pylori</i> infected participants had significant lower weekly consumption of tomatoes ($P=0.001$), onions ($P=0.002$), green pepper ($P=0.01$), apple ($P=0.001$), and citrus fruits ($P=0.001$). 5. Significant lower intake of unsaturated fatty acids ($P=0.02$). - Significant negative correlation between daily intake of fish ($P=0.001$), olive oil ($P=0.002$), honey ($P=0.002$), peas and beans ($P=0.03$), folate ($P= 0.01$) and vitamin C ($P=0.02$) and <i>H. pylori</i> infection.
Altheeb AlKalbani, et al. 2016	Oman	18 years and above	Adult Omani patients attending Sultan Qaboos University	100	- Pilot cross-sectional study. - face-to-face interview using a semi-structured questionnaire to	41%	-There was no significant correlation between sociodemographic characteristic and <i>H. pylori</i> status. - No clear correlation was found between total daily energy, carbohydrate, protein or fat intake and the risk of <i>H. pylori</i> infection.

			hospital day care unit for Oesophago-gastro-duodenoscopy (OGD)”		collect demographic data and dietary intake. - Dietary intake was evaluated using FFQ that contains 117 items of different food groups and traditional Omani dishes. - Portion size was specified using variety of commonly used household unit/utensils. - H. pylori status was determined: oesophago-gastro-duodenoscopy biopsy histopathological assessment.		- 71% of those who consume soft drinks in daily basis or nearly daily basis had <i>H. pylori</i> positive results (<i>P</i> value 0.04). - No significant correlation between <i>H. pylori</i> infection and other food items.
Xia et al., 2016	China (Tianjin)	-Mean age <i>H. pylori</i> negative 40.1 (39.8, 40.3)	Chinese adults with no previous <i>H. pylori</i> eradication	10407	- Cross-sectional study. - Self-administered questionnaire:	28.6%	-Characteristics of participants with <i>H. pylori</i> infection were men ($P < 0.0001$), older in age ($P < 0.0001$), lower education level ($P < 0.0001$), higher BMI ($P < 0.0001$) and higher physical activity ($P = 0.01$).

		- Mean age <i>H. pylori</i> positive 43.2 (42.8, 43.7)	therapy or gastrointestinal symptoms.		Sociodemographic data, lifestyle factors, medical history, and dietary pattern. - Anthropometric parameters were measured and recorded and blood sample were collected for the analysis of fasting blood sugar, serum triglycerides (TG) and high-density lipoprotein cholesterol (HDL). - <i>H. pylori</i> status was determined through serological detection of anti-<i>H. pylori</i> antibodies (IgG) using enzyme-linked immunosorbent assay (ELISA).		- They have a higher intake of salt ($P < 0.0001$) and drink alcohol everyday ($P < 0.01$). These participants also had higher prevalence of metabolic syndrome ($P < 0.001$), and type 2 diabetes ($P = 0.03$). - There was a positive association between high-carbohydrate/sweet pattern and the prevalence of <i>H. pylori</i> infection ($P < 0.001$). - Participants who are in the upper quartiles of the high carbohydrate/sweet pattern had an OR 1.65 for the prevalence of <i>H. pylori</i> infection in contrast to those in the lower quartiles. - While high-protein/cholesterol pattern was associated with a lower prevalence of <i>H. pylori</i> infection ($P = 0.04$). - When adjusting for age, sex, and BMI the previous associations were not significant. - There was no significant association between balanced pattern and <i>H. pylori</i> infection after adjustment of these variables.
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Eslami et al. 2017	Iran (Zaheda)	18–24 years old	Undergraduate students of medical science	363 students who were 18-24 years	- cross-sectional study. - A self-administered questionnaire (sociodemographic and dietary habits). - Blood samples were collected after an overnight fasting to measure the total cholesterol (TC), low-density lipoprotein-cholesterol (LDL-C), high-density lipoprotein-cholesterol (HDL-C), triglycerides (TG), and fasting blood sugar (FBS). - <i>H. pylori</i> status was determined by assessing specific IgG antibodies (ELISA).	45.7%.	- <i>H. pylori</i>-positive had lower mean levels of TC and TG, lower levels of LDL-C ($P = 0.044$), FBS ($P = 0.05$) and higher levels of HDL-C compared to <i>H. pylori</i>-negative subjects. - Rare consumption of raw vegetables (OR=3.74) and higher levels of FBS (OR = 1.031) were the only variables significantly associated with higher odds of <i>H. pylori</i> infection in both the univariate and multiple logistic regression analysis.
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Assaad et al. 2018	Lebanon	18 years and above	Patients who were undergoing endoscopic examination at a tertiary health care center in Lebanon.	294	- Cross- sectional study. - Participants were recruited from gastroenterologic al unit after being referred for an upper gastrointestinal endoscopic examination. -Face-to-face interviews conducted by one trained interviewer prior to the endoscopic examination. -A structured questionnaire composed of five sections: socio-demographic characteristics, lifestyle factors, dietary habits, a short version of FFQ and a clinical section was used for data collection.	52. 4%	- <i>H. pylori</i> infection risk was significantly higher among participants with : 1. University education or above (OR=2.74) 2. Vitamin D deficiency (OR=29.14) 3. History of peptic ulcers (OR=3.80) 4. Participants with gastric adenocarcinoma (OR=3.99). - Participants with hyperglycemia were less likely to have <i>H. pylori</i> infection (OR=0.18) - There was no association between dietary habits and <i>H. pylori</i> infection after adjustment of possible confounders.
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					- The FFQ assessed the frequency of consumption of 13 food items. - Data were retrieved from medical records: 1. medical history 2. biochemical measurements including glucose level, lipid profile, iron and vitamin D levels. 3. Anthropometric measurements and blood pressure - <i>H. pylori</i> status: upper GI endoscopy and histopathological assessment of gastric biopsy		
Monno et al. 2019	Italy (Apulia)	18—64 years	Individuals who underwent H. pylori	- <i>H. pylori</i> positive: 201 - <i>H.</i>	- retrospective study. - Questionnaire was used to	Not Applicable	H. pylori infection was positively associated with: 1. cigarette smoking 2. Living in the same house with H. pylori positive relatives.

			screening in a tertiary center	<i>pylori</i> negative subjects: 259	collect data on socio-demographic characteristics and the consumption of different foods and beverages in the last year. - The <i>H. pylori</i> status was assessed by urea breath test.		3. The consumption of uncooked seafood and uncooked vegetables such as tomatoes, pepper, and chicory. 4. The consumption of raw vegetables purchased from street vendors and 5. Intake of municipal water 6. The number of cups of coffee consumed per week 7. The consumption of meals outside home - No significant relation was found between sociodemographic characteristics, and consumption of other food and beverages and <i>H. pylori</i> infection.
Shu et al., 2019	China (Hangzhou city, Zhejiang province)	45 -59 years	Chinese residing in Hangzhou city, Zhejiang province, China	3014	- Cross-sectional. - Stratified cluster random sampling method. - Data was collected by face-to-face interview by using a written questionnaire (Sociodemographic, lifestyle and dietary habits) - 135-item validated FFQ was used to assess dietary intake in previous 12 months (frequency and	27.5%	- Participants with <i>H. pylori</i> infection were significantly older, male, had lower economic income and lower total energy intake (P<.05). - Using factor analysis four dietary patterns were identified: health-conscious, Western, grains-vegetables and high-salt patterns. - “grains-vegetables” pattern is associated with a decreased risk of H. pylori infection. - “high-salt” pattern is associated with an increased risk of H pylori infection. - “health-conscious” and “Western” dietary patterns: no significant with the risk of H pylori infection.

					portion size in gram or cup/time) - Test to determine H. pylori status: 13C-urea breath test.		
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Appendix 2: English version of the study questionnaire

College of Science
Department of Biology
MSc Nutrition and Dietetics Program
University of Bahrain



Research Study Questionnaire

Study Title: Dietary Habits and *Helicobacter pylori* infection among Bahraini adults

Helicobacter pylori is the main bacterial cause of several gastrointestinal disorders. Diet plays a role in the development of this infection. The main objective of this study is to evaluate the association between *H. pylori* infection and dietary patterns among Bahraini adults. Studying the trend of *H. pylori* prevalence and predisposing risk factors including dietary habits among Bahraini adults is important to establish national health policies and dietary recommendations to prevent *H. pylori*-related diseases.

Please note that the information provided is for research purposes only and will be kept confidential under all circumstances. Your identity will also remain anonymous. You have the right to refuse to participate in this study. You may also refuse to answer any of the questions or to withdraw from the study at any time. Refusal to participate in this form will not affect your care in anyway.

Contacts and Questions: If you have any questions about the study or the questionnaire, please contact:

Dr. Fatema Ebrahim Habbash

Email: fatimahabbash31@gmail.com

A. Sociodemographic Data

CPR:

1. Age:

Please choose **only one** response for the below questions.

2. Gender

A. Male

B. Female

3. Marital status

A. Single

B. Married

C. Divorced

D. Widowed/ Widower

4. What is the highest level of education you have completed?

A. Primary school

B. Intermediate school

C. High school

D. College/University

5. Which of the following best describes your main work status over the past 12 months?

A. Student

B. Homemaker/housewife

C. Employed

D. Unemployed

E. Retired

6. Can you give an estimate of the monthly household income during the last 12 months?

A. Equal or less than 300BD

B. 300-600BD

C. 600-900BD

D. More than 900 BD

7. How many people live in your household?

.....

8. How many rooms are in your household?

.....

B. Lifestyle

9. What is your smoking status?

- A. Non smoker
- B. Ex-smoker (*How long has it been since you stopped smoking?.....*)
- C. Current smoker (*How long has it been since you first smoked?.....*)

10. **Please answer this question if you are an Ex-smoker or a Current smoker only**, how many cigarettes do you smoke or were you smoking per day?

- A. less than 1 cigarette/day (occasional smoker)
- B. 1–10 cigarettes/day
- C. 11–20 cigarettes/day
- D. > 20 cigarettes/day
- E. Not Applicable

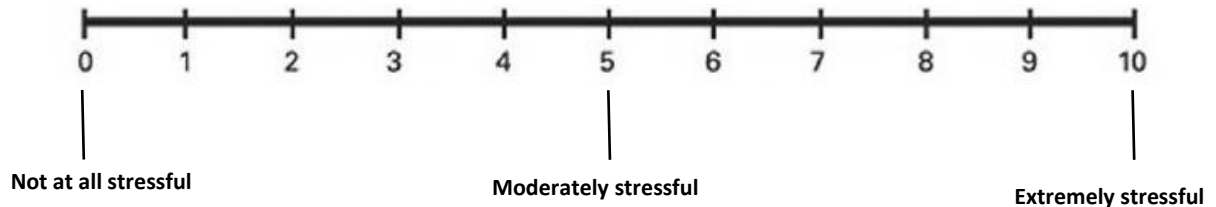
11. Do you drink alcohol?

- A. No
- B. Yes, answer question 12

12. How often do you consume alcohol?

- A. Monthly or less
- B. 2-4 times/month
- C. 2-3 times/week
- D. 4 or more times/week
- E. Not Applicable

13. How stressed have you been feeling recently? (Please indicate your answer on the provided scale)



14. How many hours of sleep do you get every night? ----- hour/day

15. How many times do you participate in physical activity?

- A. Less than once per week
- B. One to two times per week
- C. Three times or more per week

16. How long do you participate in physical activity (per session)?

- A. Less than 20 minutes
- B. 20 minutes or more
- C. Not applicable (If you do not participate in any physical activity)

C. Medical Data

17. Do you have any upper gastrointestinal symptoms that persist at least 1 month within the past 3 years?

- A. Yes
- B. No

18. **If your response to question 17 was yes**, please choose from these symptoms below (you can choose one or more).

- A. Indigestion
- B. Bloating.
- C. Epigastric pain.
- D. Regurgitation.
- E. Heart burn.
- F. Others, please specify.....

19. Have you ever been told by a medical doctor or other health worker that you have, or have had, gastric cancer?

- A. Yes
- B. No

20. Have you ever been told by a medical doctor or other health worker that you have, or have had, *H. pylori* infection?

- A. Yes
- B. No

Please put a tick in the box to indicate how often on average you have consumed each food/drink during the past 18 months:					
Food items	less than once per month/ None	1-2 times /month	1-2 times /week	3-4 times /week	Every Day
1. Grains (example: white and brown bread, pasta, rice, cereals and others)					
2. Green vegetable (example: parsley, coriander, spinach, lettuce, kale and others)					
3. Tuberous vegetables (example: carrot, potato, sweet potato)					
4. Fish					
5. Chicken					
6. Red meat					
7. sausage					
8. Hot dog					
9. Salami or ham					
10. Hamburger					
11. Milk					
12. Yogurt					
13. Salty Cheese (Example: Halloumi, feta, edam, cheese spreads, cheddar)					

Please put a tick in the box to indicate how often on average you have consumed each food/drink during the past 18 months:					
Food and Drink Items	less than once per month/ None	1-2 times /month	1-2 times /week	3-4 times /week	Every Day
14. Fresh Fruits					
15. legumes					
16. Eggs					
17. Nuts and dried fruits					
18. Salted fish					
19. Pickled vegetables					
20. Onion					
21. Garlic					
22. Tomato					
23. Butter and ghee					
24. Vegetable oils (example: olive, canola, corn oils and others)					
25. deserts (example: traditional sweets, kunafa, cakes, cookies and others)					
26. Tea (Example: English breakfast tea)					
27. Green tea					
28. Coffee					
29. Soft drinks					
30. Honey					

21. What was the source of drinking water during your childhood?
- A. Tap water
 - B. Well water
 - C. Filtered or mineral water
22. Do you add chili pepper to your food?
- A. yes
 - B. No
23. What is the usual salt status of your dishes?
- A. Very salty
 - B. Salty
 - C. Less salty
 - D. Salt free
24. How fast do you usually consume your meals?
- A. Very fast
 - B. Fast
 - C. Normal
 - D. Slow
25. The meals that you consume are typically:
- A. Cool/warm
 - B. Hot
 - C. Very hot
26. On average, how many meals do you eat that were not prepared at a home (meals from restaurants and cafeterias)?
- A. Never or less than one per month
 - B. 1-3 times/month
 - C. 1-2times per week
 - D. 3-6 times per week
 - E. Everyday

Data to be obtained from medical records

This Section to be filled by doctor (Please state NA (not available) if data to not available in medical record OR Old if more than 18 months has passed from obtaining the results)

27. Weight (kg)	28. Height (cm)	29. BMI
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30. Is there any documentation/history of previous diagnosis of hypertension?

- A. Yes
- B. No

31. Is there any documentation/history of previous diagnosis of diabetes?

- A. Yes
- B. No

32. Is there any documentation/history of previous diagnosis of hyperlipidemia?

- C. Yes
- D. No

33. BP (mm/Hg)	
34. Cholesterol	
35. Triglyceride	
36. LDL	
37. HDL	
38. FBS	
39. HbA1c (for diabetic patients)	
40. Vitamin D	

41. *H. pylori* status

- A. Positive
- B. Negative

42. Diagnostic method used:

- A. Urea breath test
- B. Gastric biopsy testing
- C. both

Appendix 3: Arabic version of the study questionnaire

جامعة البحرين

كلية العلوم

قسم علوم الحياة

برنامج ماجستير التغذية و النظم الغذائية



استبيان دراسة بحثية

عنوان الدراسة: العادات الغذائية وعدوى بكتيريا الملوية البوابية (جرثومة المعدة)
بين البالغين البحرينيين

تعد بكتيريا الملوية البوابية (جرثومة المعدة) السبب البكتيري الرئيسي للعديد من أمراض المعدة و الأمعاء. يلعب النظام الغذائي دوراً في تطور هذه العدوى. الهدف الرئيسي من هذه الدراسة هو تقييم العلاقة بين عدوى بكتيريا الملوية البوابية والأنماط الغذائية لدى البالغين البحرينيين. تكمن أهمية هذا البحث حول دراسة انتشار هذه العدوى وعوامل الخطر المهيئة بما في ذلك العادات الغذائية بين البالغين البحرينيين للمساهمة في وضع سياسات صحية وطنية وتوصيات غذائية للوقاية من الأمراض المرتبطة بالبكتيريا الحلزونية.

يرجى ملاحظة أن المعلومات المقدمة هي لأغراض البحث فقط وستظل سرية في جميع الظروف. ستبقى هويتك أيضاً مجهولة. للمرضى الحق في رفض المشاركة في هذه الدراسة ، كما يمكنهم رفض الإجابة على أي من الأسئلة أو الانسحاب من الدراسة في أي وقت. لن يؤثر رفض المشاركة في هذا النموذج على رعايتهم بأي حال.

جهات الاتصال والأسئلة: إذا كان لديك أي أسئلة حول الدراسة أو الاستبيان ، يرجى الاتصال بـ:

د. فاطمة إبراهيم هباش

البريد الإلكتروني: fatimahabbash31@gmail.com

A. البيانات الاجتماعية الديموغرافية

الرقم الشخصي:

1. العمر:

الرجاء اختيار إجابة واحدة فقط للأسئلة أدناه

2. الجنس
A. ذكر
B. أنثى
3. الوضع العائلي
A. غير مرتبط/ غير مرتبطة
B. متزوج/ متزوجة
C. مطلق/ مطلقة
D. أرمل / أرملة
4. ما هو أعلى مستوى تعليمي أتممته؟
A. المدرسة ابتدائية
B. المدرسة المتوسطة
C. المدرسة الثانوية
D. الكلية / الجامعة
5. أي مما يلي يصف بشكل أفضل حالة عملك الرئيسي على مدار الاثني عشر شهرًا الماضية؟
A. طالب
B. ربة منزل
C. موظف
D. عاطل عن العمل
E. متقاعد
6. هل يمكنك إعطاء تقدير لدخل الأسرة الشهري خلال الـ 12 شهرًا الماضية؟
A. يساوي أو أقل من 300 دينار بحريني
B. 300-600 دينار بحريني
C. 600-900 دينار بحريني
D. أكثر من 900 دينار بحريني
7. كم عدد الأشخاص الذين يعيشون في منزلك؟.....
8. كم عدد الغرف في منزلك؟.....

B. أسلوب الحياة

9. ما هي حالة التدخين لديك؟

- A. لم أَدخن أبداً
 B. مدخن سابق، كم مضى منذ أن توقفت عن التدخين؟
 C. مدخن الحالي، ما هي المدة منذ أن قمت بالتدخين لأول مرة؟
 10. الرجاء الإجابة على هذا السؤال إذا كنت مدخناً سابقاً أو مدخناً حالياً فقط، كم عدد السجائر التي تدخنها أو كنت تدخن يومياً؟

- A. أقل من سيجارة واحدة في اليوم (مدخن عرضي)
 B. من 1-10 سجائر / يوم
 C. من 11-20 سيجارة / يوم
 D. أكثر من 20 سيجارة / يوم
 E. لا ينطبق (غير مدخن)

11. هل تتعاطى أي نوع من المشروبات الكحولية؟
 A. لا

- B. نعم، الرجاء الإجابة على السؤال 12
 12. كم مرة تتناول المشروبات الكحولية؟

- A. مرة في الشهر أو أقل
 B. من 2-4 مرات / شهر
 C. من 2-3 مرات / أسبوع
 D. تقريباً 4 مرات أو أكثر / أسبوع
 E. لا ينطبق (لا تتناول المشروبات الكحولية)

13. إلى أي مدى شعورك بالتوتر في معظم الأوقات؟ (يرجى الإشارة في المقياس المقدم من 1 إلى 10 عن مدى شعورك بمستوى التوتر لديك)



14. ما هو عدد ساعات نومك في الليلة الواحدة؟.....ساعة/اليوم

15. كم عدد المرات التي تمارس فيها نشاطاً بدنياً؟

- A. أقل من مرة في الأسبوع
 B. مرة إلى مرتين في الأسبوع
 C. ثلاث مرات أو أكثر في الأسبوع

16. مدة النشاط البدني في كل مرة؟

- A. أقل من 20 دقيقة
B. تقريبا 20 دقيقة أو أكثر
C. لا ينطبق (إذا لم تشارك في أي نشاط بدني)

C. البيانات الطبية

17. هل لديك أي أعراض في الجهاز الهضمي العلوي استمرت لمدة شهر واحد على الأقل خلال السنوات الثلاث الماضية؟

- A. نعم
B. لا

18. إذا كانت إجابتك على السؤال 17 بنعم، فيرجى الاختيار من بين هذه الأعراض أدناه (يمكنك اختيار إجابة واحدة أو أكثر)

- A. عسر الهضم
B. الانتفاخ
C. ألم في أعلى البطن
D. إرتجاع مريئي
E. حرقة في المعدة
F. أخرى، يرجى التحديد
G. لا أشتكي من أي أعراض

19. هل سبق أن أخبرك طبيب أو غيره من العاملين الصحيين بأنك مصاب أو أصبت بسرطان المعدة؟

- A. نعم
B. لا

20. هل سبق أن أخبرك طبيب أو غيره من العاملين الصحيين بأنك مصاب أو أصبت بعدوى بكتيريا الملوية البوابية (جرثومة المعدة)؟

- A. نعم
B. لا

إستبيان تواتر الغذاء

يرجى وضع علامة في المربع للإشارة إلى عدد المرات التي استهلكت فيها كل طعام / شراب في المتوسط خلال ال 18 شهر الماضية:					
أقل من مرة في الشهر / أبدا	2-1 مرات في الشهر	2-1 مرات / الأسبوع	4-3 مرات / الأسبوع	يومية	المواد الغذائية والمشروبات
					1. الحبوب (مثال: الخبز الأبيض والبنّي والمعكرونة والأرز والحبوب وغيرها)
					2. خضروات خضراء (مثال: البقدونس والكزبرة والسبانخ والخس وغيرها)
					3. الخضار الدرنية (مثال: جزر ، بطاطس ، بطاطا حلوة)
					4. السمك
					5. الدجاج
					6. اللحوم الحمراء
					7. السجق
					8. النقانق
					9. السلامي
					10. الهمبرجر
					11. الحليب
					12. الروب
					13. الأجبان المملحة (مثال: حلومي ، جبنة فيتا ، إيدام ، جبنة قابلة للدهن ، شيدر)

يُرجى وضع علامة في المربع للإشارة إلى عدد المرات التي استهلكت فيها كل طعام / شراب في المتوسط خلال الـ 18 شهر الماضية:					
المواد الغذائية والمشروبات	أقل من مرة في الشهر / أبدا	2-1 مرات في الشهر	2-1 مرات / الأسبوع	4-3 مرات / الأسبوع	يومية
14. الفواكه الطازجة					
15. البقوليات					
16. البيض					
17. المكسرات و الفواكه المجففة					
18. الأسماك المملحة					
19. مخللات الخضار					
20. البصل					
21. الثوم					
22. الطماطم					
23. الزبدة و السمن					
24. الزيوت النباتية (مثل زيت الزيتون والكانولا وزيوت الذرة وغيرها)					
25. الحلويات (مثل: الحلويات الشعبية، كنافه، كعك، بسكويت و غيرها)					
26. الشاي (مثل: شاي الفطور الإنجليزي)					
27. الشاي الأخضر					
28. القهوة					
29. المشروبات الغازية					
30. العسل					

21. ما هو مصدر مياه الشرب خلال طفولتك؟

- A. ماء الصنبور
- B. مياه الآبار
- C. المياه المفلترة أو المعدنية

22. هل تستخدم الفلفل الحار في طعامك؟

- A. نعم
- B. لا

23. ما هي حالة الملح المعتادة في أطباقك؟

- A. ملح جدا
- B. ملح
- C. قليل الملوحة
- D. خالي من الملح

24. ما هو معدل سرعتك في الأكل عادة؟

- A. سريع جدا
- B. سريع
- C. عادي
- D. بطيئة

25. ما هي درجة الحرارة المعتادة للطعام الذي تستهلكه؟

- A. بارد/ دافئ
- B. حار
- C. حار جدا

26. في المتوسط ، كم عدد الوجبات التي تتناولها ولم يتم تحضيرها في المنزل (وجبات المطاعم و الكافيتريات)؟

- A. أبداً أو أقل من واحد شهرياً
- B. من 1-3 مرات / شهر
- C. من 1-2 مرات في الأسبوع
- D. من 3-6 مرات في الأسبوع
- E. كل يوم

البيانات التي سيتم الحصول عليها من السجلات الطبية

يجب ملء هذا القسم من قبل الطبيب (يرجى ذكر NA (غير متوفر) إذا كانت البيانات غير متوفرة في السجل الطبي أو قديم إذا مر أكثر من 18 شهر على الحصول على النتائج)

27. الوزن (كيلوجرام)	28. الطول (سنتيمتر)	29. مؤشر كتلة الجسم
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30. هل هناك أي توثيق / تاريخ سابق لتشخيص إرتفاع ضغط الدم؟

أ. نعم

ب. لا

31. هل هناك أي توثيق / تاريخ سابق لتشخيص مرض السكري؟

أ. نعم

ب. لا

32. هل هناك أي توثيق / تاريخ سابق لتشخيص إرتفاع الدهون في الدم؟

أ. نعم

ب. لا

33. ضغط الدم (مليمتر زئبقي)	
34. الكوليسترول	
35. الدهون الثلاثية	
36. الدهون منخفضة الكثافة	
37. الدهون عالية الكثافة	
38. مستوى السكر في الدم (صائم)	
39. الهيموجلوبين السكري لمرضى السكري (HbA1c)	
40. فيتامين د	

41. حالة العدوى بجرثومة المعدة

أ. ايجابي

ب. سلبي

42. طريقة التشخيص المستخدمة:

A. اختبار التنفس اليوريا

B. اختبار خزعة المعدة

C. كلاهما

الملخص

تعد عدوى البكتيريا الملوية البوابية (*H. pylori*) هي السبب الجرثومي الرئيسي للعديد من اضطرابات الجهاز الهضمي. كما تشير الدراسات التي أجريت حول مدى انتشار عدوى (*H. pylori*) والعوامل المساعدة لها على مجموعات سكانية ومناطق جغرافية مختلفة إلى نتائج متضاربة. تهدف هذه الدراسة إلى تقدير مدى انتشار هذه العدوى بين مجموعة من البالغين الذين تظهر عليهم الأعراض والذين يتابعون في أحد مستشفيات الرعاية الصحية الثلاثية في مملكة البحرين وفحص العلاقة بين العادات الغذائية وعوامل أخرى مع عدوى الملوية البوابية وفحص العلاقة بين العادات الغذائية وعوامل أخرى مع الإصابة بالبكتيريا ضمن مملكة البحرين. تعتمد هذه الدراسة المقطعية على التقييم التحليلي بأثر رجعي حيث تجمع بين بيانات السجلات الطبية لحالة عدوى (*H. pylori*) ، والأمراض المصاحبة الأخرى ، والمؤشرات الكيميائية الحيوية مع المعلومات الاجتماعية والديموغرافية وأنماط الحياة والعادات الغذائية باستخدام مقابلة هاتفية. أجريت الدراسة على 200 مريض في أحد مستشفيات مملكة البحرين بين يناير وسبتمبر 2021. تم استخدام استبيان معدل تكرار الطعام مصادق لجمع المعلومات حول العادات الغذائية. تم استخدام الانحدار اللوجستي الثنائي لاختبار العلاقة بين عدوى (*H. pylori*) والعوامل الاجتماعية والديموغرافية وأنماط الحياة والعادات الغذائية وعوامل أخرى متعلقة بالصحة.

بلغ معدل انتشار الإصابة بعدوى (*H. pylori*) بين المجموعة المدروسة 55.5% حيث كانت العدوى أكثر انتشاراً بين حملة الشهادة الثانوية العامة أو أقل (60.3%) مقارنة بحملة الشهادة الجامعية (44.1%) ($p = 0.035$). من بين العادات الغذائية، كان متوسط تكرار تناول الشاي الأخضر والقهوة والعسل أقل بشكل ملحوظ بين المشاركين المصابين بـ (*H. pylori*) مقارنة بنظرائهم غير المصابين. كان مستوى فيتامين (د) أقل بشكل ملحوظ بين المشاركين المصابين بعدوى (*H. pylori*) وكان كل انخفاض في فيتامين (د) في الدم مرتبطاً بزيادة خطر الإصابة بعدوى (*H. pylori*) بمقدار 1.1 مرة ($OR = 1.1$ ؛ 95% CI: 1.05 ، 1.18 ؛ $p > 0.001$).

تبين من خلال الدراسة أن المستوى التعليمي واستهلاك العسل والشاي الأخضر والقهوة ومستوى فيتامين (د) في الدم مرتبط بعدوى (*H. pylori*). هناك حاجة لدراسات إضافية لتقدير انتشار والعوامل المساعدة لعدوى (*H. pylori*) في عموم السكان.

جامعة البحرين

قسم
علوم الحياة



كلية
العلوم

العادات الغذائية و عدوى بكتيريا الملوية البوابية (*H pylori*) بين البالغين البحرينيين

أطروحة مقدمة كجزء من متطلبات الحصول على درجة الماجستير في التغذية
والنظم الغذائية

مقدمة من:

فاطمة إبراهيم هباش

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جامعة البحرين

مملكة البحرين

فبراير 2022