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Prevalence of *Helicobacter pylori* Infection among Type 2 Diabetes Mellitus Patients in Taiz City- Yemen

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مدى انتشار الإصابة بالبكتيريا الملوية البوابية بين المرضى المصابين بالسكري النوع الثاني في مدينة تعز- اليمن

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الملخص

مرضى السكري عادة هم أكثر عرضة للإصابة بالبكتيريا الملوية البوابية التي تعتبر واحده من أكثر البكتيريا الممرضة على مستوى العالم. هذه الإصابة هي حادة ومتكررة في أولئك المرضى الذين ربما عندهم خلل في جهازهم المناعي. الأهداف: هدفت هذه الدراسة إلى تحديد مدى انتشار الإصابة بالبكتيريا الملوية البوابية بين المرضى المصابين بالسكري النوع الثاني في مدينة تعز – اليمن وتحديد العلاقة بين الإصابة بالبكتيريا مع عوامل الخطورة المختلفة بين المرضى. الطريقة: أجريت الدراسة على 200 مريضا بالسكري النوع الثاني وتم تحديد الهيموجلوبين السكري A1c وسكر الدم (FBS) من عينات الدم. وتحديد مستضد البكتيريا (*H. pylori* Ag) من عينة البراز بواسطة اختبار المقايسة المناعية. النتائج: أظهرت الدراسة ان نسبة معدل انتشار الإصابة بالبكتيريا الملوية البوابية بين مرضى السكري النوع الثاني 39.5%، كما وجدت ان هناك علاقه ذات دلاله إحصائية بين الإصابة بالبكتيريا الملوية البوابيه ومؤشر كتلة الجسم (BMI)، وأعراض الجهاز الهضمي (GIT), أيضا مع مستوى الهيموجلوبين السكري .A1c. p=0.001، $p < 0.05$ وp=0.017، على التوالي. الاستنتاج: أظهرت الدراسة ان هناك انتشار للإصابة بالبكتيريا بين مرضى السكري من النوع الثاني. بالإضافة ان مستوى الهيموجلوبين السكري مرتفع في المرضي الذين لديهم ارتفاع في مؤشر كتلة الجسم، لذلك يمكن اعتبار ارتفاع مؤشر كتلة الجسم والهيموجلوبين السكري A1c كعوامل خطرة للإصابة بالبكتيريا الملوية البوابية ومضاعفات المرض السكري. لذلك أوصت الدراسة بان مرضى السكري الذين عندهم ارتفاع في مؤشر كتلة الجسم يجب انقاص وزنهم. ايضا يجب ادارة الاصابة المزمنة بالبكتيريا في التحكم في مستويات السكر في الدم لمرض السكري النوع الثاني

الكلمات المفتاحية: المرض السكري النوع الثاني، البكتيريا الملوية البوابية، تعز، اليمن.

Prevalence of *Helicobacter pylori* Infection among Type 2 Diabetes Mellitus Patients in Taiz City- Yemen

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Abstract

Background: Diabetic patients are usually more prone to *Helicobacter pylori* infection is considered as one of the most pathogenic bacteria worldwide. This infection is frequent and severe in those patients who may have defect in their immune system. Objectives: The present study is aimed to determine the prevalence of *H. pylori* infection among type 2 diabetes mellitus patients in Taiz city-Yemen and to determine the relationship between the prevalence of *H. pylori* infection among T2DM patients with different risk factors. Methods: This cross-sectional study was conducted on 200 T2DM patients. Blood samples were collected from patients to determine glycosylated hemoglobin (HbA1c), serum was prepared to determine fasting blood sugar (FBS), and stool samples were also collected to detect *H. pylori* antigen by immunochromatographic assay. Results: The prevalence of *H. pylori* infection among T2DM patients was 39.5%. There were statistically significant relationships between *H. pylori* infection and body mass index (BMI), gastrointestinal tract (GIT) symptoms, and glycosylated hemoglobin (HbA1c) among diabetic patients, $p = 0.001$, $p < 0.05$, and $p = 0.017$, respectively. Conclusion: The study confirmed that there was a prevalence of *H. pylori* infection among T2DM patients. In addition, HbA1c level was increased in diabetics with high BMI. Therefore, the high BMI and HbA1c level are considered as risk factors for *H. pylori* infection and DM complications. So, this study recommended that diabetics with high BMI should decrease their weight, and chronic *H. pylori* infection should be managed in glycemic control of T2DM.

Keywords: Type 2 diabetes mellitus, *Helicobacter pylori*, Taiz, Yemen.

Introduction

Diabetes mellitus (DM) is a metabolic disorder characterized by high blood glucose (hyperglycemia). Type 2 diabetes mellitus (T2DM) is the most common type of diabetes. It is known as "non-insulin dependent diabetes" or "adult diabetes" which is characterized by high blood glucose levels. The T2DM occurs when the body is unable to use insufficiently insulin hormone, a dysfunction known as insulin resistance and relative insulin deficiency (Grundy, 2012 & El-Sakka *et al.,* 2013). Globally, T2DM affects around 463 million persons worldwide. The prevalence of T2DM is predicted to increase to 640 million by 2040 (Sharma *et al.,* 2024). In T2DM patients, the pancreas can no longer produce enough insulin which plays an important role in energy metabolism inside the cell, where insufficient insulin leads to the accumulation of sugar in the bloodstream (He *et al.*, 2014). It is one of serious problems to health in the twenty one century. T2DM has a complex pathogenesis mechanism resulting from insufficiency of insulin secretion, insulin resistance (IR), chronic inflammation due to impaired pancreatic beta-cells, glucose toxicity, and lipotoxicity (He *et al.,* 2014). Severe hyperglycemia can lead to macrovascular complications like heart diseases and microvascular complications like retinopathy, neuropathy, and nephropathy which lead to increased mortality in persons with DM (Cole & Florez, 2022).

Helicobacter pylori (*H. pylori*) is a Gram-negative, microaerophilic, spiral shaped flagellate bacterium, and urease positive. It mainly colonizes the gastric epithelium of human and causes various upper gastrointestinal diseases such as chronic gastritis, peptic ulcer disease, gastric cancer, and mucosa-associated lymphoid tissue (MALT) (Franceschi *et al.,* 2014 & Tsay and Hsu, 2018). *H. pylori* infection is usually acquired in the childhood and persists throughout life without a specific treatment (Malfertheiner *et al.,* 2023). It is transmitted by different routes including fecal-oral, oral-oral or gastro-oral route (Malaty, 2007 & Vale and Vitor, 2010). In fact, *H. pylori* infection represents one of the most common health problems worldwide and has a high prevalence in developing countries than developed countries (He *et al.,* 2014 & Kayali *et al.,* 2018). It is more common in diabetic patients who have inappropriate metabolic control which may occur due to their immune status impairment in cellular and

humoral immunity (Kayar *et al.,* 2015 & Moalim *et al.,* 2023). In addition, the increase of *H. pylori* infection in diabetics may be due to the delayed gastric emptying and decreased gastric motility, which are important causes of dyspepsia in diabetics. *H. pylori* infection in diabetic dyspepsia is often related to blood glucose concentration (Sargin *et al.,* 2003 & Devrajani *et al.,* 2010). Hyperglycemia also plays an important role in *H. pylori* colonization in the gastric epithelium (Talley *et al.,* 2001 & Kayar *et al.,* 2015). Glycosylated hemoglobin (HbA1c) levels in diabetics with *H. pylori* infection are higher than diabetic patients without the infection (Hsieh *et al.,* 2013; Abdelaty *et al.,* 2019 & Taha, 2024). In addition, insulin action inhibition or metabolism of altered glucose may produce number of chemical changes in the gastric mucosa that help to colonization of *H. pylori.* Consequently, diabetic patients are more likely to be exposed to pathogens than healthy people (De Luis *et al.,* 1998; Wellen and Hotamisligil, 2005 & Manco *et al.,* 2010). Infection with *H. pylori* is the main risk factor for DM patients which may cause serious complications. Therefore, *H. pylori* should be eradicated to manage such a disease among populations (Kayar *et al.,* 2015 & Li *et al.,* 2024).

The correlation between diabetes mellitus and *H. pylori* infection was firstly explored by Simon *et al.,* 1989, who found out that the prevalence of *H. pylori* infection in diabetic patients was significantly higher than in asymptomatic controls. Several studies around the world have demonstrated high prevalence of *H. pylori* infection among diabetic patients 75.6%, 73%, 88.2%, 75%, 73.11% &72%, respectively. (Gulcelik *et al.,* 2005; Devrajani *et al.,* 2010; Ebule *et al.,* 2017; Wali *et al.,* 2018; Mabku *et al.,* 2020 & Younis *et al.,* 2022). The higher prevalence of *H. pylori* infection among diabetic patients in Egypt was 66.4% (Rizk *et al.,* 2016), in Qatar was 73.5% (Bener *et al.,* 2020), in Yemen was 49% (Al-Awadhi *et al.,* 2020), in Iraq was 73.3% (Saeed, 2021), in Libya was 72% (Younis *et al.,* 2022), and Sudan was 52.9% (Moalim *et al.,* 2023).

Diabetes mellitus is the most serious and common disease that causes death globally, especially in Yemen. According to the latest World Health Organization data published in 2020, diabetes mellitus deaths in Yemen reached 1,794 or 1.15% of total deaths. The age adjusted death rate was 15.42% per 100,000 of population which ranks Yemen to be number 120 in

the world (World Health Ranking, 2020). Diabetic patients are susceptible to *H. pylori* infection. Knowledge of the prevalence of *H. pylori* infection among DM patients and the risk factors helps to control and manage such a disease. This study is designed to investigate the prevalence of *H. pylori* infection among T2DM in Taiz city–Yemen and to determine the relationship between the prevalence of *H. pylori* infection among T2DM patients with different risk factors which, in turn, help in providing us with the important data that is useful in the medical and epidemiological fields.

Materials and Methods

Study design

A cross-sectional study was conducted on 200 type 2 diabetes mellitus patients attended endocrine and diabetes clinics in some public hospitals, and private clinics in Taiz city-Yemen, during the period from November 2022 to February 2023.

Sample size

The sample size was calculated by Cochran's formula as follows:

$$Sample\ number(n) = \frac{Z^2(p)\ (1-p)}{d^2}$$

where Z= significance level (1.96) at 95% confidence level, P= the expected prevalence of *H. pylori* infection in diabetic patients was 85% (Hamed *et al.*, 2008), and d= level of precision (0.05).

Study population

The study included 200 participants with type 2 diabetes mellitus. Samples were taken under the following inclusion and exclusion criteria: Inclusion criteria including, patients who have type 2 diabetes mellitus and given consent to participate in this study. Exclusion criteria including, patients of type 1 diabetes mellitus, patients having already a history of *H. pylori* eradication therapy, patients who administrated *H. pylori* antibiotics in the last 4 months, patients with a history of non-steroidal anti-inflammatory drugs in the last 4 months and patients who performed a surgery of upper gastrointestinal tract.

Data collection

Data were collected from all participants by using questionnaire which including, sociodemographic characteristics (age, gender, education level)

and risk factors including, smoking, Qat chewing, feeding habit, hypertension, dyspepsia, antibiotics use, body mass index, in addition to clinical data symptoms (gastrointestinal tract symptoms and DM complications).

Samples collection

Blood samples

The blood samples were collected from patients to detect the glycosylated hemoglobin (HbA1c) and fasting blood sugar (F.B.S). Four milliliter of venous blood was aseptically collected from each patient by venipuncture. Two milliliters of blood was put in a sterile tube without an anticoagulant to detect fasting blood sugar. The another 2 ml of blood was put in another tube with an anticoagulant, 0.04 ml of ethylene diamin tetra acetic acid (EDTA) to detect the glycosylated hemoglobin (Ceron *et al.*, 2008). Then both tubes were labeled by patient's name.

Stool samples

Stool samples were collected in a clean and dry containers for detection of *H. pylori* antigen by immonochromatographic assay. The advantage of this method was 95% sensitivity and 80% specificity (Sultana *et al.*, 2021).

Laboratory diagnosis

Blood samples

Fasting blood sugar and glycosylated hemoglobin were determined by using the COBAS INTEGRA 400 plus analyzer method (Roche, 2011).

Stool samples

H. pylori antigen in stool samples was detected by immunochromatographic assay (ICT) according to the instructions of the manufactured company of the kit (Safecare Biotetch- china)

Statistical analysis

The data were collected, organized, tabulated, and statistically analyzed using SPSS (Statistical Package for Social Sciences) version 24.0. Continuous variables were shown as mean ± standard deviation, whereas frequency and percentage were used for the presentation of categorical variables. Chi-square ($\chi 2$) test and Fischer's exact test were used to assess categorical variables. The Student's t-test was used to determine the means of two independent groups. Logistic regression analysis was performed to identify the risk factors correlated with the presence of *H. pylori* infection

among T2DM patients. It is considered statistically significant at *p*-value < 0.05. Odds ratios and their 95% confidence intervals were calculated.

Results

The prevalence of *H. pylori* infection among the diabetic patients was shown in Figure (1). *H. pylori* positivity was found in 79 (39.5%) of T2DM patients while 121 (60.5%) of the T2DM patients were negative.

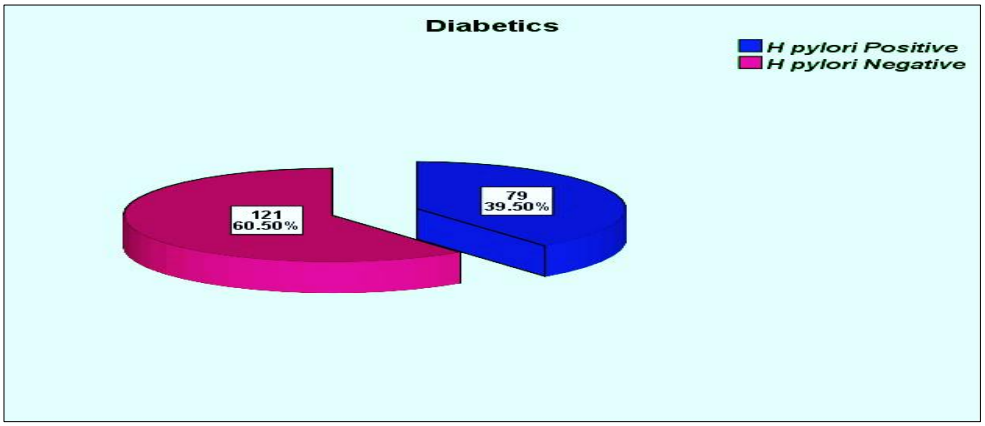

Figure 1. The prevalence of *H. pylori* infection among T2DM patients in Taiz city– Yemen, 2023

According to age, the highest prevalence of *H. pylori* infection was found among age group of 40-49 years, 47.6%, followed by the age group of ≥ 60 years, 40%. The prevalence of *H. pylori* infection in relation to age group was found to be non-significant among the diabetic patients, *p*-value= 0.599, Fisher test= 1.86. (Table 1). Among T2DM patients, the results showed that the females were higher positive for *H. pylori* infection 46.2% than males 33.9%, but with no significant relationship, where *p*-value= 0.079, χ^2= 3.093, and OR:0.6 (95% CI 0.34-1.06). (Table 1). Similarly, the highest prevalence of *H. pylori* infection among T2DM patients was found in diabetics with primary education, 53.8%, while the lowest prevalence of *H. pylori* infection was found in diabetics with secondary education, 34.4%. The results showed no-significant relationship, where *p*-value= 0.420, $\chi 2$ = 2.849. (Table 1).

Table 1. The relationship between *H. pylori* positivity and sociodemographic characteristics among T2DM patients in Taiz city- Yemen, 2023

Variable	Total	*H. pylori* positivity n =79 N (%)	*H. pylori* negativity n =121 N (%)	χ^2	*OR (95% CI)*	*p- value*
Gender						
Male	**109**	**37 (33.9%)**	**72 (66.1%)**	**3.093**	**0.6 (0.34-1.06)**	**0.079**
Female	**91**	**42 (46.2%)**	**49 (53.8%)**			
Age group				**Fisher test**		
30-39	**9**	**3 (33.3%)**	**6 (66.7%)**			
40-49	**42**	**20 (47.6%)**	**22 (52.4%)**	**1.86**		**0.599**
50-59	**79**	**28 (35.4%)**	**51 (64.6%)**			
≥60	**70**	**28 (40%)**	**42 (60%)**			
Education Level				χ^2		
Illiterate	**79**	**29 (36.7%)**	**50 (63.3%)**			
Primary	**26**	**14 (53.8%)**	**12 (46.2%)**	**2.849**		**0.420**
Secondary	**32**	**11 (34.4%)**	**21 (65.6%)**			
Graduate	**63**	**25(39.7%)**	**38 (60.3%)**			

OR (95%CI): odd ratio, 95 confidence interval, p ≤ 0.05 significant

The relationship between *H. pylori* positivity and risk factors among T2DM patients was shown in table 2. *H. pylori* positivity has no significant relationship with smoking, Qat chewing, feeding habits, hypertension, dyspepsia and antibiotic use (all $p > 0.05$). According to BMI, the highest positivity for *H. pylori* infection was observed in obese diabetics, 50%, followed by diabetics with overweight, 45.8%, mean ± SD (31. 08 ± 4.77). Therefore, there was a strong statistically significant relationship between BMI and *H. pylori* positivity among T2DM patients, where the *p*-value= 0.001, t =6.3. Table 2. Regarding HbA1c, the level of HbA1c was higher in diabetics with *H. pylori* infection than in diabetics without infection, mean ± SD (9.3 ± 2.1%), (8.5 ± 2.2%), respectively, where the *p*-value= 0.017, t = 2.4. Therefore, there was a high statistically significant relationship between HbA1c and *H. pylori* infection. Similarly, the diabetics with *H pylori* infection had high level of fasting blood sugar than in diabetics without *H. pylori* infection, mean ± SD (179.16 ± 88.50), (156.46 ± 72.22), respectively, where *p*-value= 0.048, t= 1.99. Therefore, there was a statistically significant relationship between FBS and *H. pylori* positivity among diabetic patients. (Table 2).

Table 2. The relationship between *H. pylori* positivity and risk factors among T2DM patients in Taiz city- Yemen, 2023

Variable		*H. pylori* positivity n =79 N (%)	*H. pylori* negativity n =121 N (%)	χ^2/t	*p- value*
Smoking	Yes	19 (38.8%)	30 (61.2%)	0.014	0.905
	No	60 (39.7%)	91 (60.3%)		
Qat chewing	Yes	58 (39.7%)	88 (60.3%)	0.012	0.914
	No	21 (38.9%)	33 (61.1%)		
Feeding at home	Outside	71 (38.8%)	112 (61.2%)	0.444	0.505
	Inside	8 (47.1%)	9 (52.9%)		
Hypertension	Yes	48 (36.6%)	83 (63.4%)	1.299	0.254
	No	31 (44.9%)	38 (55.1%)		
Dyspepsia	Yes	56 (43.1%)	74 (56.9%)	1.989	0.158
	No	23 (32.9%)	47 (67.1%)		
Antibiotic use	Yes	12 (41.4%)	17 (58.6%)	0.050	0.823
	No	67 (39.2%)	104 (60.8%)		
BMI (kg/m^2)				6.3	0.001
Underweight < 18		0 (0%)	4 (100%)		
Normal weight 18.6–24.9		19 (27.5%)	50 (72.5%)		
Overweight 25–29.9		38 (45.8%)	45 (54.2%)		
Obese > 30		22 (50%)	22 (50%)		
BMI Mean ± SD		31. 08 ± 4.77	27.12 ± 4.0		
HbA1c% Mean ± SD		9.3 ± 2.1	8.5 ± 2.2	2.4	0.017
FBS mg/dl Mean ± SD		179.16 ± 88.50	156.46 ± 72.22	1.99	0.048

p ≤ 0.05 significant, t: student t test

Results showed that, the presence of symptoms as vomiting, nausea, abdominal pain and diarrhea among type 2 diabetics with *H. pylori* infection were higher than diabetics without *H. pylori* infection; vomiting was 78.8% vs. 21.2%, where *p*-value was 0.001, nausea was 66.7% vs. 33.3%, *p*-value 0.001, abdominal pain was 58.3% vs. 41.7%, *p*-value 0.002 and diarrhea was 69.2% vs. 30.8%, *p*-value 0.001. Therefore, there was a strong

statistically significant relationship between GIT symptoms and *H. pylori* infection. (Table 3).

Table 3. The relationship between *H. pylori* positivity and gastrointestinal symptoms among T2DM patients in Taiz city- Yemen, 2023

Symptom	*H. pylori* positivity (n=79) N (%)	*H. pylori* negativity (n=121) N (%)	*OR (95% CI)*	*p- value*
Vomiting	**41 (78.8%)**	**11 (21.2%)**	**10.8 (5.0-23.1)**	**0.001**
Nausea	**32 (66.7%)**	**16 (33.3 %)**	**4.5 (2.23-8.92)**	**0.001**
Abdominal pain	**28 (58.3%)**	**20 (41.7%)**	**2.8 (1.42-5.39)**	**0.002**
Diarrhea	**27 (69.2%)**	**12 (30.8%)**	**4.7 (2.21-10.04)**	**0.001**

OR (95%CI): odd ratio, 95 confidence interval, p ≤ 0.05 significant

There was no significantly relationship between *H. pylori* infection with neuropathy, 39%, *p*-value= 0.909, nephropathy 39.7%, *p*-value= 0.971 and retinopathy, 46.6%, *p*-value 0.069. (Table 4).

Table 4. The relationship between *H. pylori* positivity and DM complications among T2DM patients in Taiz city- Yemen, 2023

Complication	*H. pylori* positivity (n=79) N (%)	*H. pylori* negativity (n=121) N (%)	*OR (95% CI)*	*p- value*
Neuropathy	**32 (39%)**	**50 (61.4%)**	**0.97 (0.54-1.72)**	**0.909**
Nephropathy	**25 (39.7%)**	**38(60.3%)**	**1.01 (0.55-1.86)**	**0.971**
Retinopathy	**41 (46.6%)**	**47(53.4%)**	**1.69 (0.95-3.01)**	**0.069**

OR (95%CI): odd ratio, 95 confidence interval, p ≤ 0.05 significant

The correlation between BMI and HbA1c which is considered as a risk factor for *H. pylori* infection among diabetic patients was studied. It was found that there was a strong statistically significant correlation between BMI, *p*-value= 0.009, OR 0.59 (0.40 -0.88) and HbA1c, *p*-value= 0.021, OR 0.58 (0.36 -0.92). (Table 5).

Table 5. The correlation between BMI and HbA1c as a risk factor for *H. pylori* infection among T2DM patients in Taiz city- Yemen, 2023

Variable	OR (95%Cl)	*p- value* *
BMI	**0.59 (0.40 -0.88)**	**0.009**
HbA1c	**0.58 (0.36 -0.92)**	**0.021**

****Logistic regression***

Discussion

In the present study, the prevalence of *H. pylori* infection was 39.5% among T2DM patients. This result was close to some previous studies by Anastasios *et al.* (2002), 37.3%; Zekery and Abd Elwahid, (2013), 40%; Tiktook *et al.* (2019), 38.4% & Ahmed *et al.* (2024), 39.7%. However, studies reported higher percentages of *H. pylori* prevalence by Pareek and Kannan, (2014), 88%; Ebule *et al.* (2017), 88.2%; Amir *et al.* (2020), 79.4% & Younis *et al.* (2022), 72%. The difference in the prevalence of *H. pylori* infection may be due to the use of different methods or a small sample size. Those studies have confirmed the prevalence of *H. pylori* infection among diabetics patients. The relating results were supported by previous studies as (El-Sakka *et al.,* 2013; Memon and Ali, 2020; Man *et al.,* 2020; Saeed, 2021 & Moalim *et al.,* 2023). In contrast, other studies reported no relationship between *H. pylori* infection and diabetes mellitus (Nasif *et al.,* 2016; Alzahrani *et al.,* 2020 & Maciel *et al.,* 2023). This may be due to the different socioeconomic status, poor personalityand public hygiene.

Among T2DM patients, the prevalence of *H. pylori* infection was found to be higher in the age group of 40-49y, 47.6%, but with no statistically significant relationship, $p= 0.599$. Such a result was in agreement with Sayılar *et al.* (2015); Saeed, (2021) & Younis *et al*. (2022) who reported no statistically relationship between *H. pylori* infection and age. In contrast, Dai *et al.* (2015) found out that, the *H. pylori* infection status was significantly associated in childhood and adolescence which indicates poor glycemic control. Result of this study was showed no statistically significant relationship, it may be due to the late acquisition of the infection, while with Dai was reported that participants have poor glycemic control. Regarding to the gender of the participants, this study found that the prevalence of *H. pylori* infection was higher in females, 46.2% than males 33.9%, but with no statistically significant relationship, $p= 0.079$. These results go in the same line with other studies which reported that there was no statistically significant relationship between gender and *H. pylori* infection among diabetics (Sayılar *et al.,* 2015; Al-Awadhi *et al.,* 2020; Saeed, 2021 & Maciel *et al.,* 2023). On the other hand, previous studies were in disagreement with the results of this study where it reported a statistically significant relationship between the prevalence of *H. pylori* infection and

gender of the diabetics (Saadallah *et al.*, 2013 & Adeleye *et al.*, 2019). The high prevalence of *H. pylori* infection among female diabetics than males in this study could be due to the stress or food habits. In this study, the prevalence of *H. pylori* infection was found to be higher in diabetics with primary education, 53.8%, but with no statistically significant relationship, p= 0.420. Such a result was in agreement with Al-Awadhi *et al.* (2020); Younis *et al.* (2022) & Moalim *et al.* (2023), while it was in disagreement with other studies by Hamrah *et al*. (2017) & Saeed *et al.* (2024). The reason of increasing the prevalence of *H. pylori* infection in this study could be due to poor health information of those patients.

The present study also revealed that, the prevalence of *H. pylori* infection in obese diabetics and those with overweight are higher when compared with diabetics who had normal weight. This study confirmed a strong significant relationship between *H. pylori* infection and body mass index (BMI) of T2DM patients, p= 0.001. In this study, diabetic patients who had obesity were more prone to *H. pylori* infection. This could be due to the impairment of immune system or frequency of eating food. Also, those obese diabetics had high level of HbA1c. Therefore, both high BMI and HbA1c are considered to be risk factors for *H, pylori* infection. These results were in agreement with the previous studies that confirmed a significant relationship between *H. pylori* infection and BMI of diabetic patients (Sayılar *et al.*, 2015; Haj *et al.*, 2017; Bener *et al.*, 2020; Mabeku *et al.*, 2020 & Zhou *et al.*, 2022). However, the results were in a disagreement with Adeleye *et al*. (2019); Tawfeeq *et al*. (2019); Eisa *et al*. (2020) & Boyina *et al.* (2024) who reported no significant relationship between BMI and *H. pylori* infection among diabetic patients. In this study, 47.1% of T2DM patients infected with *H. pylori* were feeding outside home but with no statistically significant relationship, p= 0.505. The reason of increasing *H. pylori* positivity among diabetics feeding outside home could be due to the food contamination by *H. pylori*. However, there is no previous study to discuss the relationship between feeding habit and *H. pylori* positivity among diabetic patients.

Regarding smoking, this study showed no statistically significant relationship between smoking and infection with *H. pylori* positivity, p= 0.905. This result was in a good agreement with other studies conducted in

China by Man *et al*. (2020) & Zhou *et al*. (2022), in Libya by Younis *et al.* (2022) and Yemen by Al-Awadhi *et al.* (2020), while it was in disagreement with the study conducted in Sudan by Moalim, (2023) who reported a significant relationship between *H. pylori* infection and smoking. Moreover, this present study found no significant relationship between *H. pylori* positivity and Qat chewing among T2DM patients, p= 0.914. There was no previous study which agreed with this result, while it was in disagreement with another study conducted in Yemen that revealed a statistically significant relationship between *H. pylori* infection and Qat chewing (Al-Awadhi *et al.,* 2020). This could be explained by Qat contamination with *H. pylori.* Regarding to chronic diseases among participated patients, the present study revealed that, there was no statistically significant relationship between hypertension and infection with *H. pylori*, p= 0.254. This result goes in the same line with a previous study conducted in China by Man *et al*. (2020) and another study conducted in India by Agrawal *et al*. (2023) which reported that no statistically significant relationship between *H. pylori* positivity and hypertension. However, it was in disagreement with several studies reported that, there was a significant relationship between hypertension and *H. pylori* infection (Kayar *et al.,* 2015; Sayılar *et al.,* 2015; Bener *et al.,* 2020 & Zhou *et al.,* 2022). The present study also found that, there was no statistically significant relationship between antibiotic use and *H. pylori* positivity, p= 0.823. Such a result has never reported yet elsewhere.

Although, the prevalence of *H. pylori* infection was higher in diabetic patients who had dyspepsia than those who didn't have dyspepsia, but with no significant relationship, p= 0.158. This result was in a good agreement with other studies which reported similar results (Mohamady *et al.,* 2013; Ebule *et al.,* 2017 & Saeed, 2021). Regarding to the gastrointestinal tract (GIT) symptoms, the present study found a statistically significant relationship between GIT symptoms in diabetics with the *H. pylori* infection, p <0.05. This result also goes in the same line with other studies conducted in Turkey by Bener *et al.* (2020) and Somalia by Al Mamari and Almiyah, (2024) who revealed that, the *H. pylori* infection was related to GIT symptoms in diabetics. Contradictory, this result was in disagreement with other studies conducted in Egypt by Mohamady *et al.* (2013) and Libya by Younis *et al.* (2022) who reported no significant relationship between *H. pylori* infection and GIT symptoms. The results of this study also showed

that, the *H. pylori* infection was not related with DM complications such as nephropathy, neuropathy, and retinopathy, $p > 0.05$. Some studies were in a disagreement with this result which reported that, *H. pylori* positivity was significantly associated with the presence of neuropathy and nephropathy among diabetics (Kayar *et al.*, 2015). However, Demir *et al.,* (2008) found a statistically significant relationship between *H. pylori* infection and the presence of neuropathy among diabetic patients.

Moreover, this study found a statistically significant relationship between *H. pylori* infection and high level of fasting blood sugar (FBS) among T2DM patients, $p= 0.048$. This result matches well with what have been reported previously by Rafat *et al*. (2015); Eisa *et al.* (2020) & Younis *et al.* (2022). The present study also found a higher level of glycosylated hemoglobin (HbA1c) among T2DM patients with *H. pylori* infection compared with those who are non-infected with a statistically significant relationship, $p= 0.017$. Many studies confirmed significant differences in the HbA1c level among diabetic patients infected with *H. pylori* and those who are non-infected. Therefore, the infection with *H. pylori* was related to the high of HbA1c level among DM patients (Chen & Blaser, 2012; Hsieh *et al.*, 2014; Abdelaty *et al.*, 2019; Chen *et al.*, 2019 & Wan *et al.*, 2020). The results of this study also found a correlation between the high HbA1c level and BMI among diabetic patients, which considered as a risk factors for *H. pylori* infection among T2DM patients. Similar results were reported in Egypt by Mohamady, (2013) and Somalia by Al Mamari and Almiyah, (2024) who found that, both high BMI and HbA1c level are risk factors for *H, pylori* infection.

Conclusion

This study confirmed the prevalence of *H pylori* infection among type 2 diabetic patients. It has been found that HbA1c level was increased in diabetics with high BMI. Therefore, both high BMI and HbA1c level are considered to be risk factors for *H. pylori* infection and DM complications.

Recommendations

T2DM patients should undergo routine monitoring for diagnosis of *H. pylori*, which is considered as a risk factor in the development of DM complications. Diabetics with high BMI should decrease their weight. The chronic *H. pylori* infection should be managed in glycemic control of

T2DM. Additionally, awareness of T2DM patients should be carried out on how to avoid *H. pylori* infection and it's spread. This could be through conducting hygienic programs including personal, food, and drink hygiene.

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