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Estimate the Prevalence of *Helicobacter pylori* Infection among Diabetes & Non-Diabetes Mellitus Patients and Its Correlation with Malignant Gastritis Patients Attending in Lower Shabelle Region (Somalia)

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Abstract

Background: Several conducted studies have reported a higher and more frequent *Helicobacter pylori* infection rate in type 2 diabetes mellitus (T2DM). The aim of this study was to estimation the prevalence of *H. pylori* and its association between *H. pylori* infection and T2DM. **Materials and Methods:** A sectional-cross study was conducted based on 200 patients studded with socioeconomic characteristics through a questionnaire & *H. pylori* was diagnosed by serum anti-*H. pylori* immunoglobulin G (IgG) and IgA. Furthermore, patients were investigated for fasting blood glucose (FBG) levels, glycosylated hemoglobin (HbA1c), serum cholesterol, and other biochemistry parameters. **Results:** The findings showed The prevalence of *Hp* positive infection was significantly higher in the total sample was 134 with (67%). While 66 out of 200 patients with (33%) was *H. pylori* negative infection. of *H. pylori*. Further, the mean values were statistically significant for diabetes with *H. pylori* infection for IgG > 300 titer and IgA > 250 titer, regarding, HbA1C (7.52 ± 0.41) ($P < 0.001$), FBG, LHDL, triglyceride levels, uric acid and BMI (kg/m^2). The diabetic patients showed a higher prevalence rate of symptoms with ulcer stomach 47 (45.63%), muscular symptoms 36 (34.95%) and nausea 7 (22.58%). **Conclusions:** The current study revealed that *H. pylori* prevalence infections were significantly higher in diabetic patients studied compared to non-diabetic patients. Furthermore, T2DM patients infected with *H. pylori positive* reported a higher prevalence rate of symptoms than *H. pylori* negative.

Keywords

Diabetes, *Helicobacter pylori* Infection, Prevalence, Immunoglobulin G, Gastritis

1. Introduction

Helicobacter pylori (*H. pylori*), deemed an etiology of gastritis and gastritis-associated diseases, peptic ulcer, gastric adenocarcinoma and primary gastric lymphoma [1] [2] is a major public health problem both in developed and developing countries, with high burden in economically poor countries related to poor sanitary conditions.

Epidemiologic studies have indicated that about 50% of adults in developed countries and 90% of adults in developing countries are positive for *H. pylori* [3]. Peptic ulcer disease is now approached as an infectious disease [4] [5]. The role of *H. pylori* infection is increasingly recognized in gastric cancers as well as evaluating its role in other gastrointestinal (GI) diseases [6]. Elevated antibody levels against *H. pylori* also attracted the attention of some extra-gastric diseases, including diabetes mellitus [7]. Type 2 diabetes mellitus (T2DM) is turning to be a pandemic so it is responsible for the death of 3.8 million of the adult population in the world and is regarded as a serious risk for public health. [8]. Type 2 diabetes is high blood sugar levels caused by a lack of a hormone called insulin either the broken beta cells aren't making enough insulin or the insulin it makes doesn't work properly called **insulin resistance**, living with obesity or overweight, other factors include high blood pressure, age, lifestyle, family history, genetics and which is chronically observed in the patients with diabetes [9]. Diabetes may cause long-term damage to different organs, especially eyes, kidneys, nervous system, heart, and blood vessels [10]. At least 80% of the patients with diabetes will die due to the consequences of cardiac complications [11]. Evidence indicates that diabetes may be accompanied by *H. pylori* infection, which chronic and insulin-resistant inflammation may increase the risk for T2DM. In addition, gastritis resulting from *H. pylori* may potentially affect gut-related hormones and inflammatory cytokines [12] [13]. There is controversy about the link between *H. pylori* infection and diabetes as some studies indicate a higher prevalence of infection in diabetic patients [14]. Whereas in the others, no difference has been reported [15] [16]. Other studies indicated that the first time that *H. pylori* infection led to an increase the incidence of T2DM using a prospective cohort of 782 Latino individuals older than 60 years this study showed that people with *H. pylori* infection would more suffer from diabetes in comparison to healthy individuals it is found that 84.6% of diabetic patients with *H. pylori* infection had diabetics for >10 years [17]. Besides the glycemic control, diabetes duration is the main risk factor of increasing the risk of chronic diabetes-related complications, which is important in our study is the autonomic

neuropathy and gastropathy that are critical predictors for *H. pylori* infection in diabetics [18]. This finding is in agreement with the findings of a study indicating that diabetic patients with a history of retinopathy, nephropathy, or neuropathy should be presupposed to have GI abnormalities until proven otherwise [19] [20]. *Helicobacter pylori* infection is a major global public health problem recently, which affects nearly 50% to 75% of the world's population. About 70% of people in developing countries with peptic ulcer diseases and slightly lower in developed countries [21].

The objectives: this study aimed to estimate the prevalence of *H. pylori* infection and identify the correlation *H. pylori* infection with 2 diabetes, 1daibetes mellitus patients & malignant gastritis patients attending in the medical center at lower shabelle region (Somalia).

2. Materials and Methods

The study was led in a medical center at the lower Shabelle region located in south-central Somalia. A cross-sectional study design was applied from 28 January to 30 June 2023. Those patients who came to LSRMC for treatment of 2diabetes mellitus or were admitted by gastritis lymphoma symptoms were selected and sent to the laboratory to confirm *H. Pylori* states during the data collection period were taken as source population. The study patients were 200 selected patients with symptoms of chronic gastritis and 2 diabetes mellitus patients undertaking laboratory investigation for *H. pylori*.

Information about patients was gathered by nurses and participants were interviewed about the sociodemographic profile, environmental situations, individual habits and the complications of *H. pylori*. Data were collected from patients by using a structured questionnaire. The stool samples were tested according to the procedures. Samples were collected from each participant. A lesser quantity of the stool sample was transmitted to a vial with diluents, strongly agitated for 15 seconds and after that 2 to 3 drops were mixed into the round window of the test cassette. The findings were read after 15 minutes and the results are read based on the appearance. The presence of two lines, C (control) and T (test), specifies a positive test, and the presence of only one line, C (control) shows a negative result. Serology tests are also used in this method, antibodies against *H. pylori* are detected by ELISA, immunoblotting techniques and enzyme immunoassays (EIA) [22]. Although more tests for IgA, IgG, and IgM antibodies are performed, only the IgG antibody test is reliable. These tests involve the use of serum, saliva, or urine; however, the use of whole blood is still a controversial topic [23]. These Patients were also investigated for fasting blood glucose levels (FBG), HbA1c, serum cholesterol, triglycerides, high-density lipoprotein (HDL), low-density lipoprotein (LDL), urea, creatinine, and the presence of other co-morbidities conditions. Data analysis was carried out using the statistical package for social sciences, for Windows version SPSS. Categorical variables were compared with Chi-square test. $P < 0.05$ was taken as statistically significant.

3. Results Analysis

The results in Figure 1 showed a total of 200 patients men and women were included in this study. The prevalence of *H. pylori* positive infection in the total sample was 134 with (67%). While 66 out of 200 patients with (33%) was *H. pylori* negative infection.

The distribution of detected *H. pylori* infection among diabetic and Non-diabetic patients based on HPSA & HbA1c tests status is also presented in (Table 1) the prevalence of T2DM was 103 with positive *H. pylori* (n = 103) out 200 with (51.5%) *P*-value was <0.001 incidences statistical significance. Of them, 85 (42.5%) was *H. pylori* +ve with (HpSA) and 18 (9%) was *H. pylori* -ve with (HpSA). While, in this study 29 out of 200 were diagnosed as T1DM patients with (14.5%) and positive *H. pylori* from them 11 out 29 (5.5%) with positive *H. pylori* and 18 out 29 (9%) were negative with *H. pylori*. All the 132 patients with diabetes mellitus successfully completed all requirement measurements such as HbA1c was increasingly among level 5.5 - 6.5, >6.5 the results are shown in (Table 1) that T2DM, T1DM were 57 (55.33%), 11 (61.11%) respectively *P*-value was <0.001 incidences higher statistical significance.

In Table 2 the results showed, that there was a significant difference in *H. pylori* between both groups, diabetic and non-diabetic groups. The parameter of *H. pylori* ve+ infection in a diabetic patient 132 (66%) was much higher than the non-diabetic group 68 (34%) ($P = 0.001$). This study included 81 (61.36%) males and 51 (38.64%) females in the diabetic group while 43 (63.23%) males and 25 (36.76%) females in the non-diabetic group. In both groups. There were not any significant differences in gender regardless of DM and non-DM group. Even though the numbers of the males in the DM and non-DM groups were higher than that of the females in both groups. In age division, including ≤50, 50 - 60 and ≥60 years old, the difference among these ages demonstrated statistically significant ($P = 0.001$) with 79 (59.84%) at 50 - 60 years old. In the age of more than ≥60 years old, the number of cases was 32 (24.24%) and 24 (35.29% in DM and non-DM respectively, as illustrated in Table 3. BMI parameters the ratios of obese, in DM group were different (29.42 ± 4.11) to those in the non-DM group 21.42 ± 2.19, which means that there is statistically significant differences in such ratios between the two groups also the other parameters measurement the ratios of the HbA1c (%), LDL-C (mmol/L, Uric acid (μmol/L), FPG (mmol/L) showed statistically significant (*P*-value. < 0.05) and correlated with the prevalence of T2DM group and *H. pylori* positive as illustrated in Table 2.

Table 3 By comparison among diabetic patients in relation to the detection of *H. pylori* infection as regards malignant gastritis symptoms, statistically significant higher prevalence rate of symptoms with ulcer stomach. 47 (45.63%), muscular symptoms 36 (34.95%) and nausea 7 (22.58%). While, the prevalence of *H. pylori* and it relation with T2DM did not differ statistically significant according to correlation among symptoms of bloating, hypertension status, inflammation of kidneys.

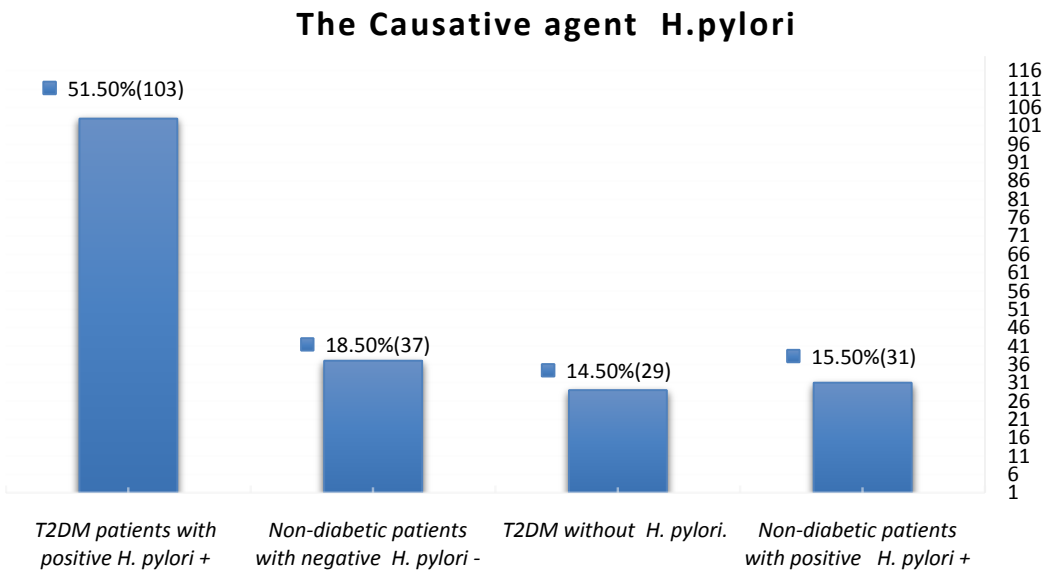

Figure 1. Prevalence of *Helicobacter pylori* infection with percentage among malignant gastritis patients attending in LSRMC, Somalia.

Table 1. Distribution of detected *H. pylori* infection among diabetic and Non-diabetic patients based on HPSA & HbA1c tests.

H. pylori infection by HPSA & HbA1c tests.	T2DM patients with positive *H. pylori* + (N = 103)	T1DM patients with positive *H. pylori* + (N11 out 29)	Diabetic mellitus patients T2DM without *H. pylori.* (N = 18 out of 103)	Non-diabetic patients with positive *H. pylori* + (N = 31)	Non-diabetic patients with negative *H. pylori* - (N = 37).	Total with percentage.
H. pylori +ve.	85	11	11	27	00	134
% with (HpSA).	(42.5%)*	(5.5%)	(5.5%)	(13.5%)	00	(67%)
H. pylori -ve.	18	00	18	00	30 (15%)	66
% with (HpSA).	(9%)	00	(9%)			(33%)
HbA1c.						
<5.5	39 (37.86%)	3 (27.29%)	4 (22.22%)	00	00	46 (34.84%)
5.5 - 6.5	57 (55.33%)*	5 (45.45%)	3 (16.66%)	00	00	65 (49.24%)*
>6.5	7 (6.79%)	3 (27.29%)	11 (61.11%)*	00	00	21 (15.90%)
*P.Value		0.43 (N.S)	0.31 (N.S)	-	-	0.001 (P.S)

- (HpSA): test: *Helicobacter Pylori* Stool Antigen Test. (HbA1c): glycohemoglobin, A1c) Test. **P*-value was <0.001 incidences statistical significance.

Table 2. Sociodemographic and clinical characteristics of patients studded with *H. pylori* infection and those without infection.

Parameters of patients.	*Helicobacter pylori* negative (n = 66)	*Helicobacter pylori* positive (n = 134)	Diabetics patients (No-132)	Non-Diabetics patients (No-68)
Gender:				
Men:	39 (50.09%)	73 (54.47%)	81 (61.36%)*	43 (63.23%)
Females:	27 (40.90%)	61 (45.53%)	51 (38.64%)	25 (36.76%)
Age (years)				
≤50	17 (25.75%)	47 (35.07%)	21 (15.90%)	11 (16.17%)
50 - 60	21 (31.81%)	39 (29.10%)	79 (59.84%)*	33 (48.52%)
≥60	28 (42.42%)	48 (35.82%)	32 (24.24%)	24 (35.29%)
Smoking (%)				
Yes:	13 (19.69%)	85 (63.43%)	97 (73.48%)	33 (48.52%)
No:	53 (80.30%)	49 (36.56%)	35 (26.51%)	35 (51.47%)

Continued

Alcohol consumption (%)				
Yes:	11 (16.66%)	87 (64.92%)*	31 (23.48%)	9 (13.23%)
No:	55 (83.33%)	47 (35.07%)	101 (76.51%)*	59 (86.76%)
BMI (kg/m^2)	23.42 ± 3.13	24.42 ± 3.17	29.42 ± 4.11*	21.42 ± 2.19
Blood pressure (mmHg).	124.67 ± 19.89	131.67 ± 17.91	147.51 ± 19.79	132.49 ± 19.66
HbA1c (%)	4.75 ± 1.22	6. 75 ± 1.24	7.52 ± 0.41*P	4.41 ± 0.39
Total Cholesterol	4.91 ± 0.90	5.93 ± 0.93	5.11 ± 1.06	4.90 ± 0.73
HDL-C (mmol/L)	1.2 ± 0.40	1.53 ± 0.53	1.41 ± 0.43	1.32 ± 0.31
LDL-C (mmol/L)	3. 13 ± 0.67	4.12 ± 0.77	3.04 ± 0.88	3.26 ± 0.72
Uric acid (μmol/L)	33.58 ± 92.46	38.70 ± 87.38	78.12 ± 85.39	340.05 ± 92.11
FPG (mmol/L)	5.69 ± 0.92	7.83 ± 1.17*	8.58 ± 2.05*	5.47 ± 0.58

BMI, body mass index; TC, total cholesterol; TG, triglycerides; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; HbA1c (%), glycated hemoglobin A1c; FPG, fasting plasma glucose.* *P*-value was <0.001 incidences statistical significance. *P*-value was without * means incidences no statistical significance. **P*-value. < 0.05 significant. **P*-value: N S.

Table 3. The comparison reported symptoms and diseases among the seropositive diabetic patients with seronegative diabetic patients (n = 200).

Disease Symptoms	T2DM with *H. pylori* positive (n = 103), n (%).	Non-DM with *H. pylori* positive (n = 31), n (%).	T1DM patients with positive *H. pylori* + (N = 29).	*P*. value
Ulcer stomach.	47 (45.63%)*	17 (54.83%)*	15 (51.72%)*	0.001
Diarrhea	9 (8.73%)	3 (9.67%)	1 (3.44%)	N.S
Muscular Symptoms.	36 (34.95%)*	1 (3.22%)	9 (31.03%)*	0.001
Inflammation of Kidneys.	3 (2.91%)	0 (0%)	2 (6.89%)	N.S
Bloating.	5 (4.85%)	2 (6.45%)	1 (3.44%)	N.S
Hypertension.	2 (1.94%)	1 (3.22%)	0 (0%)	N.S
Nausea .	1 (0.97%)	7 (22.58%)*	1 (3.44%)	0.001

4. Discussion

In the present study, we found a positive associate among *H. pylori* infection and the risk of T2DM. In (**Figure 1**, **Table 2**) presented the prevalence of T2DM was 103 with positive *H. pylori* (n = 103) out 200 with percentage (51.5%) *P*-value was <0.001 incidences statistical significance. While the findings of study on the prevalence of *H. pylori* positivity in all DM patients were 134 out of 200 patients investigated in this study with percentage (67%). The prevalence of *H. pylori* +ve in this study was higher than negative *H. pylori* where the result was 66 out of 200 patients with (33%) and incidences found statistical significance *P*-value <0.001. This result are similar with Gentile *et al.* found that the prevalence of *H. pylori* infection was 74.4% in DM patients (*P*-value < 0.001), Gentile et al. found that the prevalence of *H. pylori* was significantly higher in the T2DM group compared to the T1DM [24]. Bayati *et al.* in a study concluded that 61.5% of those with *H pylori*-positive status had one or more of the chronic diabetic complications. This finding is in agreement with the findings of our study. The global magnitude of *H. Pylori* was 70.1% in Africa, 69.4% in western Asia, 34.3%

Western Europe, 37.1% North America [25]. Turkey presented the highest prevalence (77.2%). Among the 62 countries investigated in the most recent global prevalence study in 2018, there were no informative prevalent data about *H. pylori* in Somalia. Nevertheless, stressed that there is no satisfactory explanation for the differences in *H. pylori* infection between diabetics and nondiabetics [26].

However, in neighboring countries such as Ethiopia and Uganda, the prevalence of *H. pylori* was estimated to be 49.1% and 65.9%, respectively [27]. Therefore, the estimation of *H. pylori* infection and its relation with T2DM very much needs to be explored in Somalia. However, some authors [28] did not detect and confirm an association between *H. pylori* infection and diabetes. For example, a Greek study [29] did not support an association between *H. pylori* infection and diabetes mellitus. We explained that diabetic patients are prone and correlate to chronic *H. pylori* infections because evidence indicates that diabetes may be accompanied by *H. pylori* infection, which chronic and insulin-resistant inflammation may increase the risk for T2DM. In addition, gastritis resulting from *H. pylori* may potentially affect gut-related hormones and inflammatory cytokines [30]. This relationship, some reasons can be considered to discuss it, which are summarized in the following: First, diabetes causes impairment in the function of cellular and humoral immunity, which also increases the individual's sensitivity to *H. pylori* infection. Second, it reduces GI movements and secretion of gastric acid, which in turn increases colonization and bacterial infections. Third, changes in glucose metabolism may alter chemical production in the gastric mucosa, which results in the colonization of more bacteria. [31]. More importantly, our current study demonstrated in the table-3 there were not any significant differences in gender regardless of the prevalence of *H. pylori* and DM and non-DM group. In age division, including 51 - 60 years, old it was correlated with diabetics patients 79 out 132 with percentage (59.84%) *P*-value < 0.001. While the difference among other ages groups did not demonstrate any statistically significant.

The mean of obesity (BMI parameter) in patients with *H. pylori* seropositive and DM group were higher 29.42 ± 4.11 than those in the *H. pylori*-positivity and non-DM group, which means that there was statistically significant between presence of BMI parameter and prevalence of DM patients. Furthermore, blood pressure, cholesterol, triglyceride and uric acid mean values were no significantly associated with the presence of diabetes among subjects with *H. pylori* infection. Prevalence of *H. pylori* infection correlated to HbA1c as demonstrated in **Table 3** and there was higher 7.52 ± 0.41 in patients with T2DM and T1DM, while HbA1c in the majority of patients without DM was at normal range 4.41 ± 0.39. Type 2 diabetes mellitus is a metabolic disorder characterized by the increase in blood glucose due to insulin resistance or deficiency of insulin. The subjects are more likely to be prone to *H. pylori* infection. So, it could be correlated with *Helicobacter pylori* infection, which means that chronic gastrointestinal inflammation which showed in **Figure 2** might be affected by uncontrolled glycemic

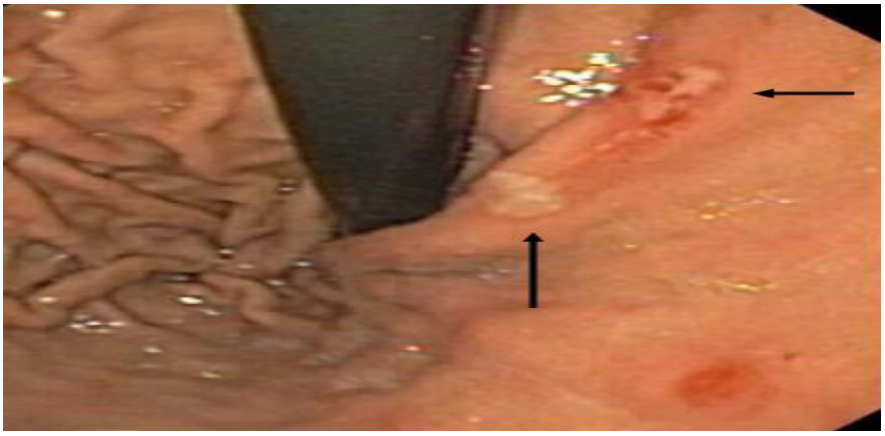

Figure 2. Endoscopic photograph which showed the gastric ulcers of stomach in positive patient with *H. pylori* gastropathy.

level and which lead to increasing the HbA1c too. **Table 3** shows the reported symptoms, signs and diseases among the diabetic patients and non-diabetic subjects with *H. pylori* infection as can be seen with rate of symptoms of muscular symptoms, ulcer stomach and nausea which were more common and correlated with prevalence of diabetic mellitus patients infected with *H. pylori* infection and the prevalence of *H. pylori* and it relate with T2DM did not find differ significantly with other symptoms such as hypertension, diarrhea, inflammation of kidneys. This finding accords with those of several studies and which also recommended preventing the *H. pylori* infection through practice good hygiene and hand washing, especially with food preparation, all positive patients with chronic gastrointestinal symptoms that may be associated with *H. pylori* infection should be tested and treated to prevent exposure to family members. Positive patients should complete the full course of therapy (antibiotics and acid blockers) to maximize the potential for a cure [31]. Medications-No single drug cures *H. pylori* infection. Most treatment regimens involve taking several medications for 14 days. Most of the treatment regimens include a medication called a proton pump inhibitor. This medication decreases the stomach's production of acid, which allows the tissues damaged by the infection to heal. Examples of proton pump inhibitors include lansoprazole (Prevacid), omeprazole (Prilosec), pantoprazole (Protonix), rabeprazole (AcipHex), dexlansoprazole (Dexilant), and esomeprazole (Nexium) [32].

5. Conclusion

The number of positive *H. pylori* in this study was common with all patients and does not only increase with the higher HbA1c parameters but also with higher BMI. It can also concluded that a significant difference in the rate of *H. pylori* infection was observed in type II DM group compared to that in the non-DM group in this study. In summary, we found that Hp infection is positively associated with the risk of T2DM, which may be further exacerbated under the coexistence of Hp infection and some traditional risk factors.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Borody, T., Ren, Z., Pang, G. and Clancy, R. (2002) Impaired Host Immunity Contributes to *Helicobacter pylori* Eradication Failure. *American Journal of Gastroenterology*, **97**, 3032-3037. https://doi.org/10.1111/j.1572-0241.2002.07121.x

[2] Bener, A., Micallef, R., Afifi, M., Derbala, M., Al-Mulla, H.M. and Usmani, M.A. (2007) Association between Type 2 Diabetes Mellitus and *Helicobacter pylori* Infection. *Turkish Journal of Gastroenterology*, **18**, 225-229.

[3] Chang, A.H. and Parsonnet, J. (2010) Role of Bacteria in Oncogenesis. *Clinical Microbiology Reviews*, **23**, 837-857. https://doi.org/10.1128/CMR.00012-10

[4] Chen, Y. and Blaser, M.J. (2012) Association between Gastric *Helicobacter pylori* Colonization and Glycated Hemoglobin Levels. *The Journal of Infectious Diseases*, **205**, 1195-1202. https://doi.org/10.1093/infdis/jis106

[5] Chey, W.D., Leontiadis, G.I., Howden, C.W. and Moss, S.F. (2017) ACG Clinical Guideline: Treatment of *Helicobacter pylori* Infection. *American Journal of Gastroenterology*, **112**, 212-239. https://doi.org/10.1038/ajg.2016.563

[6] De Luis, D.A., De La Calle, H., Roy, G., De Argila, C.M., Valdezate, S., Canton, R., *et al.* (1998) *Helicobacter pylori* Infection and Insulin-Dependent Diabetes Mellitus. *Diabetes Research and Clinical Practice*, **39**, 143-146. https://doi.org/10.1016/S0168-8227(97)00127-7

[7] Gentile, S., Turco, S., Oliviero, B. and Torella, R. (1998) The Role of Autonomic Neuropathy as a Risk Factor of *Helicobacter pylori* Infection in Dyspeptic Patients with Type 2 Diabetes Mellitus. *Diabetes Research and Clinical Practice*, **42**, 41-48. https://doi.org/10.1016/S0168-8227(98)00088-6

[8] Hooi, J.K.Y., Lai, W.Y., Ng, W.K., Suen, M.M.Y., Underwood, F.E., Tanyingoh, D., Malfertheiner, P., Graham, D.Y., Wong, V.W.S., Wu, J.C.Y., *et al.* (2017) Global Prevalence of *Helicobacter pylori* Infection: Systematic Review and Meta-Analysis. *Gastroenterology*, **153**, 420-429. https://doi.org/10.1053/j.gastro.2017.04.022

[9] Lu, H.B., Han, X.W., Ren. J.Z., *et al.* (2020) Synergic Effect of Diabetes Mellitus and *H. pylori* Infection on Proliferation of Cells via Down regulating the Expression of PTEN by Hypermethylating Its Promoter Region. https://doi.org/10.21203/rs.3.rs-20761/v1

[10] Isaeva, G.S. and Fagoonee, S. (2018) Biological Properties and Pathogenicity Factors of *Helicobacter pylori*. *Minerva Gastroenterologica and Dietologica*, **64**, 255-266. https://doi.org/10.23736/S1121-421X.18.02479-0

[11] Jeon, C.Y., Haan, M.N., Cheng, C., Clayton, E.R., Mayeda, E.R., Miller, J.W., *et al.* (2012) *Helicobacter pylori* Infection Is Associated with an Increased Rate of Diabetes. *Diabetes Care*, **35**, 520-525. https://doi.org/10.2337/dc11-1043

[12] Johannes, G., Arnoud, H. and Ernst, J. (2006) Pathogenesis of *Helicobacter pylori*

Infection. *Clinical Microbiology Reviews*, **19**, 449-490. https://doi.org/10.1128/CMR.00054-05

[13] Mansori, K., Yousef, M. and Sara, N. (2020) *Helicobacter pylori* Infection as a Risk Factor for Diabetes: A Meta-Analysis of Case-Control Studies. *BMC Gastroenterology*, **20**, Article No. 77. https://doi.org/10.1186/s12876-020-01223-0

[14] Kouitcheu, M.L.B., Noudjeu, M.I. and Leundji, H. (2018) Potential Risk Factors and Prevalence of *Helicobacter pylori* Infection among Adult Patients with Dyspepsia Symptoms in Cameroon. *BMC Infectious Diseases*, **18**, Article 278. https://doi.org/10.1186/s12879-018-3146-1

[15] Melese, A., Genet, C., Zeleke, B., *et al.* (2019) *Helicobacter pylori* Infections in Ethiopia; Prevalence and Associated Factors: A Systematic Review and Meta-Analysis. *BMC Gastroenterology*, **19**, Article No. 8. https://doi.org/10.1186/s12876-018-0927-3

[16] Mohamady, O., Ramadan, N. and Arnaout, H. (2013) The Prevalence of *H. pylori* Infection in Diabetic Patients and Its Relation to the Presence of Gastrointestinal Tract Complications. *International Journal of Academic Research Part A*, **5**, 201-209. https://doi.org/10.7813/2075-4124.2013/5-4/A.28

[17] Nurgalieva, Z., Malaty, H., Graham, D., *et al.* (2002) *Helicobacter pylori* Infection in Kazakhstan: Effect of Water Source and Household Hygiene. *The American Journal of Tropical Medicine and Hygiene*, **67**, 201-206. https://doi.org/10.4269/ajtmh.2002.67.201

[18] Ofori, E.G., Adinortey, C.A., Bockarie, A.S., *et al.* (2019) *Helicobacter pylori* Infection, Virulence Genes' Distribution and Accompanying Clinical Outcomes: The West Africa Situation. *BioMed Research International*, **2019**, Article ID: 7312908. https://doi.org/10.1155/2019/7312908

[19] Adu, P., Isaac, D., Prosper, K., *et al.* (2017) No Association between *Helicobacter Pylori* Infection and Type 2 Diabetes Mellitus; A Case-Control Study in the North-Western Part of Ghana. *Asian Journal of Medicine and Health*, **2**, 1-7. https://doi.org/10.9734/AJMAH/2017/31952

[20] Tawfeeq, R.D., Amin, Z.A., Nuraddin, S.M., *et al.* (2019) Relationship between Type II Diabetes Mellitus and *Helicobacter pylori* Infection in Erbil City. *Journal of Medical Sciences*, **23**, 43-50. https://doi.org/10.15218/zjms.2019.006

[21] Refaeli, R., Chodick, G., Haj, S., Goren, S., Shalev, V. and Muhsen, K. (2018) Relationships of *H. pylori* Infection and Its Related Gastroduodenal Morbidity with Metabolic Syndrome: A Large Cross-Sectional Study. *Scientific Reports*, **8**, Article No. 4088. https://doi.org/10.1038/s41598-018-22198-9

[22] Man, S., Ma, Y., Jin, C., *et al.* (2020) Association between *Helicobacter pylori* Infection and Diabetes: A Cross-Sectional Study in China. *Journal of Diabetes Research*, **2020**, Article ID: 7201379. https://doi.org/10.1155/2020/7201379

[23] Seyed, A., Hosseininasab, N. and Nabavi, A. (2019) The Interaction of *Helicobacter pylori* Infection and Type 2 Diabetes Mellitus. *Advanced Biomedical Research*, **8**, 15. https://doi.org/10.4103/abr.abr_37_18

[24] Sgouros, S.N. and Bergele, C. (2006) Clinical Outcome of Patients with *Helicobacter pylori* Infection: The Bug, the Host or the Environment. *Postgraduate Medical Journal*, **82**, 338-342. https://doi.org/10.1136/pgmj.2005.038273

[25] Schreiber, S., Konradt, M., Groll, C., Scheid, P., Hanauer, G., Werling, H.-O., Josenhans, C. and Suerbaum, S. (2004) The Spatial Orientation of *Helicobacter pylori* in the Gastric Mucus. *Proceedings of the National Academy of Sciences*, **101**, 5024-5029. https://doi.org/10.1073/pnas.0308386101

[26] Smith, S., Fowora, M. and Pellicano, R. (2019) Infections with *Helicobacter pylori* and Challenges Encountered in Africa. *World Journal of Gastroenterology*, **25**, 3183-3195. https://doi.org/10.3748/wjg.v25.i25.3183

[27] Stella, S., Abraham, A., *et al.* (2022) *Helicobacter pylori* Infection in Africa: Update of the Current Situation and Challenges. *Digestive Diseases*, **40**, 535-544. https://doi.org/10.1159/000518959

[28] American Diabetes Association (2019) 6. Glycemic Targets: Standards of Medical Care in Diabetes—2019. *American Diabetes Association Diabetes Care*, **42**, S61-S70. https://doi.org/10.2337/dc19-S006

[29] Tonkic, A., Vukovic, J., Cindro, P.V., Pisac, V.P., Tonkic, M. (2018) Diagnosis of *Helicobacter pylori* Infection. *Wiener Klinische Wochenschrift*, **130**, 530-534. https://doi.org/10.1007/s00508-018-1356-6

[30] Vaishnav, B., Shaikh, S., Bamanikar, A., Kakrani, A. and Tambile, R. (2018) Diagnostic upper Gastrointestinal Endoscopy and Prevalence of *Helicobacter pylori* Infection in Dyspeptic Type 2 Diabetes Mellitus Patients. *Journal of Digestive Endoscopy*, **9**, 53-60. https://doi.org/10.4103/jde.JDE_10_18

[31] Wang, F., Feng, J., Chen, P., Liu, X., Ma, M., Zhou, R., Chang, Y., Liu, J., Li, J. and Zhao, Q. (2017) Probiotics in *Helicobacter pylori* Eradication Therapy: Systematic Review and Network Meta-Analysis. *Clinics and Research in Hepatology and Gastroenterology*, **41**, 466-475. https://doi.org/10.1016/j.clinre.2017.04.004

[32] Zhou, J., Wang, X.Y., Liu, K.Y., *et al.* (2022) Association between *Helicobacter pylori* Infection and the Risk of Type 2 Diabetes Mellitus Based on a Middle-Aged and Elderly Chinese Population. *Endocrine Journal*, **69**, 839-846. https://doi.org/10.1507/endocrj.EJ21-0591