BMC Gastroenterology

RESEARCH

Open Access

Prevalence and associated risk factors of *Helicobacter pylori* infection among medical students at Shendi university, Sudan

Nemat Khalid Abd Almajed Naser[1], Mazin Babekir Musa Bashir[1] and Alhaj Saad Mohamed Ahmed Ali[2*]

Abstract

Background *Helicobacter pylori* is a significant pathogen of the gastrointestinal tract infection connected with gastritis, peptic ulcers, and gastric carcinoma. Its infection influences more than half of the world's inhabitants.

Objective This study aimed to investigate the prevalence of *H. pylori* infection among medical students. Focusing to identify associated risk factors, and provide insights to improve awareness and prevention strategies.

Materials and methods This cross-sectional study was conducted at Shendi University, Sudan, during the period from January to May 2025. The research took place in the Microbiology Laboratory, Faculty of Medical Laboratory Sciences, and included a total of 50 medical students were selected randomly. Data were collected using a structured questionnaire, and *H. pylori* infection was diagnosed using a fecal antigen test.

Results Out of the 50 participating students, 18 (36.0%) tested positive for *H. pylori* infection. The infection was more prevalent among females (46.4%) compared to males (22.7%). The highest infection rate was observed in the 22–23 age group (54.5%). Clinical symptoms such as abdominal pain ($p=0.010$) and nausea or vomiting ($p=0.026$) were significantly associated with infection. A history of previous diagnosis ($p<0.001$) and treatment ($p<0.001$) was also strongly correlated with a positive test result. However, no significant associations were found between infection and other factors such as dietary habits, hygiene practices, or smoking.

Conclusions The findings indicate a relatively high prevalence of *H. pylori* infection among medical students at Shendi University. These results highlight the need for targeted awareness campaigns and improved preventive strategies within this population.

Keywords *H. pylori*, Prevalence, Fecal antigen test, Students, Sudan

*Correspondence:
Alhaj Saad Mohamed Ahmed Ali
alhajsm198@gmail.com
[1]Department of Microbiology, Faculty of Medical Laboratory Sciences, Shendi University, Shendi Cite, Sudan
[2]Department of public health- faculty of public health, Shendi University, Shendi City, Sudan

© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by-nc-nd/4.0/.

Introduction

Helicobacter pylori (*H. pylori*) infection remains a global health **concern**, **particularly prevalent in developing countries** [1, 2]. *H. pylori* is a gram-negative, spiral-shaped, flagellated bacterium capable of producing large amounts of urease, which allows it to survive in the acidic environment of the stomach. It typically resides beneath the gastric mucus layer, in close proximity to epithelial cells [3]. Since its discovery by Warren and Marshall, *H. pylori* has been recognized as a chronic infection that may persist throughout life without treatment [4]. Recent studies have also explored its genetic variability, particularly the *vacA* genotypes, and their role in ulcerogenic and non-ulcerogenic strains [18].

It is estimated that nearly 50% of the global population is infected with *H. pylori*. The prevalence varies by socioeconomic status, population density, hygiene levels, and access to clean water. Most infections occur in childhood and persist silently into adulthood, with many individuals remaining asymptomatic carriers [5]. Although the exact transmission routes are unclear, fecal–oral and oral–oral routes are commonly proposed. Risk factors for infection include poor sanitation, unsafe drinking water, smoking, consumption of meat, and overcrowded living conditions. Interestingly, chili pepper consumption and co-existing parasitic infections have been suggested to exert protective effects [6]. Despite being largely asymptomatic, *H. pylori* infection carries a 1–2% lifetime risk of developing peptic ulcer disease and a lower than 1% lifetime risk of developing gastric MALT lymphoma [7]. Diagnostic methods include both invasive and non-invasive approaches, such as bacterial culture, urea breath test, serology, ELISA, PCR, and stool antigen testing [8]. Recent validation studies have assessed the accuracy of these methods in different populations [19].

University students have been the focus of recent research investigating the prevalence, awareness, and risk factors of *H. pylori* infection across various countries. A 2023 study in Saudi Arabia found that while over half of the surveyed medical students had a positive attitude toward the infection, less than half demonstrated adequate knowledge, with knowledge levels varying by gender and year of study [9]. In Lithuania, a longitudinal study showed a significant decline in *H. pylori* seroprevalence among medical students over the past 25 years, with no clear association with gender or dyspeptic symptoms [10]. A 2020 study in Iraq reported a 23.4% prevalence among students, with females and younger age groups showing significantly higher rates [11]. Similarly, studies from Libya and Nigeria indicated infection rates of 43% and above, often with higher prevalence among females and students aged 21–25 years [12, 13]. Earlier studies in Iraq and Yemen also reported high prevalence rates exceeding 50%, with no significant association with dietary or hygiene practices, but a tendency for higher rates among females and older age groups [14, 15, 17].

Despite this growing body of research, data on *H. pylori* prevalence and awareness remain limited in Sudan, particularly in semi-urban and underserved regions such as Shendi. These areas face notable socioeconomic vulnerabilities, which may contribute to higher infection rates. Moreover, medical students represent a key population due to their future role in healthcare delivery and public education. Understanding the prevalence and associated risk factors among this group is therefore of particular importance. This study was conducted to estimate the prevalence of *H. pylori* infection among medical students at Shendi University, identify associated risk factors such as dietary habits, hygiene practices, and family history, evaluate the influence of lifestyle behaviors like smoking and eating habits, and assess students' awareness and knowledge regarding the infection. By identifying gaps in awareness and patterns of exposure, the findings aim to inform evidence-based prevention and education strategies tailored to university populations in similar settings.

Materials and methods

Study design A descriptive cross-sectional study was conducted to determine the prevalence of *Helicobacter pylori* infection among medical students at Shendi University.

Study area The study was conducted at Shendi University, located in Shendi town, River Nile State, northern Sudan. Shendi is situated on the eastern bank of the Nile River, approximately 150 km northeast of Khartoum.

Study population The target population included undergraduate students enrolled in the Faculty of Medicine at Shendi University.

Study duration The study was conducted over a period of four months, from January to April 2025.

Inclusion criteria Medical students who were officially enrolled in Shendi University during the study period and consented to participate were included.

Exclusion criteria Students who were not enrolled in Shendi University or declined to participate were excluded. In addition, students who had used antibiotics or proton pump inhibitors (PPIs) within two weeks prior to sample collection were excluded, as these medications could affect the accuracy of the fecal antigen test.

Sampling procedure A total of 50 stool samples were collected from participating students. Students were selected using convenience sampling from different aca-

demic years and were invited to participate voluntarily after providing informed consent. Each sample was obtained using a sterile stool collection container.

Sample size The sample consisted of 50 medical students selected for stool sample testing.

Study variables The primary variables collected included age, gender, and potential risk factors associated with *H. pylori* infection.

Data collection tool Data were collected using a structured questionnaire designed to capture demographic information and relevant clinical history.

Laboratory procedures

❖ □ **Stool sample collection**

Participants were instructed to provide approximately 1–2 g of fresh fecal material in a clean, dry, leak-proof container. Samples contaminated with urine or improperly sealed were rejected.

❖ □ **Immunochromatographic test (ICT)**

✓ □ **Fecal antigen detection method**

The presence of *H. pylori* antigen in fecal specimens was detected using a commercially available rapid antigen test cassette, based on immunochromatographic technology.

✓ □ **Test kit details**

The test kit used was the "RightSign H. pylori Rapid Test Cassette", manufactured by Biotest RightSign Medical Equipment Company. The manufacturer reports a sensitivity of 94.4% and specificity of 96.3%. The unit price was 1,375 EGP.

✓ □ **Test principle**

The test detects *H. pylori* antigens in feces using antibodies specific to *H. pylori* embedded in the test strip. A visible colored line appears if the antigen is present, indicating a positive result.

✓ □ **Test procedure**

- Fresh stool specimens were collected in labeled containers.
- Using the applicator stick, three different portions of the stool were sampled and mixed into the extraction buffer tube.
- The mixture was shaken and allowed to stand for 2 min.
- Two drops (approximately 80 µl) of the prepared sample were placed into the specimen well of the test cassette.
- The test was allowed to develop at room temperature for 10 min.
- Results were interpreted according to the manufacturer's instructions.

□ **Interpretation of results**

□ **Positive result**: Two red lines appear one in the control (C) region and another in the test (T) region.

□ **Negative result**: Only one red line appears in the control (C) region; no line in the test region.

□ **Invalid result**: No control line appears or only a test line appears. In such cases, the test was repeated using a new specimen.

Data analysis and presentation

Collected data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to summarize participant characteristics and prevalence rates. Inferential statistics were applied to examine associations between variables and *H. pylori* infection. Chi-square tests were used for categorical variables, and independent t-tests were used for continuous variables where applicable. A p-value of < 0.05 was considered statistically significant.

Ethical considerations

Ethical approval was obtained from the Department of Microbiology, Faculty of Medical Laboratory Sciences, Shendi University. All participants provided written informed consent after being fully informed about the purpose and procedures of the study. Participation was entirely voluntary, and students were informed of their right to withdraw at any time without penalty or consequence. Confidentiality and privacy were strictly maintained throughout the study.

Results

In this study, out of 50 medical students tested for *Helicobacter pylori* infection at Shendi University, 18 students (36.0%) tested positive, while 32 students (64.0%) tested negative.

The prevalence was higher among females (46.4%) compared to males (22.7%), but the difference was not statistically significant ($P = 0.083$; OR = 2.89, 95% CI: 0.85–9.74) (Table 1). The highest prevalence was observed in the 22–23 age group, reaching 54.5%, although this difference also did not reach statistical significance ($P = 0.067$; OR = 3.69, 95% CI: 0.88–15.45).

Several potential risk factors were assessed, including water consumption, eating habits, and hygiene practices. Although the majority of students reported consuming untreated or unfiltered water, **there was no statistically significant association** with *H. pylori* infection ($P = 0.449$; OR = 1.53, 95% CI: 0.50–4.67).

Table 1 Distribution of *H. pylori* infection by gender and age among medical students at Shendi university ($N = 50$)

Gender	Result		Total	*P*. value
	Positive	Negative		
Male	5 (22.7%)	17 (77.3%)	22 (100.0%)	0.083
Female	13 (46.4%)	15 (53.6%)	28 (100.0%)	
Age				
18 to 19 yrs	0	6 (100.0%)	6 (100.0%)	0.127
20 to 21 yrs	1 (20.0%)	4 (80.0%)	5 (100.0%)	
22 to 23 yrs	6 (54.5%)	5 (45.5%)	11 (100.0%)	
24 to 25 yrs	11 (39.3%)	17 (60.7%)	28 (100.0%)	

Students who frequently consumed food from restaurants or street vendors had a higher infection rate than those who did not; however, this association was also not statistically significant ($P = 0.559$; OR = 1.36, 95% CI: 0.46–4.00).

Hand washing before meals did not show a significant protective effect against infection ($P = 0.118$; OR = 0.41, 95% CI: 0.13–1.27), Table 2.

Additionally, no significant relationship was observed between *H. pylori* infection and personal habits such as smoking, drinking tea/coffee, or meal skipping ($P = 0.298$; OR = 1.80, 95% CI: 0.58–5.55).

In contrast, certain clinical symptoms were significantly associated with *H. pylori* infection. Abdominal pain was significantly more common among infected individuals ($P = 0.010$; OR = 5.67, 95% CI: 1.45–22.20), as was nausea or vomiting ($P = 0.026$; OR = 4.00, 95% CI: 1.19–13.48).

A prior diagnosis of *H. pylori* infection was strongly correlated with a current positive test result (**$P < 0.001$**; OR = 12.75, 95% CI: 3.21–50.70).

Similarly, a history of previous treatment was significantly associated with a positive result (**$P < 0.001$**; OR = 10.50, 95% CI: 2.79–39.47).

On the other hand, a **family history** of *H. pylori* infection did **not show a statistically significant association** with the infection rate among students ($P = 0.481$; OR = 1.44, 95% CI: 0.49–4.24).

Finally, the findings indicated that the students had generally good awareness and knowledge about *H. pylori* infection, although the correlation between awareness levels and infection status was **not statistically significant** ($P = 0.229$), Table 3.

Discussion

This study investigated the prevalence of *Helicobacter pylori* (H. pylori) infection among medical students at Shendi University and examined its potential associations with various demographic, behavioral, and clinical factors. The results revealed a prevalence rate of 36.0%, which represents a moderate level of infection in a young, medically aware population. This finding suggests that *H. pylori* infection remains a relevant public health concern even in populations with presumed high levels of health knowledge and hygiene awareness.

The presence of infection in this cohort may be attributed to factors such as shared accommodation, common dietary habits, or exposure to asymptomatic carriers. Despite examining several risk factors, only a few demonstrated statistically significant associations. This section aims to interpret the study's findings in light of previous research, exploring both significant and non-significant associations, and discussing possible explanations such as sample size limitations, homogeneity of behaviors, or the presence of unmeasured confounders.

Table 2 Association of lifestyle factors (Water consumption, eating habits, hand washing, smoking, and caffeine Intake) with *H. pylori* infection

Consume untreated or unfiltered water	Result		Total	*P*. value
	Positive	Negative		
Yes	18 (36.7%)	31 (63.3%)	49 (100.0%)	0.449
No	0	1 (100.0%)	1 (100.0%)	
Eat food from outside				
Rarely	4 (26.7%)	11 (73.3%)	15 (100.0%)	0.559
Occasionally	4 (33.3%)	8 (66.7%)	12 (100.0%)	
Frequently	10 (43.5%)	13 (56.5%)	23 (100.0%)	
Regularly wash hands before meals	**Result**		**Total**	**P. value**
	Positive	**Negative**		
Yes	18 (39.1%)	28 (60.9%)	46 (100.0%)	0.118
No	0	4 (100.0%)	4 (100.0%)	
Habits				
Smoker	0	2 (100.0%)	2 (100.0%)	0.298
Caffeine	12 (48.0%)	13 (52.0%)	25 (100.0%)	
Not taking all	3 (25.0%)	9 (75.0%)	12 (100.0%)	
Caffeine +Smoker	3 (27.3%)	8 (72.7%)	11 (100.0%)	

Table 3 Association between clinical symptoms, medical history, and awareness with *H. pylori* infection

Clinical Symptoms		Result		Total	*P.* value
		Positive	Negative		
Abdominal Pain	Yes	16 (48.5%)	17 (51.5%)	33 (100.0%)	0.010
	No	2 (11.8%)	15 (88.2%)	17 (100.0%)	
Bloating	Yes	11 (44.0%)	14 (56.0%)	25 (100.0%)	0.239
	No	7(28.0%)	18 (72.0%)	25 (100.0%)	
Nausea or Vomiting	Yes	8 (61.5%)	5 (38.5%)	13 (100.0%)	0.026
	No	10 (27.0%)	27 (73.0%)	37 (100.0%)	
Loss of Appetite	Yes	11 (50.0%)	11 (50.0%)	22 (100.0%)	0.068
	No	7 (25.0%)	21 (75.0%)	28 (100.0%)	
Blood in Stool	Yes	1 (50.0%)	1 (50.0%)	2 (100.0%)	0.674
	No	17 (35.4%)	31 (64.6%)	48 (100.0%)	
Unexplained Weight loss	Yes	11 (50.0%)	11(50.0%)	22 (100.0%)	0.068
	No	7 (25.0%)	21 (75.0%)	28 (100.0%)	
Received treatment for *H. pylori*infection					
Yes		10 (83.3%)	2 (16.7%)	12 (100.0%)	0.000
No		8 (21.1%)	30 (78.9%)	38 (100.0%)	
Diagnosed with *H. pylori*before					
Yes		12 (70.6%)	5 (29.4%)	17 (100.0%)	0.000
No		6 (18.2%)	27 (81.8%)	33 (100.0%)	
Family history of *H. pylori infection*					
Yes		8 (42.1%)	11 (57.9%)	19 (100.0%)	0.481
No		10 (32.3%)	21 (67.7%)	31(100.0%)	
Know what *H. pylori*					
Yes		18 (40.0%)	27 (60.0%)	45 (100.0%)	0.077
No		0	5 (100.0%)	5 (100.0%)	

H. pylori is a gram-negative, microaerophilic bacterium known for its ability to colonize the gastric mucosa and contribute to chronic gastritis, peptic ulcer disease, and gastric malignancies [16]. The observed prevalence in this population underscores the need to further investigate the patterns of transmission and persistence of infection, particularly in educational institutions where students often live and eat in shared environments.

Although females showed a higher prevalence (46.4%) than males (22.7%), the difference was not statistically significant ($p = 0.083$). This trend might point to behavioral, hormonal, or healthcare-seeking differences, though conclusive associations cannot be drawn. Similar gender trends were noted in a Lithuanian study by Ieva Renata et al., which found no significant gender difference [11]. Contrastingly, Khaleel A.A. et al. reported a significant association in an Iraqi cohort [15], possibly reflecting regional behavioral or cultural variances.

The highest infection rate (54.5%) was found among students aged 22–23, although this was not statistically significant ($p = 0.067$). This finding may reflect a clustering effect due to the narrow age distribution among participants or similar environmental exposures. Comparable results from Khaleel A.A. et al. [14] found age-related differences in a younger population, suggesting the role of age may be more pronounced in broader age-range studies.

Environmental and lifestyle factors such as water source, eating habits, and hygiene practices were not significantly associated with infection. The lack of significant relationships (e.g., unfiltered water: $p = 0.449$; eating out: $p = 0.559$; handwashing: $p = 0.118$) could be due to uniform behaviors among medical students or the limited sample size reducing statistical power. These findings align with those of Ahmed M. Al-Kadassy et al. [13] and Bashdar M. Hussen et al. [14], who also found weak associations between environmental factors and *H. pylori* prevalence. Moreover, unmeasured confounders such as family socioeconomic status or early childhood exposure could have influenced infection risk but were not captured in the current analysis.

Personal habits such as smoking, tea/coffee consumption, and meal skipping also showed no significant association ($p = 0.298$). This aligns with the findings of Hussein et al. [19], who reported that alcohol and cigarette use were not significantly associated with *H. pylori* infection in Iraqi patients. These behaviors, while generally associated with gastrointestinal morbidity, may not independently influence *H. pylori* colonization in relatively healthy young adults [21].

On the other hand, specific gastrointestinal symptoms were significantly associated with infection. Abdominal pain ($p = 0.010$) and nausea/vomiting ($p = 0.026$) were notably more frequent in infected students. These findings affirm the pathogenic impact of *H. pylori* and are consistent with literature identifying the bacterium as a key contributor to upper gastrointestinal symptoms. However, the lack of association with symptoms like bloating and heartburn aligns with findings by Ieva Renata Jonaityte et al. [11], who reported mixed symptom associations.

A history of prior diagnosis ($p < 0.001$) and treatment ($p < 0.001$) was strongly correlated with current infection, suggesting possibilities of incomplete eradication, reinfection, or antibiotic resistance. This underscores the importance of monitoring treatment outcomes and tailoring therapeutic strategies based on local antibiotic resistance patterns. The inclusion of molecular methods, as advocated by Hussein et al. [20], who investigated *H. pylori* resistance mutations, could enhance diagnosis and treatment accuracy.

Interestingly, family history of infection ($p = 0.481$) and students' awareness levels ($p = 0.229$) did not significantly affect current infection rates. These findings might indicate that within this cohort, *H. pylori* transmission is not

primarily intrafamilial and that awareness alone may not equate to protective behaviors or reduced risk. Still, high awareness may partially explain the moderate infection rate, suggesting some preventive impact.

Conclusion

This study underscores the complexity of *H. pylori* transmission and the multifactorial nature of its persistence, even among knowledgeable populations. While significant associations were found with clinical symptoms and prior history, most demographic and lifestyle variables did not reach statistical significance possibly due to sample size limitations or homogeneity in participant behaviors. The results highlight the need for robust follow-up after treatment, enhanced diagnostic strategies including molecular testing, and broader studies to explore reinfection rates. Health education remains critical, but future research should also address antibiotic resistance and the role of asymptomatic carriers.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12876-025-04074-9.

Supplementary Material 1

Author contributions

NKAAN designed the study, collect and analyzed the data and designed tables, MBMB and ASMA Supervised and wrote the manuscript. All authors reviewed manuscript. All authors read and approved the final manuscript. All authors contributed significantly to this work, conceiving the idea of the research, collection and analysis of data, writing and editing of the manuscript. All authors read and approved the manuscript.

Funding

The researchers did not receive any fund from any source.

Data availability

The datasets used and analyzed during this study are available from the corresponding author or reasonable request.

Declarations

Ethical approval and consent to participate

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The study was initially approved by the ethical committee of the Faculty of Medical laboratories sciences(Institutional Research Board) at Shendi University. In addition, permission was obtained from directors of faculty, and Students to be studied. All participants provided written informed consent after being fully informed about the purpose and procedures of the study. We have also ensured that all names and personal data were completely secured to protect the privacy and confidentiality of the participants. This revision now provides full transparency regarding the ethical considerations involved in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 30 April 2025 / Accepted: 9 June 2025
Published online: 01 July 2025

References

1. Frenck RW Jr., Clemens J. Helicobacter in the developing world. Microbes Infect. 2003;5(8):705–13.
2. Sjomina O, Pavlova J, Niv Y, Leja M. Epidemiology of Helicobacter pylori infection. Helicobacter. 2018;23(e12514). https://doi.org/10.1111/hel.12514.
3. Malfertheiner P, Megraud F, O'Morain C, et al. Current concepts in the management of H. pylori infection: the Maastricht III consensus report. Gut. 2007;56(6):772–81. https://doi.org/10.1136/gut.2006.101634.
4. Arents NL, Thijs JC, Kleibeuker JH. A rational approach to uninvestigated dyspepsia in primary care: review of the literature. Postgrad Med J. 2002;78(926):707–16. https://doi.org/10.1136/pmj.78.926.707.
5. Hyelnaya CS, Ifeanyi M. Helicobacter pylori: an up-to-date overview on the virulence and pathogenesis mechanism. Brazilian J Microbiol. 2022;53:33–50. https://doi.org/10.1007/s42770-021-00652-5.
6. Mhaskar RS, Ricardo I, Azliyati A, Laxminarayan R, Amol B, Santosh W, Boo K. Assessment of risk factors of Helicobacter pylori infection and peptic ulcer disease. J Global Infect Dis. 2013;5(2):60–7.
7. Zawaya KP, Dundaj A, Adamu Y, Bathnna SJ, Liman HU, Musa JJ. Helicobacter pylori infection as a risk for upper Gastrointestinal diseases among patients in North central Nigeria. Niger J Med. 2021;30(5):607–14.
8. Rajesh B, Rattan LI. (2008). Campylobacter and Helicobacter. In Essentials of Medical Microbiology (4th ed., pp. 295–296).
9. Alajmi SM, Alsulami TM, Ben Mudayhish MA, et al. Knowledge and attitude of medical students towards Helicobacter pylori infection and its prevention and management: A study from Riyadh. Saudi Arabia Cureus. 2023;15(12):e51174. https://doi.org/10.7759/cureus.51174.
10. Jonaityte IR, Ciupkeviciene E, Jonaitis P, Kupcinskas J, Petkeviciene J, Jonaitis L. Changes in the Seroprevalence of Helicobacter pylori among Lithuanian medical students over the last 25 years and its relation to dyspeptic symptoms. Medicina. 2021;57(254). https://doi.org/10.3390/medicina57030254.
11. Khaleel AA, Abdullah SMZ, Mohammed AB, Anwer SS. (2020). Screening for Helicobacter pylori IgG among undergraduate students of Hawler medical university/college of health sciences. J Kirkuk Med Coll, 8(1).
12. Almrabet W, Elazomi A, Araibi E, Shebani B, Alrandu F, Kasheem R, Shawesh F, Mohamed AA, Nami A, Bahroun S. The prevalence of Helicobacter pylori infection and the assessment of some related factors among medical technology students. Eur J Pharm Med Res. 2019;6(12):529–35.
13. Enitan SS, et al. Screening for Helicobacter pylori infection among undergraduate students of a tertiary institution using serum antibody and stool antigen detection methods. Biomedical J Sci Tech Res. 2018;3(2):BJSTRMSID000883.
14. Hussen BM, Al-Salihi NI, Hamed AA. (2013). The prevalence of Helicobacter pylori among university students in Iraq. Indian J Sci Technol, 6(8).
15. Al-Kadassy AM, Suhail MA, Baraheem OH. The prevalence of Helicobacter pylori infection among medical sciences students of Hodeidah university, Republic of Yemen. Bull High Inst Public Health. 2013;43(1):121–6.
16. Banda JM, David OS, Ida OL, Banda SF, Ede FR, Ndubuisi JC, Joshua IA, Onyemelukwe GC. Helicobacter pylori infection and risk factors among outpatient attendees of Jos and Bingham university teaching hospitals, jos, plateau state, Nigeria. Annals Med Lab Sci. 2024;3(1):66–75.
17. Jahan H, Chowdhury OA, Uddin MJ. Helicobacter pylori infection among medical students: A study on MAG Osmani medical college, Bangladesh. Int J Med Med Sci. 2010;2(11):354–8.
18. Al-Ouqaili MTS, Hussein RA, Majeed HY, Al-Marzooq F. Study of vacuolating cytotoxin A (vacA) genotypes of ulcerogenic and non-ulcerogenic strains of Helicobacter pylori and its association with gastric disease. Saudi J Biol Sci. 2023;30(12). https://doi.org/10.1016/j.sjbs.2023.103867.
19. Hussein RA, Al-Ouqaili MTS, Majeed YH. Detection of Helicobacter Pylori infection by invasive and non-invasive techniques in patients with Gastrointestinal diseases from iraq: A validation study. PLoS ONE. 2021;16(8):e0256393. https://doi.org/10.1371/journal.pone.0256393.
20. Hussein RA, Al-Ouqaili MTS, Majeed YH. (2022). Detection of clarithromycin resistance and 23SrRNA point mutations in clinical isolates of *Helicobacter pylori*: phenotypic and molecular methods. Saudi J Biol Sci, 29(1).

21. Hussein RA, Al-Ouqaili MTS, Majeed YH. Association between alcohol consumption, cigarette smoking, and Helicobacter pylori infection in Iraqi patients submitted to Gastrointestinal endoscopy. J Emerg Med Trauma Acute Care. 2022;20226:12. https://doi.org/10.5339/jemtac.2022.aimco.12.

Publisher's note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.