

## Original article

## Epidemiological Characteristics of *Helicobacter pylori* Infection and Its Association with Demographic and Seasonal Factors Among Patients Attending Al-Bayda Teaching Medical Center, Libya: A Cross-Sectional Study

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### Abstract

*Helicobacter pylori* infection remains a significant public health concern, particularly in developing regions. This cross-sectional study investigated the epidemiological characteristics of *H. pylori* infection among patients attending Al-Bayda Teaching Medical Center, Libya, in 2025, with emphasis on demographic and seasonal factors. A total of 480 patients were included, and infection status was determined using a standardized rapid stool antigen test. The overall prevalence of *H. pylori* infection was 15.8%. Adults exhibited a significantly higher infection rate compared with children, identifying age as the principal determinant of infection ( $p < 0.001$ ). Although males showed a slightly higher prevalence than females, the difference was not statistically significant. Infection was present in all seasons, with no significant seasonal variation observed. These findings indicate persistent transmission of *H. pylori* in this population and support the need for targeted screening and effective management strategies, particularly among adults.

**Keywords.** *Helicobacter pylori*; Epidemiology; Stool antigen test; Demographic factors; Libya

**Received:** 15/10/25

**Accepted:** 17/12/25

**Published:** 28/12/25

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### Introduction

*Helicobacter pylori* is a Gram-negative, microaerophilic bacterium that colonizes the human gastric mucosa and remains one of the most prevalent chronic bacterial infections worldwide. Although infection rates have declined in some high-income countries, *H. pylori* continues to represent a major public health concern in many developing regions, where infection is frequently acquired early in life and may persist into adulthood [1]. The clinical importance of *H. pylori* infection extends beyond chronic gastritis, as it is strongly associated with peptic ulcer disease, gastric mucosa-associated lymphoid tissue (MALT) lymphoma, and gastric cancer [2,3].

The epidemiology of *H. pylori* infection shows marked variation across populations and settings, influenced by geographic location, socioeconomic status, sanitation, living conditions, and age. Numerous studies have demonstrated substantial differences in prevalence both between countries and within regions of the same country [1,4]. Age-related patterns are particularly notable, with higher infection rates commonly reported among adults compared with children, reflecting cumulative exposure and cohort effects over time [5]. In contrast, gender-related differences have shown inconsistent patterns across studies, with some reporting higher infection rates among males and others finding no significant association [6].

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Seasonal variation in *H. pylori* detection has received comparatively limited attention; however, emerging evidence suggests that environmental conditions, dietary habits, and changes in healthcare-seeking behavior across seasons may influence observed infection patterns [7]. Understanding these temporal trends is important for interpreting surveillance data and optimizing diagnostic and preventive strategies, particularly in regions where climatic and lifestyle differences across seasons are pronounced.

In Libya, available epidemiological data on *H. pylori* infection remain relatively limited and heterogeneous. Earlier studies reported high prevalence rates among both symptomatic patients and asymptomatic individuals, highlighting the endemic nature of the infection in the Libyan population [8,9]. More recent investigations have reported variations in prevalence according to age, gender, and lifestyle characteristics,

suggesting that demographic factors continue to play an important role in shaping infection patterns [10,11]. However, comprehensive local data integrating demographic and seasonal determinants within a single clinical setting remain scarce, particularly in eastern Libya. Accordingly, this study aimed to describe the epidemiological characteristics of *H. pylori* infection among patients attending Al-Bayda Teaching Medical Center in 2025 and to examine its distribution according to age, gender, and seasonal variation using a cross-sectional design. By providing updated local evidence, the study contributes to a clearer understanding of *H. pylori* infection patterns in Libya and supports future public health planning and research initiatives.

## Materials & Methods

### Study Design and Setting

This study was conducted as a cross-sectional descriptive investigation at Al-Bayda Teaching Medical Center, eastern Libya, during the year 2025. The center is a major referral and teaching hospital serving Al-Bayda city and the surrounding districts. The cross-sectional design was chosen to provide a snapshot of the epidemiological distribution of *Helicobacter pylori* infection and to assess its association with demographic and seasonal factors within the study population during the specified period.

### Study Population

The study population included patients who attended the laboratory department at Al-Bayda Teaching Medical Center and were referred for *H. pylori* testing as part of routine clinical evaluation for gastrointestinal complaints. Both adult and pediatric patients were eligible for inclusion and were categorized into two age groups: children and adults. Patients of both sexes were included without restriction. Records with missing or incomplete data on age, gender, season of testing, or *H. pylori* test results were excluded from the corresponding analyses to ensure data completeness and internal validity.

### Detection of *Helicobacter pylori*

Detection of *H. pylori* infection was performed using the *H. pylori* Antigen Rapid Test System (RT27-2143; Monocent, Inc., USA), a lateral-flow immunochromatographic assay designed for the qualitative detection of *H. pylori* antigens in human stool specimens. Stool samples were collected and processed according to routine laboratory procedures and the manufacturer's instructions. Test results were interpreted visually based on the presence of control and test lines and recorded as positive or negative.

According to manufacturer-validated performance data, the assay demonstrates a relative sensitivity of 98.8% and specificity of 98.4%, with an overall diagnostic accuracy of 98.6% when evaluated against reference endoscopy-based methods. These diagnostic characteristics support its use as a reliable, non-invasive tool for detecting active *H. pylori* infection in both adult and pediatric populations. The use of a single standardized diagnostic method across all participants ensured methodological consistency and minimized diagnostic variability during the study period.

### Variables and Data Collection

Data were retrospectively extracted from laboratory records and patient files using a structured data collection form. The variables included age group (adult or child), gender (male or female), *H. pylori* infection status (positive or negative), and season of testing. Seasons were classified as winter, spring, summer, and autumn according to the month in which the specimen was collected. All data were anonymized prior to analysis; each patient was assigned a unique study code, and no personal identifiers were included in the final dataset.

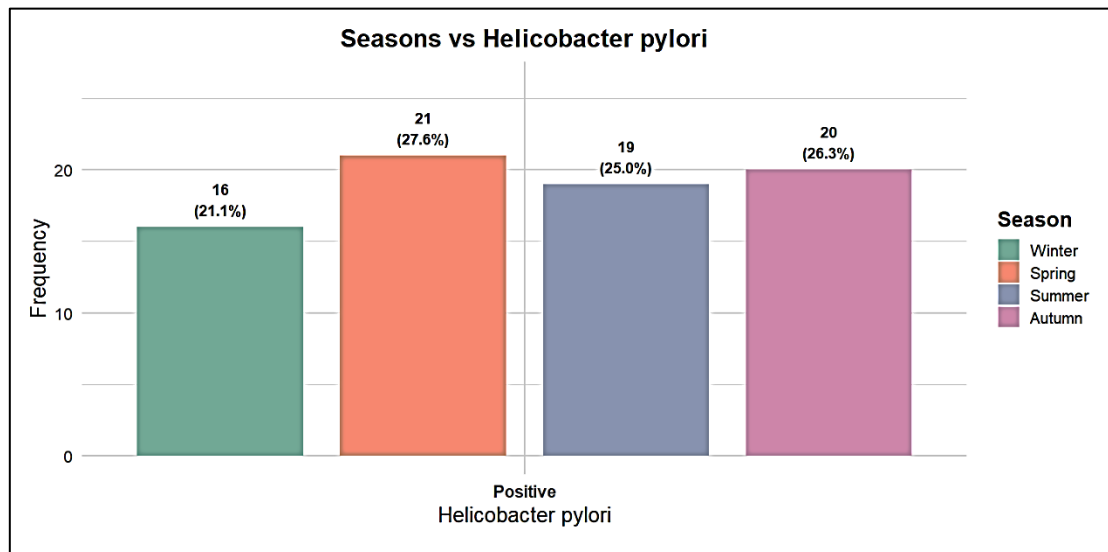
### Statistical Analysis

Statistical analysis was performed using R statistical software. Descriptive statistics were used to summarize categorical variables, and results were expressed as frequencies and percentages. Associations between *H. pylori* infection status and categorical variables (age group, gender, and season) were assessed using the chi-square ( $\chi^2$ ) test. A p-value < 0.05 was considered statistically significant. For presentation purposes, grouped bar charts were used to illustrate the distribution of infection across demographic and seasonal categories. Statistical significance values were reported alongside graphical outputs.

## Results

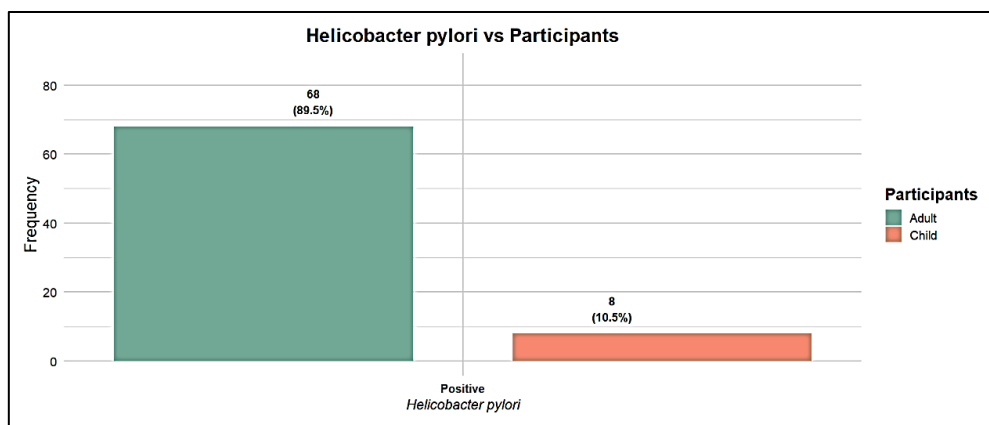
A total of 480 patients attended Al-Bayda Teaching Medical Center during 2025 and were included in the analysis. Of these, 378 were adults (79%) and 102 were children (21%). Females represented 297 participants (62%), while males accounted for 183 (38%). The study population was distributed evenly across the four seasons, with 120 patients in each season (winter, spring, summer, and autumn).

The overall prevalence of *Helicobacter pylori* infection was **15.8% (76/480)**, confirming that the bacterium remains a relevant health concern in this population. *H. pylori* infection was **present in all seasons**, and the frequency and percentage of cases by season are illustrated in Figure 1.



**Figure 1. Frequency and percentage of *H. pylori* infection by season among patients at Al-Bayda Teaching Medical Center in 2025. Infection rates were relatively uniform across seasons ( $\chi^2 = 0.737$ ,  $p > 0.001$ ).**

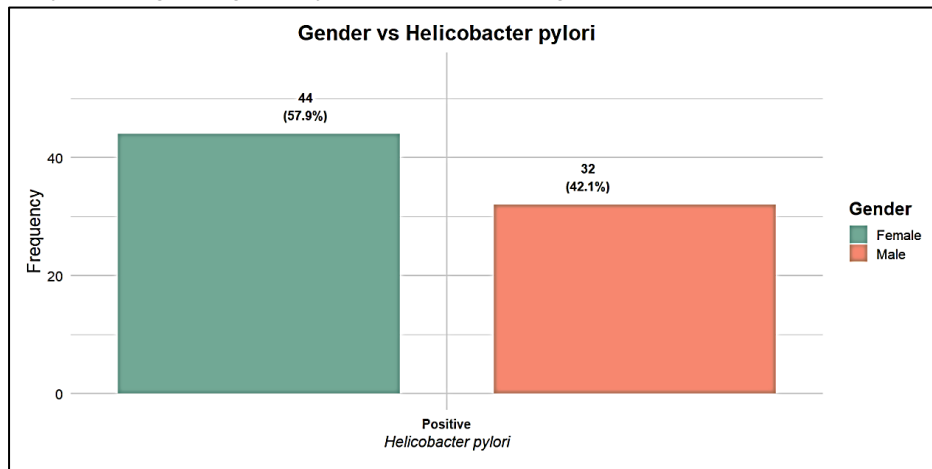
Infection rates varied slightly across seasons. Spring recorded the highest proportion of positive cases (27.6%), followed by autumn (26.3%), summer (25.0%), and winter (21.1%). However, chi-square analysis showed no statistically significant association between season and infection status ( $\chi^2 = 0.737$ ,  $df = 3$ ,  $p > 0.001$ ), indicating that *H. pylori* infection did not exhibit seasonal variation in this study population. A marked difference in infection prevalence was observed between adults and children. Among adults, 68 of 378 (18.0%) tested positive, whereas only 8 of 102 children (7.8%) were infected. This difference was statistically significant ( $\chi^2 = 47.368$ ,  $df = 1$ ,  $p < 0.001$ ), indicating that adults carried a substantially higher infection burden than children. This pattern is illustrated in Figure 2.



**Figure 2. Prevalence of *H. pylori* infection by participant type. Adults had a significantly higher infection rate compared to children ( $\chi^2 = 47.368$ ,  $p < 0.001$  is a stronger determinant of infection than seasonal variation).**

Further stratification by age and season showed that adult infections were highest in spring (29.4%) and lowest in winter (17.6%), whereas infections among children were more evenly distributed across seasons. These findings suggest that age is a stronger determinant of infection than seasonal variation. With respect to gender, 44 of 297 females (14.8%) and 32 of 183 males (17.5%) tested positive for *H. pylori*. The difference in prevalence between males and females was not statistically significant ( $\chi^2 = 1.895$ ,  $df = 1$ ,  $p > 0.001$ ), as illustrated in Figure 3.

When gender and age were examined together, adult males represented the largest proportion of infected cases (61.8% of adult infections), followed by adult females (38.2%), whereas infection among children of both genders remained low. These findings reinforce the conclusion that age, rather than gender or season, is the principal factor influencing *H. pylori* infection in this study population.



**Figure 3. Distribution of *H. pylori* infection by gender. No significant difference was observed between males and females ( $\chi^2 = 1.895$ ,  $p > 0.001$ ).**

The present study revealed that *Helicobacter pylori* infection was detected in 15.8% of the study population, with adults disproportionately affected compared to children. Age emerged as a significant determinant of infection, with adults showing considerably higher prevalence rates, while gender and seasonal variation did not exhibit statistically significant associations with infection status. The presence of *H. pylori* across all seasons suggests a consistent exposure risk throughout the year, highlighting that environmental or behavioral factors may sustain transmission regardless of seasonal changes. Among adults, males demonstrated a slightly higher prevalence than females, identifying this subgroup as the highest-risk population. These findings emphasize the need for targeted prevention and management strategies focusing on adult patients, particularly males, to effectively reduce the burden of *H. pylori* infection in this population.

## Discussion

This cross-sectional study provides updated epidemiological data on *Helicobacter pylori* infection among patients attending Al-Bayda Teaching Medical Center in eastern Libya and evaluates its association with demographic and seasonal factors. The findings confirm that *H. pylori* infection remains a relevant public health concern in this population, with clear age-related differences, while gender and seasonal variation exerted limited influence on infection prevalence.

The overall prevalence of *H. pylori* infection observed in this study (15.8%) indicates persistent circulation of the bacterium, although it is lower than rates reported in earlier Libyan studies and in several other developing countries. Previous investigations from Libya documented prevalence levels exceeding 40–60%, particularly among symptomatic individuals and asymptomatic carriers [8,9]. The lower prevalence identified in the present study may reflect gradual improvements in hygiene, living conditions, health awareness, and access to medical care. In addition, the use of stool antigen testing—which detects active infection rather than prior exposure—may yield more conservative prevalence estimates compared with serological assays used in older studies.

Age emerged as the most significant determinant of *H. pylori* infection, with adults exhibiting a substantially higher prevalence than children. This finding is consistent with global and regional epidemiological evidence demonstrating increasing prevalence with age [5,1]. The higher infection burden among adults likely reflects cumulative lifetime exposure and persistent colonization acquired earlier in life. Conversely, the lower prevalence observed among children may suggest reduced transmission in younger generations, potentially due to improved sanitation, smaller household sizes, and enhanced parental awareness of hygiene practices. The pronounced age-related disparity highlights the chronic nature of *H. pylori* infection and underscores its clinical importance, as long-standing infection in adults is associated with an increased risk of peptic ulcer disease, gastric malignancy, and other gastroduodenal complications [2,3]. These findings support the prioritization of adult populations in screening and eradication strategies.

Gender-specific analysis revealed slightly higher infection rates among males compared with females; however, this difference was not statistically significant. Similar findings have been reported in multiple studies showing inconsistent or minimal gender-related differences in *H. pylori* prevalence [6,10]. The

modest male predominance observed may be related to behavioral or occupational factors rather than biological susceptibility, but the absence of statistical significance suggests that gender alone is not a primary determinant of infection risk in this setting.

Seasonal analysis demonstrated a relatively uniform distribution of *H. pylori* infection across all four seasons, with no significant association between season and infection status. Although minor fluctuations were observed—such as a slightly higher proportion of cases during spring—these variations were not sufficient to indicate true seasonal dependency. This finding aligns with reports suggesting that *H. pylori* transmission is largely driven by long-term household and socioeconomic factors rather than short-term environmental changes [7]. The consistent presence of infection throughout the year indicates that diagnostic and screening efforts can be applied uniformly without seasonal adjustment. When age and gender were considered together, adult males constituted the largest proportion of infected cases. This pattern reflects the combined influence of age-related accumulation of infection and minor gender differences, identifying a subgroup that may benefit most from targeted screening and treatment interventions.

From a public health perspective, the persistence of *H. pylori* infection across demographic groups emphasizes the need for continued surveillance and integrated management strategies. Although prevalence appears lower than historical estimates, untreated infection may contribute to future gastrointestinal morbidity. The findings support the incorporation of non-invasive diagnostic methods, such as stool antigen testing, into routine clinical evaluation, particularly for adult patients presenting with gastrointestinal symptoms.

Several limitations should be acknowledged. The cross-sectional design precludes causal inference and limits assessment of infection dynamics over time. Reliance on a single diagnostic method, while ensuring consistency, may have influenced prevalence estimates. Additionally, socioeconomic and clinical variables were not included, which may have provided further insight into infection risk factors. Despite these limitations, the study benefits from a relatively large sample size, balanced seasonal representation, and standardized diagnostic procedures.

## Conclusion and Recommendations

In conclusion, *Helicobacter pylori* infection remains prevalent among patients attending Al-Bayda Teaching Medical Center, with adults—particularly males—bearing the greatest burden. Age is the primary determinant of infection, whereas gender and seasonal variation play limited roles. These findings contribute important contemporary epidemiological data from eastern Libya and support sustained public health efforts aimed at early detection, treatment, and prevention of *H. pylori* infection.

**Conflict of interest.** Nil

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