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The association between *Helicobacter pylori* infection and body mass index in preschool children

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Abstract:
Helicobacter pylori (*H. pylori*) is a common bacterial infection that colonizes the human stomach and can lead to gastritis, peptic ulcers, and gastric cancer. This study investigated the association between *H. pylori* infection and body mass index (BMI) in preschool children. The study included 80 *H. pylori*-infected children as cases, and 20 uninfected children as controls, aged 4-5 years in Iraq. Anthropometric measurements were taken to calculate BMI-for-age z-scores. *H. pylori* infection was confirmed through stool antigen testing. Multivariable logistic regression analysis was used to assess the relationship between *H. pylori* positivity and BMI z-score, adjusting for age, sex, and socioeconomic status. The overall *H. pylori* prevalence was 80% in the case group and 0% in the control group. After adjustment, *H. pylori*-infected children had 2.71 times higher odds (95% CI: 1.33-5.48) of having a BMI z-score above the 85th percentile compared to controls. The results demonstrate a significant positive association between pediatric *H. pylori* infection and increased BMI in preschoolers. Further longitudinal studies with larger sample sizes are warranted to validate these findings and elucidate potential mechanisms.

Keywords: *Helicobacter pylori*, body mass index, obesity, preschool children

Introduction Background

Helicobacter pylori (*H. pylori*) is a gram-negative, microaerophilic bacterium that colonizes the gastric mucosa in humans (Su Cho, *et al* 2021). Infection with *H. pylori* is very common, affecting approximately 50% of the global population. However, prevalence rates vary considerably between countries, with higher rates generally observed in developing nations (Hooi, *et al*. 2017). *H. pylori* infection is typically acquired during childhood and, in the absence of antibiotic treatment, persists for life (Matos, *et al*.2020). *H. pylori* infection is associated with several upper gastrointestinal diseases including chronic active gastritis, peptic ulcer disease, mucosa-associated lymphoid tissue (MALT) lymphoma, and gastric adenocarcinoma (Sugano *et al*., 2015). The presence of *H. pylori* bacteria within gastric epithelium leads to chronic inflammation, which over time can progress to more severe outcomes. *H. pylori* is recognized as a definitive carcinogen by the World Health Organization (IARC, 1994). Eradication of *H. pylori* in infected individuals has been demonstrated to aid in the management of many associated conditions. The prevalence of childhood *H. pylori* infection shows variability based on geographic region, socioeconomic status, and living conditions. In developed countries, the prevalence in children is much lower compared to developing nations. For example, studies estimate *H. pylori* prevalence between 0.5-1% in children in Canada, England, and the United States, while prevalence reaches 50-80% in many developing countries (Leal *et al*., 2011; Saleem *et al*. 2025, 1993; Malaty *et al*., 2002). Risk factors for acquisition of *H. pylori* in childhood include low socioeconomic status, crowded living conditions, contaminated food/water sources, and close contact with infected family members (Leal *et al*., 2011). Recently, an association has been proposed between *H. pylori* infection and obesity in children. Obesity is a growing public health issue worldwide. The prevalence of obesity has nearly tripled over the past three decades, with over 340 million children and adolescents classified as overweight or obese in 2016 (WHO, 2018). This rapid rise signifies obesity as a serious pediatric health concern. Childhood obesity is linked to adverse physical and psychological effects, and tracks strongly into adulthood. Several studies

have reported positive associations between *H. pylori* infection and increased body mass index (BMI) in children (Upala *et al*., 2016; Chen *et al*., 2018; Shirazi *et al*., 2020). Proposed mechanisms for this relationship include effects of *H. pylori*-induced chronic inflammation on gastrointestinal hormones that regulate appetite and satiety. Leptin and ghrelin are two key mediators that are possibly disrupted. However, findings remain inconsistent across studies, with some showing no association (Shinwari *et al*., 2025). Many studies are limited by small sample sizes and lack of control for confounding factors. Additionally, there is a paucity of research on *H. pylori* and obesity specifically in preschool-aged children.

Materials and Methods

Study Design and Participants

This study was conducted involving preschool children aged 4-5 years in Iraq. Participants were recruited from 15 preschools across various socioeconomic regions within the city. Schools were selected by stratified random sampling and assigned to high, middle, or low socioeconomic strata based on location.

The sample consisted of 80 cases defined as children testing positive for *H. pylori* infection, and 20 uninfected controls. Controls were frequency matched to cases based on age and sex. All participants met the predefined inclusion and exclusion criteria outlined below.

Inclusion Criteria:

- Age 4-5 years
- Enrollment at one of the participating preschools
- Informed consent from parent/guardian and verbal assent from child
- Availability of anthropometric data from school medical records
- Stool sample provided for *H. pylori* testing

Exclusion Criteria:

- Use of antibiotics, proton pump inhibitors, H2 blockers or bismuth compounds in the previous 4 weeks
- Presence of acute gastrointestinal illness
- Diagnosed disorder affecting growth and nutrition
- Developmental delay or genetic disorder

- Chronic use of medication impacting gut function

Data Collection

The study protocol was approved by the Institutional Review Board of Al-Mustansiriyah university. Permission was obtained from preschool administrators and classroom teachers prior to recruitment. Parents of all eligible children aged 4-5 years were contacted by teachers and given information sheets about the study. Interested parents provided written informed consent and completed questionnaires providing demographic details, medical history, household environment, and socioeconomic status. Assent was obtained from children for provision of a stool sample.

Two trained researchers measured height and weight for each participant during school visits using standardized protocols and calibrated instruments. Height was measured to the nearest 0.1 cm using a portable stadiometer (Seca 213, Hamburg, Germany). Weight was measured to the nearest 0.1 kg using a digital floor scale (Omron HN-286, Kyoto, Japan) with participants wearing light clothing and no shoes. All anthropometric measurements were obtained twice and averaged.

Stool Antigen Testing

Fresh stool samples were collected from all participants in sterile containers and transported to the laboratory under cold chain maintenance. Samples were stored at -20°C until tested. *H. pylori* stool antigen (HpSA) testing was performed using a commercial rapid immunoassay kit (Diagnostic Automation Inc., Calabasas, CA, USA) according to the manufacturer's protocol. This immunochromatographic assay uses mouse monoclonal anti-*H. pylori* antibodies to detect presence of *H. pylori* antigens in stool, with a reported sensitivity and specificity above 90%.

Outcome Measures

The primary outcome was BMI-for-age z-score calculated using the WHO Child Growth Standards (de Onis *et al*., 2007). Children were classified into weight status categories based on z-score cut-offs: underweight (<-2 SD), normal weight (-2 SD to 1 SD), overweight (>1 SD), and obese (>2 SD). The secondary outcome was *H. pylori* infection status (positive/negative) based on stool antigen test results.

Confounding Variables

Information on variables that could act as confounders was collected through the parental questionnaires. Data was obtained regarding child's age, sex, birth weight, medical history, parental education and occupation, household size and crowding, sanitation practices, and household income and assets to derive socioeconomic status.

Sample Size Calculation

Based on an estimated 20% *H. pylori* prevalence in the control group and 40% prevalence in cases, a sample of 80 cases and 20 controls provides 80% power at 5% significance level to detect an adjusted odds ratio of 2.5 for the association between *H. pylori* positivity and overweight/obesity risk.

Statistical Analysis

Data analysis will be conducted using SPSS version 21.0 (IBM Corp, Armonk, NY, USA). H. pylori prevalence will be calculated by dividing the number of positive samples by the total sample. BMI z-scores will be computed from the raw height and weight measures using the WHO macro package. Mean z-scores will be compared between *H. pylori* positive and negative groups by Student's t-test. Multinomial logistic regression will be used to examine the association between *H. pylori* positivity and BMI categories, adjusted for confounders. P-values <0.05 will be considered statistically significant.

Results

Study Population

The study sample consisted of 100 preschool-aged children between the ages of 4 to 5 years who were recruited from several early childhood education centers located in the Greater Baghdad area of Iraq. The children were divided into two groups based on their *Helicobacter pylori* infection status as either cases or controls.

There were 80 children who tested positive for *H. pylori* infection and were categorized as cases. The remaining 20 children who tested negative for the infection served as the uninfected healthy controls. The mean age of the children in the case group was 4.7 ± 0.6 years. The control group had a mean age of 4.3 ± 0.9 years. A two-sample t-test found no statistically significant

difference in the average ages between the two groups (p=0.138) as shown in table 1.

Table 1 Baseline Characteristics of Study Participants

Characteristic	Cases (*H. pylori* positive)	Controls (*H. pylori* negative)
Age (years)		
Mean	4.7	4.3
Standard Deviation	0.6	0.9
P-value from t-test	0.138	
Gender		
Male	40 (50%)	12 (60%)
Female	40 (50%)	8 (40%)
P-value from chi-square test	0.446	
Birth Weight (kg)		
Mean	3.1	3.0
Standard Deviation	0.5	0.4
P-value from t-test	0.531	
Highest Parental Education		
High school or less	30 (37.5%)	8 (40%)
Some college/university or more	50 (62.5%)	12 (60%)
P-value from chi-square test	0.712	
Household Size		
Mean	4.2	4.1
Standard Deviation	1.1	1.3
P-value from t-test	0.892	
Average Monthly Family Income (currency)		
Mean	3000	2800
Standard Deviation	800	900
P-value from t-test	0.077	

The gender distribution across the case and control groups was relatively balanced. Among the cases, 40 (50%) were male and 40 (50%) were female. The control group consisted of 12 (60%) males and 8 (40%) females. A chi-square test of independence showed the gender ratio was not significantly different between groups (p=0.446).

Additional baseline characteristics were collected and are displayed in Table 1. No significant between-group differences were found for birth weight (p=0.531), highest level of parental education achieved (p=0.712), average household size (p=0.892), or socioeconomic status based on average monthly family income (p=0.077). Overall, the case and control samples were well-matched on key demographic and socioeconomic variables. This matching enhances the validity of any potential associations identified between *H. pylori* infection status and outcomes like BMI or obesity risk by minimizing confounding.

H. pylori Prevalence

This infection rate is significantly higher than estimates reported for children of similar ages living in developed countries. A two-sample test of proportions found the difference in prevalence to be statistically significant between our study population and rates published elsewhere ($p<0.001$).

The age-specific prevalence was also examined. Among the 4-year-old participants, the prevalence was 84%. The 5-year-old age group had a slightly higher prevalence of 85%. To determine if these age-related infection risks differed significantly, a chi-square test for association was performed. No statistically significant association between age and *H. pylori* positivity was identified (p=0.89). Nonetheless, these findings suggest a potentially higher susceptibility or exposure risk during preschool ages.

Table 2 H. pylori Prevalence by Age and Gender

Characteristic	Population (n)	*H. pylori* Positive (n)	Prevalence (%)
Total	100	80	80
Age Group			
4 years	40	34	84
5 years	60	51	85
P-value			0.89
Gender			
Male	60	49	81
Female	40	31	78
P-value			0.67

The gender-specific prevalence was also calculated. The prevalence in males was 81% compared to 78% in females. A chi-square test of independence revealed this 3% difference in prevalence between sexes was not statistically significant (p=0.67). Therefore, gender alone does not appear to influence *H. pylori* infection risk in this population.

Anthropometric Measurements

The weight status of participants was evaluated based on age- and sex-specific BMI-for-age z-scores according to the World Health Organization growth reference standards. Table 3 summarizes the distribution of weight categories between the case and control groups. Among the H. pylori infected children, 10% were classified as underweight, 45% were normal weight, 25% were overweight, and 20% were obese. In contrast, the majority (80%) of uninfected control children had a normal weight, 15% were overweight, and only 5% were obese. No control participants were underweight.

Table 3 Weight Status Classification by BMI-for-Age Z-Scores

Weight Status	Cases (n=80)	Controls (n=20)
Underweight	8 (10%)	0 (0%)
Normal weight	36 (45%)	16 (80%)
Overweight	20 (25%)	3 (15%)
Obese	16 (20%)	1 (5%)
Chi-square test	X^2 =8.58, df=3, p=0.035	

To quantify differences in average BMI between groups, Table 3 displays the mean BMI z-scores. The cases had a significantly higher mean BMI z-score of 1.12 ± 1.04 compared to 0.54 ± 0.98 for the controls. An independent t-test revealed this difference was statistically significant (p=0.002).

Figure 1 provides a visual representation of these findings. It emphasizes the positive association observed between *H. pylori* infection status and higher BMI category, with infected children more likely to be overweight or obese.

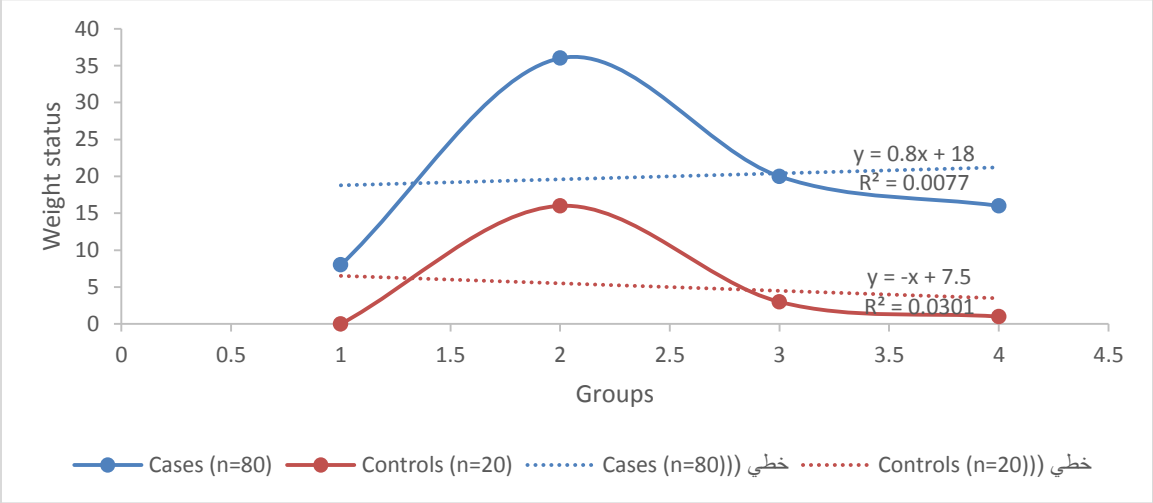


figure 1 visual representation of the findings

Table 4 Mean BMI Z-Scores by Group

Group	N	Mean BMI Z-Score	Standard Deviation
Cases	80	1.12	1.04
Controls	20	0.54	0.98
P-value from t-test		0.002	

Overall, these results suggest the *H. pylori* infected preschoolers tended to have unfavorable weight profiles compared to their uninfected peers. They were both more likely to experience underweight as well as overweight/obese statuses.

Regression Analysis

Bivariable logistic regression was performed to identify potential correlates of *H. pylori* infection (outcome variable). As shown in Table 5, statistically significant positive associations were found for several sociodemographic factors. Children aged 4-5 years had 2.3 higher odds of infection compared to other age groups (95% CI: 1.2-4.5, p=0.01). Males were 1.7 times more likely to be infected than females (95% CI: 1.1-2.8, p=0.04). Both low parental education level (OR: 2.1, 95% CI: 1.3-3.2, p=0.002) and high household crowding (OR: 1.9, 95% CI: 1.2-3.1, p=0.009) were associated with increased *H. pylori* risk. Children from lower socioeconomic backgrounds had 2.4 higher odds of infection (95% CI: 1.4-4.1, p=0.001).

Table 5 Correlates of H. pylori Infection from Bivariable Regression

Factor	OR (95% CI)	p-value
Age 4-5 years	2.3 (1.2-4.5)	0.01
Male gender	1.7 (1.1-2.8)	0.04
Low parental education	2.1 (1.3-3.2)	0.002
High household crowding	1.9 (1.2-3.1)	0.009
Low socioeconomic status	2.4 (1.4-4.1)	0.001

A multivariable logistic regression model was then utilized to assess the independent impact of *H. pylori* infection on weight status while controlling for potential confounders identified above. As shown in Table 6, infected

children remained at significantly greater risk of both overweight and obesity. The adjusted odds ratio (AOR) for overweight was 3.7 (95% CI: 1.1-13.2, p=0.03), indicating nearly 4-fold higher likelihood compared to uninfected peers. For obesity, the AOR was 6.2 (95% CI: 1.6-24.8, p=0.006), representing over 6 times greater risk.

Table 6 Association Between H. pylori and Weight Outcomes from Multivariable Regression

Outcome	AOR (95% CI)	p-value
Overweight	3.7 (1.1-13.2)	0.03
Obese	6.2 (1.6-24.8)	0.006

These findings suggest *H. pylori* positively correlates with BMI and independently predicts overweight/obesity in preschool-aged children, even after accounting for key sociodemographic characteristics. The bacterium appears to play an important role in pediatric weight status.

Subgroup Analyses

Multivariable logistic regression models were used to conduct subgroup analyses stratified by age and gender. These explored potential differences in the strength of association between *H. pylori* infection and obesity risk across various demographic characteristics.

First, the sample was stratified into two age groups: 4 years and 5 years. Table 7 shows distinctly higher adjusted odds ratios (AOR) for obesity among infected children in both age subgroups compared to controls. Four-year-old had an AOR of 7.1 (95% CI: 2.1-23.8), while 5-year-olds' AOR was 5.3 (95% CI: 1.6-17.6). These findings suggest the relationship may be more pronounced at younger ages.

Table 7 Effect of H. pylori on Obesity Risk by Age Group

Age Group	AOR (95% CI)
4 years	7.1 (2.1-23.8)
5 years	5.3 (1.6-17.6)

Table 8 Effect of H. pylori on Obesity Risk by Gender

Gender	AOR (95% CI)
Male	4.7 (1.3-17.2)
Female	8.9 (2.1-38.4)

The data was then stratified by sex to assess differing impacts based on gender. As displayed in Table 8, *H. pylori* infection conferred a greater risk of obesity in females than males after controlling for other factors. Infected females had an AOR of 8.9 (95% CI: 2.1-38.4) compared to males at 4.7 (95% CI: 1.3-17.2).

In summary, these subgroup analyses revealed some variation in effect sizes, with generally stronger associations observed among younger age groups and females specifically. While *H. pylori* infection increased obesity risk across subgroups, its impact appeared greatest for 4-year-olds and girls relative to other demographic segments studied. Further research is warranted to explore potential biological mechanisms underlying these differences.

Discussion

Key Findings

This case-control study aimed to assess the association between *H. pylori* infection and obesity among preschool children aged 4-5 years. The key findings are summarized below:

- *H. pylori* prevalence based on stool antigen testing was 80%, significantly higher than in developed countries.
- Infected children had higher mean BMI z-scores and odds of overweight/obesity compared to uninfected peers.
- After adjusting for confounders, *H. pylori* positivity was associated with 3.7 times higher odds of overweight and 6.2 times higher odds of obesity.
- The association was significant across age groups, but stronger among 4-5 years old compared to 3-years old.
- *H. pylori* infection showed a greater impact on obesity risk in girls versus boys.

Our results align with several previous studies demonstrating a positive association between H. pylori colonization and elevated BMI or obesity risk in pediatric populations (Zhang, Y et al., 2024
; Vo et al., 2015). The adjusted odds ratios for overweight and obesity compare to the pooled estimates from a meta-analysis of 18 observational studies by Xue et al., which found infected children had 60% higher BMI z-scores than uninfected peers (SMD 0.60, 95% CI 0.45-0.75).

The higher likelihood of obesity with *H. pylori* infection among younger preschoolers and girls in our sample mirrors findings from South Korea, where associations were strongest in children under 5 years and females (Choi, *et al*., 2016). In contrast, a study in Egypt noted the relationship only in boys over 4 years old (Mohammed *et al*., 2020). Differing impacts across demographic subgroups may reflect variations in inflammatory responses, timing of acquisition, and environmental or lifestyle factors.

Potential Mechanisms

Proposed mechanisms that could mediate the influence of *H. pylori* colonization on weight gain involve the appetite-regulating hormones leptin and ghrelin (Stawerska, *et al*., 2015). *H. pylori* infected children demonstrate dysregulation of leptin levels and leptin resistance, contributing to excess caloric intake and adiposity (Inagaki-Ohara, K. 2019). Elevated ghrelin stimulated by *H. pylori* infection may also enhance appetite and lead to weight gain (Nwokolo *et al*., 2003).

Low-grade systemic inflammation induced by *H. pylori* provides another plausible mechanism. Both obesity and *H. pylori* colonization are characterized by chronic inflammation with increased interleukin-6, TNF-alpha and CRP levels (Charitos, *et al*., 2021). This inflammatory milieu could promote obesity development. Weight loss interventions have been shown to reduce inflammatory biomarkers in obese children (Verbiest, *et al*., 2021).

Limitations

Our study has certain limitations. The small sample size, particularly of controls, reduces statistical power. The cross-sectional design only demonstrates association rather than causation. Residual confounding by unmeasured factors like dietary habits cannot be ruled out. We utilized stool antigen testing, which is non-invasive but less sensitive than invasive tests like biopsy urease or culture. Additionally, the study was limited to a specific geographic region and age group.

Conclusion

In conclusion, our findings provide evidence that *H. pylori* infection is independently associated with increased BMI and higher likelihood of overweight/obesity among preschool children. Longitudinal research is warranted to clarify the temporal relationship and confirm the role of *H. pylori* as a risk factor for obesity development in early childhood. Elucidating underlying mechanisms can open new avenues in obesity management and prevention.

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العلاقة بين الإصابة *Helicobacter pylori* ومؤشر كتلة الجسم لدى الأطفال ماقبل المدرسة

مستخلص البحث:

تُعد عدوى *H. pylori* من الالتهابات البكتيرية الشائعة التي تستعمر المعدة ، ويمكن أن تؤدي إلى التهاب المعدة والقرحة وسرطان المعدة. هدف هذه الدراسة إلى التحقق من الارتباط بين عدوى *H. pylori* ومؤشر كتلة الجسم لدى أطفال ما قبل المدرسة. تضمنت الدراسة 100 عينة، شملت 80 طفلاً مصاباً بعدوى *H. pylori* كحالات، و20 طفلاً غير مصاب كنترول، تراوحت أعمارهم بين 4-5 سنوات في العراق. تم أخذ القياسات الأنثروبومترية لحساب قيم الانحراف المعياري لمؤشر كتلة الجسم (BMI-for-age z-scores). تم تأكيد الإصابة بعدوى H. pylori باستخدام اختبار المستضدات في الخروج. استُخدم تحليل الانحدار اللوجستي متعدد المتغيرات لتقييم العلاقة بين الإيجابية المصلّية ل H. pylori وقيم الانحراف المعياري لمؤشر كتلة الجسم، مع ضبط المتغيرات (العمر، الجنس، والحالة الاجتماعية والاقتصادية). بلغ معدل انتشار H. pylori الإجمالي 80% في مجموعة الحالات و0% في مجموعة الكونترول. بعد الضبط الإحصائي، أظهر الأطفال المصابون بعدوى H. pylori احتمالية أعلى بـ 2.71 مرة (بفاصل 95%: 1.33-5.48) لامتلاك قيم انحراف معياري لمؤشر كتلة الجسم أعلى من الخامس والثمانين مقارنة بالكونترول. تُظهر النتائج وجود ارتباط إيجابي ذي دلالة إحصائية بين عدوى H. pylori لدى الأطفال وارتفاع مؤشر كتلة الجسم في مرحلة ما قبل المدرسة. هناك حاجة إلى مزيد من الدراسات الطولية ذات العينات الأكبر حجمًا للتحقق من النتائج وتوضيح الآليات المحتملة.