Association between Helicobacter pylori Infection and Vitamin D Statue:A Cross-sectional Study in Women

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Research Article

Keywords: Helicobacter pylori, vitamin D, cross-sectional study, inflammation

Posted Date: May 4th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9233625/v1

Additional Declarations: No competing interests reported.

Abstract

Background

Recent research has increasingly suggested that vitamin D plays an important role in immunoregulation and antibacterial defense. However, the relationship between *Helicobacter pylori ((H. pylori*) infection and vitamin D remains unclear.

Materials and Methods

We conducted a cross-sectional study to assess the association between *H.pylori* infection and vitamin D statue in a Chinese female population.

Result

Among 1,554 participants, the overall H.pylori infection rate was 53.5%. Mean serum 25(OH) vitamin D concentration was significantly lower in H.pylori-positive patients than in H.pylori-negative patients (p = 0.042). Serum folic acid levels were also lower in H.pylori-positive patients compared with H.pylori-negative patients (10.4 ng/mL vs. 11.1 ng/mL, p < 0.001). White blood cells were higher in H.pylori-positive patients (6.2×10^9/L vs. 5.9×10^9/L, p = 0.005). Univariate and multivariate logistic regression analysis showed that a high Body Mass Index (BMI) score (≥ 30 kg/m2) and low 25(OH) vitamin D levels (< 13.9 ng/mL) were associated with H.pylori infection. In summary, *H. pylori* infection is significantly associated with 25(OH) vitamin D deficiency in women, which may have important implications for the treatment and monitoring of *H.pylori* infection and related conditions.

Conclusions

This is the first cross-sectional study to establish the association between *H. pylori* infection and vitamin D deficiency. It not only improved our understanding of the pathophysiological mechanisms of *H. pylori* infection but also opens a new direction of clinical research and public health intervention and provides new hope for reducing the risk of *H. pylori* infection and its related diseases. This article reminds us that in addition to focusing on the eradication of *H. pylori*, we need to pay attention to the nutritional indexes like vitamin D, folic acid and BMI to achieve individualized treatment.

Introduction

Helicobacter pylori ((H.pylori) is a kind of gram-negative bacteria that can resist strong acidic environment[1]. It often exists in the human stomach and duodenum, which lead to increased gastric acid secretion, damages the gastric mucosal barrier, causing various gastrointestinal symptoms[2–3]. *H.pylori* infection is widespread worldwide and becoming a serious public health problem. Many studies have

shown that *H.pylori* infection is an important factor causing gastritis, peptic ulcer, and even gastric cancer[4–6].Therefore,the treatment and prevention of *H.pylori* infection is particularly important.Quadruple therapy is now widely used in the treatment of *H.pylori* infection and has obtained definite curative effect[7–9].However,since the early symptoms of *H.pylori* infection are not typical,it is very important to find effective indicators that can predict *H.pylori* infection.At present,clinical methods for detecting *H.pylori* infection are primarily categorized as invasive and non-invasive.The current gold standard for clinical diagnosis of *H.pylori* involves endoscopic biopsy with histological examination or urease testing.However,these methods have inherent limitations.First,the biopsy procedures are invasive which may increase risks of perforation.Second,due to the potential patchy distribution of *H.pylori* in the stomach,single or limited biopsies may lead to false-negative results.Third,histological evaluation is time-consuming.Fourth,the need for specialized pathological expertise limits its feasibility in resource-limited settings.Among non-invasive methods,the$^{13}C/^{14}C$-urea breath test offers high accuracy but is susceptible to recent use of proton pump inhibitors,antibiotics,and dietary factors,which may compromise its reliability.Meanwhile,serological antibody tests and stool antigen assays still exhibit considerable false-negative rates.Therefore,identifying reliable predictive indicators for effective detection of *H.pylori* infection is of critical importance.

Vitamin D is a fat-soluble vitamin which can be absorbed from food or synthesized by the human body. Vitamin D is one of the most important vitamins needed by people's metabolism and plays an extremely important role in child growth and bone development[10–12].Vitamin D deficiency is widespread in the world, and women are especially prone to vitamin D deficiency. Vitamin D deficiency can lead to various diseases such as Rickets, osteoporosis and osteomalacia[13–14]. 25(OH) vitamin D is the main action form of vitamin D and its level lower than 20 ng/mL is vitamin D deficiency [15].Many studies have confirmed that vitamin D has a good protective effect on many digestive diseases [16–17]. However, there is still rare definite evidence whether vitamin D is related to *H. pylori* infection in women. Here, we conducted a cross-sectional study in women to investigate the correlation between *H. pylori* infection and vitamin D, and to explore the indicators that can predict *H. pylori* infection.

Materials and Methods

Research population and exclusion criteria

This cross-sectional research was conducted in a cohort of female population who underwent physical examination at Lishui Central Hospital between 2019 and 2024. A total of 185,137 physical examination results were included in the research data, and those patients were excluded when they met more than one of the following criteria: 1) lack of follow up; 2) missing data on urea breath test; 3) missing data on laboratory results. Flowchart of the study participants was shown in Fig. 1.

Data collection

In this research, basic characteristics (including age, gender, height, weight, post-menopause status, BMI score), *H. pylori* infection status, 25(OH) vitamin D level and a series of laboratory data were obtained from the physical examination results. Body mass index (BMI) score was calculated by dividing the subject's weight (kg) by the square of the subject's height (m^2). This research and related data collection have been evaluated and approved by the Ethics Committee of Lishui Central Hospital.

Helicobacter pylori infection and 25(OH)vitamin D level assessment

Helicobacter pylori infection was detected by 14C-urea breath test and 13C-urea breath test according to the manufacturer's instructions. If the test result of urea breath test exceeded the normal value, the patient was diagnosed as positive *H. pylori* infection. The level of 25(OH)vitamin D was detected by automatic chemiluminescence instrument (Abbott I2000). The status of 25(OH)vitamin D was divided into four quartiles according to the test result. The 1st quartile was under 13.9 ng/mL, the 2nd quartile was between 13.9 ng/mL and 18.6 ng/mL; the 3rd quartile was between 18.6 ng/mL and 23.9 ng/mL; and the 4th quartile was over 23.9 ng/mL.

Statistical methods

Data are presented in the form of mean and standard deviation. Student's t-test and Chi-square test were used for comparisons between the groups. Univariate and multivariate logistic regression analyses were used to analyze the association of different factors and *H. pylori* infection and the odds ratio (OR) and 95% CI were calculated. All data were analyzed with SPSS 26.0 software and the *p* value under 0.05 was considered as significantly different.

Results

Characteristics of the research population

A total of 185,137 physical examination results were included in the study. A total of 1554 results were finally analyzed after screening by exclusion criteria (Participant characteristics seen in Table 1). All patients in this cohort were female, and the average age of all patients was 51.4 years. In this cohort, 850 were postmenopausal and 704 were not. There was no statistical difference between menopausal population volume and non-menopausal population volume ($p = 0.721$). In addition, the average height of this cohort is 155.3 cm, the average weight is 58.2 kg, and the average BMI score is 24.2 kg/m^2.

Table 1
Participant characteristics by *Helicobacter pylori* infection status.

Median age,years	**All(n = 1554)**	**H.pylori negative(n = 750)**	**H.pylori positive(n = 804)**	**P value**
	51.4(8.8)	**51.6(8.8)**	**51.1(8.9)**	**0.306**
Age group				0.720
< 65years	1418(91.2)	682(90.9)	736(91.5)	
65+	136(8.8)	68(9.1)	68(8.5)	
Post-menopause				
Yes	850(54.7)	414(55.2)	436(54.2)	0.721
No	704(45.3)	336(44.8)	368(45.8)	
Height,cm	155.3(5.6)	155.1(5.7)	155.4(5.6)	0.234
Weight,kg	58.3(8.5)	57.9(8.4)	58.7(8.6)	0.064
BMI(kg/m^2)				
	24.2(3.2)	24.1(3.1)	24.3(3.2)	0.136
< 18.5	32(2.1)	20(2.7)	12(1.5)	
18.5–24.9	970(62.4)	465(62.0)	505(62.8)	
25-29.9	480(30.9)	242(32.3)	238(29.6)	
≥ 30	72(4.6)	23(3.0)	49(6.1)	

Important factors associated with Helicobacter pylori infection

Of the 1554 participants, 750 were *H.pylori*-negative and 804 were *H.pylori*-positive. The overall infection rate of *H.pylori* was 53.5% (Table 2). The median age of *H.pylori*-negative patients was 51.6 years old, and the median age of *H.pylori*-positive patients was 51.1 years, followed by no significant difference (Table 2, p = 0.306). We then explored the association between menopause and *H.pylori* infection. Among postmenopausal women, 414 of them were *H.pylori*-negative and 436 were *H.pylori*-positive. Among premenopausal women, 336 were *H.pylori*-negative and 368 were *H.pylori*-positive. Results showed there was no significant correlation between menopause and *H.pylori* infection in women (Table 2). It is worth mentioning that *H.pylori*-positive patients had higher body weight than *H.pylori*-negative patients (58.7 kg *vs* 57.9 kg, *p* = 0.064), which indicated that the body weight may be closely related to *H.pylori* infection (Table 2).

Table 2
Serum 25(OH) vitamin D levels and other laboratory results by *Helicobacter pylori* infection status.

25(OH) vitamin D, ng/mL	**Hp negative (n = 750)**	**Hp positive (n = 804)**	**P value**
	19.8(7.5)	**19.0(7.2)**	**0.042**
25(OH) vitamin D groups, n (%)			
< 20 ng/mL	414(55.2)	482(44.8)	0.064
25(OH) vitamin D quartiles, n (%)			
1st quartile (< 13.9)	173(23.1)	210(26.1)	
2nd quartile (13.9–18.6)	183(24.4)	207(25.7)	
3rd quartile (18.6–23.9)	188(25.1)	202(25.1)	
4th quartile (≥ 23.9)	206(27.4)	185(23.1)	
Hemoglobin, g/dL	132.7(12.5)	131.9(13.0)	0.235
Ferritin, ng/mL	106.7(101.5)	101.0(98.4)	0.257
Vitamin B12, pg/mL	469.8(184.2)	464.1(184.8)	0.538
Folic acid, ng/mL	11.1(3.5)	10.4(3.5)	< 0.001
Sedimentation rate, mm/hr	14.1(11.0)	14.5(10.6)	0.854
White blood cells, 10^9/L	5.9(1.6)	6.2(1.7)	0.005
Neu mount, 10^9/L	3.5(1.4)	3.7(1.4)	0.010
Neu percentage, %	58.7(8.9)	59.3(8.1)	0.122
Reported values are medians (Interquartile range) or counts (percent)			
p value for trend across quartiles			

The association between Helicobacter pylori infection with Vitamin D status

The average level of serum 25(OH)vitamin D of *H.pylori*-negative patients was 19.8 ng/mL, while that of *H.pylori*-positive patients was 19.0 ng/mL, showing an obvious decrease (Fig. 2, p = 0.042). Taking 20 ng/mL as the standard to define vitamin D deficiency, 414 *H.pylori*-negative patients had serum vitamin D levels lower than 20 ng/mL, while the number of *H.pylori*-positive with vitamin D deficiency was 482

(Table 2, p = 0.064). These data suggested that *H.pylori* infection is usually accompanied by a decrease of vitamin D.

It is very interesting that when we analyzed patients with low vitamin D level (under 13.9 ng/mL), there were only 173 patients in the *H. pylori*-negative group, but in the *H. pylori*-positive group the number was 210. On the contrary, when we analyzed patients with very high vitamin D level (over 23.9 ng/mL), there were 206 patients in the *H. pylori*-negative group, but in the *H. pylori*-positive group the number was 210, which was greatly elevated. This set of data showed that with the increase of vitamin D level in the human body, *H. pylori* infection presented a downward trend. This suggested vitamin D may have a protective effect on *H. pylori* infection (Table 2).

Other biochemical indicators related to Helicobacter pylori infection

In addition to vitamin D,we also detected some other blood indicators to explore their association with *H.pylori* infection.Our results showed that there was no statistically significant difference in serum hemoglobin,ferritin and vitamin B12 levels between *H.pylori*-positive and *H.pylori*-negative individuals.However,the level of serum folic acid of *H.pylori*-positive individuals was significantly higher than that of *H.pylori*-negative individuals (Table 2, 10.4 ng/mL vs. 11.1 ng/mL, $p < 0.001$).Folic acid is closely related to the hematopoietic function of the body,which suggested that *H.pylori* infection may affect the normal function of the blood system.In addition,the number of white blood cells (6.2×10^9/L vs. 5.9×10^9/L, $p = 0.005$) and the number of neutrophils (3.7×10^9/L vs. 3.5×10^9/L, $p = 0.010$) in *H.pylori*-positive patients also increased significantly compared with those without *H.pylori* infection.These results indicated that *H.pylori* infection can significantly enhance the level of leukocytes in the body,which may be a defense response of the immune system(Table 2).

Univariate and multivariate analyses of predictors of H.pylori infection.

Univariate and multivariate logistic regression analysis was performed to identify the relevant factors for *H.pylori* infection. The results suggested that patients with a high BMI score (over or equal to 30 kg/m^2) were 3.551 times (univariate logistic regression analysis, 95%CI: 1.487, 8.479) or 3.623 times more likely to be *H.pylori* infected (multivariate logistic regression analysis, 95%CI: 1.515, 8.665) (Table 3). In addition, high serum vitamin D levels showed a significant negative correlation trend with *H.pylori* infection. Patients with a high 25(OH) vitamin D level (over or equal to 23.9 ng/mL) were only 0.740 times less likely to be *H.pylori* infected (univariate logistic regression analysis, 95%CI: 0.558, 0.982) or 0.732 times less likely to be *H.pylori* infected (multivariate logistic regression analysis, 95%CI: 0.661, 0.972). The results suggested that patients with high levels of vitamin D have a significantly lower risk of *H.pylori* infection, indicating that vitamin D may have a protective effect for *H.pylori* infection (Table 3).

Table 3. Analysis of univariate and multivariate analyses of predictors of *Helicobacter pylori* infection.

Variable(reference group)	Univariate			Multivariate		
	OR	95%CI	P value	OR	95%CI	P value
Age group(years)						
<65years	1.0(reference)			1.0(reference)		
65+	0.927	0.652,1.317	0.671			
Post-menopause						
No	1.0(reference)			1.0(reference)		
Yes	0.962	0.787,1.174	0.701			
BMI(kg/m^2)						
<18.5	1.0(reference)			1.0(reference)		
18.5-24.9	1.810	0.875,3.744	0.110	1.842	0.889,3.814	0.100
25-29.9	1.639	0.784,3.428	0.189	1.663	0.794,3.482	0.177
≥30	3.551	1.487,8.479	0.004	3.623	1.515,8.665	0.004
25(OH)vitamin D quartiles,n(%)						
1st quartile (<13.9)	1.0(reference)			1.0(reference)		
2nd quartile (13.9-18.6)	0.932	0.702,1.237	0.625	0.923	0.694,1.226	0.580
3rd quartile (18.6-23.9)	0.922	0.667,1.174	0.398	0.878	0.661,1.166	0.370
4th quartile (≥23.9)	0.740	0.558,0.982	0.037	0.732	0.661,0.972	0.031

Discussion

Helicobacter pylori infection is widespread worldwide, affecting about half of the global population, with reported rates typically ranging from 30% to 60%[6]. In China, the prevalence is approximately 40–50%[18]. *Helicobacter pylori* is an opportunistic pathogen. It is safe in most hosts, but in others it can cause a range of diseases, including chronic active gastritis, peptic ulcer disease, and gastric adenocarcinoma. Multiple studies have shown that *H. pylori* can secrete cytotoxins and cytokines that elicit immune

responses and bind tightly to gastric epithelial cells through its special spiral shape with flagella and specific adhesins to avoid emptying with food and gastric mucus, leading to recurrent chronic inflammation of the gastric mucosa and a range of digestive symptoms[19–20].However,about 70%-85% of patients with *H.pylori* infection do not develop any symptoms during their lifetime,so it is particularly important to find predictors closely related to *H.pylori* infection.Prietl et al.detailed the key role of vitamin D in innate and adaptive immunity,including the induction mechanism of its antimicrobial peptides.This provides strong theoretical support for the argument that the role of vitamin D in immune regulation and antimicrobial defense has been increasingly recognized[21].This is the first study to reveal a significant inverse association between *H. pylori* infection and serum 25(OH)vitamin D levels through a large cross-sectional survey of Chinese women. Our data showed that the mean serum 25(OH)vitamin D concentration in *H. pylori* infected patients was significantly lower than that in *H. pylori* uninfected patients (p = 0.042), and multivariate logistic regression analysis further confirmed that vitamin D level below 13.9 ng/mL was an independent related factor for *H. pylori* infection.This study aims to explore the early warning indicators of female infection with this bacterium. Vitamin D deficiency in *H. pylori* infection was observed in this study, and the underlying mechanisms may be multifactorial. Firstly, *H. pylori* infection induces a chronic inflammatory response in the gastric mucosa, which may systematically affect the absorption and metabolism of nutrients, including vitamin D. Second, it has been suggested that the chronic infection state may lead to decreased levels of active vitamin D in the body, either through a depleting mechanism or by affecting liver and kidney function. In addition, vitamin D deficiency may weaken the mucosal innate immune defense and reduce the body's ability to clear *H. pylori*, thus forming a vicious circle of infection and nutritional deficiency.Wajid Ameen Mirza et al. found that most dengue patients with *H. pylori* infection were vitamin D deficient compared with dengue negative patients with *H. pylori* infection. Multivariate logistic regression analysis showed that the possibility of vitamin D "deficiency" in dengue patients with *H. pylori* infection was 0.056 times higher than that in patients without *H. pylori* infection (95% CI: 0.024, 0.128, P = 0.000) [22], which was similar to the results of our study.

In recent years, vitamin D has also been implicated in various digestive disorders, such as inflammatory bowel disease and nonalcoholic fatty liver disease[16–17]. Vitamin D deficiency is particularly common in middle-aged and elderly women. Therefore, we chose to investigate the association between vitamin D levels and *H. pylori* infection in the female population. We included 1,554 female patients who underwent physical examination at Lishui Central Hospital and analyzed their physical examination data. The overall detection rate of *H. pylori* infection in this cohort was 53.5%, which is like the rate in the Chinese population[18]. We further explored the relationship between *H.pylori* infection and menopause in women, and the data showed no significant association, indicating that menopausal hormonal changes do not increase the risk of *H.pylori* infection in women.

But it's worth noting that the weight of patients who were positive for *H. pylori* was significantly higher than that of patients who were negative, which suggests that weight gain may increase the risk of infection.Several studies have confirmed the association between overweight and *H.pylori* infection, and

Zhang and Xu et al found a positive association between *H. pylori* infection and overweight in studies in adults.*H.pylori* might be one of the risk factors for obesity, the combined OR was 1.15 (95% CI: 1.09–1.22).In addition, the mean difference of BMI in *H.pylori* positive patients was higher than that in *H.pylori* negative patients, and the *H.pylori* infection rate in obese patients was higher than that in normal weight population, suggesting that *H.pylori* infection was positively correlated with obesity. Compared with the *H.pylori* negative group, the BMI, systolic blood pressure, diastolic blood pressure, triglyceride, total cholesterol, and serum LDL cholesterol in the *H.pylori* positive group were increased, and the mean HDL cholesterol was decreased, suggesting poor energy metabolism.However,the exact mechanism between high BMI and *H.pylori* infection is not clear. Polymorphonuclear bactericidal previous studies have confirmed that morbidly obese patients have markedly reduced capacity and impaired monocyte-to-macrophage maturation,and severely obese patients have markedly reduced natural-killer cell activity[23].This suggests that the immune environment of obese individuals is more conducive to the survival of *H.pylori*. And *H.pylori* infection stimulates excessive secretion of proinflammatory cytokines such as interleukin-6, IL-8, IL-1β, and TNF-α[24]. Chronic inflammation triggered by these proinflammatory cytokines can further lead to insulin resistance and lipid metabolism disorders. Insulin resistance and lipid metabolism disorders have important effects on the development of obesity. In addition, *H.pylori* infection reduces the secretion of the appetite hormone ghrelin[25].Ghrelin is primarily secreted by the stomach and is involved in the regulation of feeding behavior and weight management[26]. Circulating ghrelin levels are reduced with obesity in humans[27], which suggests a potential link between ghrelin and obesity. In addition, serum leptin levels are lower in patients with *H. pylori* infection[28].Decreased serum leptin levels may stimulate appetite, and overeating may lead to overweight and obesity. However, the study by the Moran-Leff group found an inverse association between *H. pylori* infection and overweight among children, suggesting differences in the response to infection according to age[29]. Therefore, obesity and *H. pylori* infection may interact to form a complex mechanism. Further studies are needed to elucidate the mechanism of this association.

In our study,we focused on the analysis of the correlation between vitamin D status and *H.pylori* infection.We found that in H.pylori-positive patients,vitamin D levels were significantly reduced.Gao et al found a significant association between *H.pylori* seropositivity and vitamin D deficiency in children aged 6–36 months[30].The prevalence of vitamin D deficiency in the *H. pylori* seropositive groups was obviously elevated compared with *H. pylori* negative groups (20.7% vs. 12.1%, $p < 0.001$). Surmeli et al found vitamin D deficiency was associated with increased risk of *H. pylori* infection in older adults aged over 65[31].Their research showed that more *H. pylori* positive patients were vitamin D deficient (< 20 ng/mL) (86% vs. 67.3%, $p = 0.014$) in older population. Here, we also found a similar result with Surmeli et al and Gao et al, which suggested the association between vitamin D deficiency and *H. pylori* infection could occur in different age groups and genders. In general, our research revealed that in the female population, the proportion of *H. pylori* infection is significantly negatively correlated with the level of serum vitamin D.

In addition, many studies have found that the level of vitamin D was closely related to the eradication of *H. pylori* infection. A meta-analysis[32] found that those patients who successfully eliminated *H. pylori* had

significantly higher serum vitamin D levels than those who failed to eradicate *H. pylori* (Standardized mean difference, SMD = 1.31 ng/mL, 95% CI = [0.60, 2.02 ng/mL]).Additionally, *H. pylori* eradication rates were lower in vitamin D deficient patients (OR = 0.09, 95% CI = [0.02, 0.41]). These results suggested that high vitamin D levels may have a positive effect on the treatment of *H. pylori*. At present, there has been some research highlighting the protective effect of vitamin D on *H. pylori* infection.Hu et al. found that vitamin D3 could activate the autolysosomal degradation function through the PDIA3 receptor, thereby protecting against *H. pylori* infection. Zhang et al. [33–34] found that oral administration of vitamin D3 could reduce the colonization rate of *Helicobacter pylori* and up-regulated the expressions of Vitamin D receptor (VDR) and Cyclic adenosine monophosphate (CAMP) in the gastric mucosa, promoting their eradication. Research by Zhang et al [35] indicated 1α,25-Dihydroxy vitamin D3 could protect gastric mucosal epithelial cells from apoptosis induced by *H. pylori* infection through VDR-dependent c-Raf/MEK/ERK pathway. Wanibuchi et al [36] found that one kind of indene compound synthetically derived from vitamin D had selective antibacterial activity against *H. pylori* infection.This compound could induce *Helicobacter pylori* lysis and have a very high selective bactericidal effect without affecting the viability of common bacteria. In addition, Hosoda et al.[37] found the breakdown product of vitamin D3, VDP1, could cause the collapse of cell membrane in *Helicobacter pylori* structure and eradicate the bacteria. The above results indicated that vitamin D and the related metabolites could play an important role in promoting the clearance of *Helicobacter pylori* and protecting the gastric mucosal barrier function.

Besides,our study found a significant inverse association between *H. pylori* infection rate and folate level in the female population.Several studies have shown that *H. pylori* infection affects the absorption of many trace elements,especially vitamin B12 and folic acid,by disrupting gastric secretion and weakening acidification function.The specific mechanism of this effect is not clear.There are several possibilities.First,the decreased gastric acid secretion caused by Hp may not only lead to difficulties in the breakdown of folate from food binders but also interfere with the transfer of cobalamin from food.Second,Hp infection can lead to decreased secretion of intrinsic factors.Finally,decreased ascorbic acid secretion in the gastric mucosa and increased pH of gastric juice can affect the absorption of folic acid.Thus,patients with Hp infection may have a low folate level because of malabsorption[38–40].However, no study has confirmed the association between these two indicators. If folate is indeed involved in the pathogenesis of *H. pylori* infection, it may be a promising therapeutic target; more prospective studies are needed to clarify its specific mechanism of action.

Finally,we analyzed relevant factors that might predict *H.pylori* infection.By univariate or multivariate regression analysis,it was found that high BMI score and low vitamin D level might be independent factors for predicting *Helicobacter pylori* infection.These results suggest that people with higher BMI and lower vitamin levels are at higher risk for *H.pylori* infection.In addition to vitamin D,our study found serum folate level was lower,while white blood cell count and BMI(≥ 30 kg/m²)were higher in H.pylori-positive patients.The decrease of folate level may be related to the dysfunction of gastrointestinal absorption caused by *H.pylori* infection.The increase of white blood cell count intuitively reflects the systemic inflammatory response of the body in the state of infection.The association between high BMI and *H.*

pylori infection suggests that metabolic factors may play a complex role in the susceptibility or persistent infection of *H. pylori*. These associations point to a central point:*H. pylori* infection should not be viewed in isolation as a localized gastric problem, but rather as a systemic disease closely related to the systemic nutritional status, inflammatory state, and metabolic health of the host. In addition, Surmeli et al. found that men in older age groups and the very elderly were also more likely to have *H. pylori* infection[31].These people should pay special attention to monitoring their infection status to avoid further disease progression. Our findings have important clinical and public health implications. In clinical practice, it suggests that physicians should have a holistic concept when diagnosing and treating *H. pylori* infection.It is necessary to routinely evaluate vitamin D, folate and BMI in patients with *H.pylori* infection, especially in those with refractory infection. Correction of nutritional problems, such as vitamin D deficiency, is expected to improve the efficacy of eradication therapy by enhancing host immunity and reduce the long-term risk of associated diseases. At the public health level, in areas with high prevalence of *H.pylori*, vitamin D nutritional status screening and supplementation can become a cost-effective population intervention, providing new hope for reducing the burden of *H.pylori* infection and its related disease risk.In the meantime,this study has some limitations:first,the sample size is small. Larger studies are urgently needed to verify the association between vitamin D levels and *H. pylori* infection,particularly in women.Second,this study only analyzed the correlation between vitamin D levels and *H. pylori* infection,further studies are needed to clarify the molecular mechanism of their interaction.This study was a cross-sectional study,the causal relationship between vitamin D deficiency and *H. pylori* infection cannot be determined.We will refine this work further in follow-up studies.

Conclusion

In conclusion,our study explored the potential relationship between *H.pylori* infection and vitamin D status.Vitamin D levels were significantly lower in *H.pylori*-positive patients.High BMI score and low vitamin level can be independent factors to predict *H.pylori* infection,which can play an important role in prompting the early diagnosis of *H.pylori* infection.Vitamin D may become a potential therapeutic target of *H.pylori infection* and the related diseases.

Declarations

Institutional Review Board Statement

This research has been reviewed and approved by the Ethics Committee of Lishui Municipal Central Hospital.

Informed Consent Statement

The need for written informed consent was waived owing to the observational nature of the study.

Human Ethics and Consent to Participate declarations

Not applicable

Funding

Not applicable

Declaration of Conflicting Interests

The author(s) declare no potential conflicts of interest concerning this article's research, authorship, and publication.

Patient Consent for Publication

Not applicable

Data Availability Statement

Data are available upon request to the corresponding author.

Author contributions

XMW is mainly responsible for writing the manuscript and analyzing and interpreting the data.CC and JHZ collects and analyzes data.YTC analyzes data and supervises writing.JQWcollects data.JBW supervised the project.

Acknowledgments

The authors have nothing to report.

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Figures

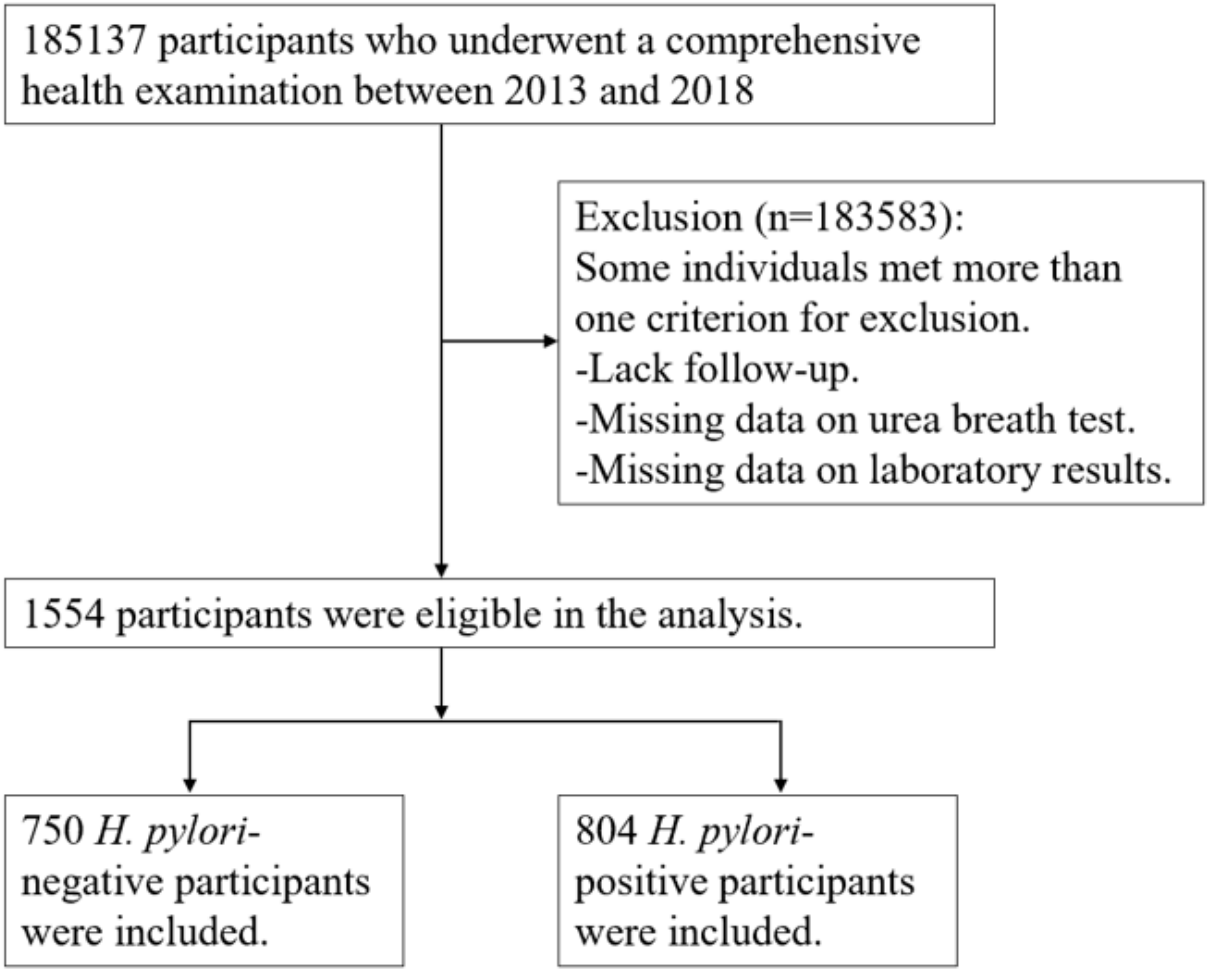

Figure 1

Flowchart of the study participants.

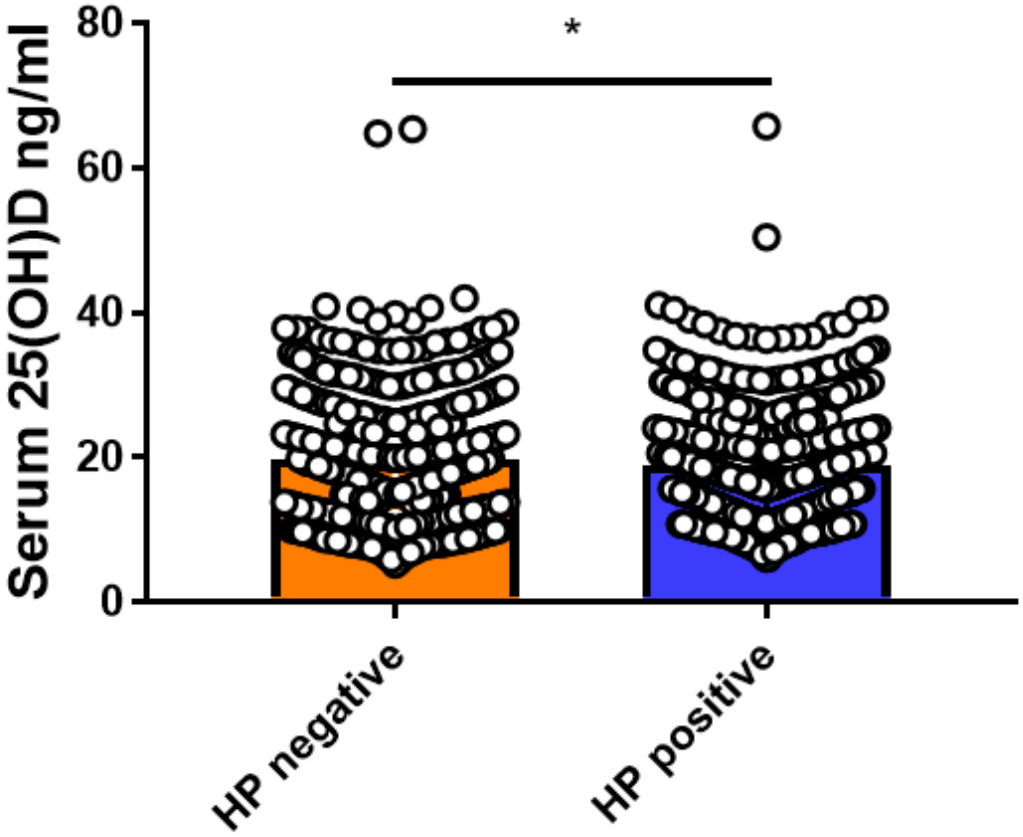

Figure 2

Serum 25(OH)vitamin D levels according to *Helicobacter pylori*infection status.