Original paper

Connection of vitamin D levels in blood serum with helicobacter pylori infection in paediatric patients

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Abstract

Introduction: *Helicobacter pylori* is a globally prevalent infection, particularly in developing countries, with significant implications for gastrointestinal health in children. Recent studies suggest a potential link between vitamin D and its metabolites in enhancing the effectiveness of *H. pylori* eradication therapies through their bactericidal properties.

Aim: To investigate the correlation between the vitamin D levels and their influence on clinical management and treatment results of children patients, tested for *H. pylori*.

Material and methods: The study was conducted on a cohort of 128 paediatric patients. They were divided into 2 groups, depending on whether positive (first group – A) or negative (second group – B) for *H. pylori*. To determine vitamin D levels, venous blood was taken from all participants from both groups. Group 1 included patients whose indexes were up to 10 ng/ml; Group 2 included patients whose indexes were from 10 ng/ml to 20 ng/ml; Group 3 levels were from 20 ng/ml to 30 ng/ml; and Group 4 indexes were over 30 ng/ml. The efficiency of the *H. pylori* eradication scheme in participants of these groups was evaluated.

Results: The mean values in Group A were higher than those in Group B: 17.1 and 14.9, respectively, *p*-value 0.03. *Helicobacter pylori* prevalence was higher in participants with vitamin D levels below 30 ng/ml. As a result of the study, it was established that vitamin D levels below 30 ng/ml in blood serum could be a predisposing factor in the spread of *H. pylori* in paediatric patients. At the same time, different levels of deficiency below 30 ng/ml did not affect the frequency of *H. pylori* infection.

Conclusions: The obtained data can be used in developing guidelines for clinical management of children patients who are primarily diagnosed with *H. pylori* and require eradication therapy.

Introduction

Helicobacter pylori (*H. pylori*) is a widespread infection in many countries, affecting 50% of the world's population [1]. The prevalence of *H. pylori* among children varies widely and depends on factors such as geographical location, socioeconomic conditions, and population density [2]. There is no doubt that in adults the prevalence is greater than in children, being 48.6% and 32.6%, respectively [3]. At the same time, *H. pylori* infection most often occurs in the first 5 years of life [4, 5].

On average, *H. pylori* prevalence in children globally ranges from 30% to 50%: in developed countries, infection rates range between 1.2% and 12.2%, while in developing countries it may amount to 90% [6].

The prevalence of *H. pylori* infection varies significantly in different populations worldwide, with a higher prevalence observed in developing countries [7]. In addition, recent research suggests that *H. pylori* infection may play a role in the regulation of the immune system and could potentially have a protective effect against some autoimmune diseases [8]. Eradication of the bacterium is essential to prevent the development of peptic ulcers, gastric cancer, and other complications. However, the emergence of antibiotic-resistant strains of *H. pylori* has made the eradication process challenging in some cases. New therapies and diagnostic methods are continuously being developed to improve the accuracy of diagnosis and treatment outcomes of *H. pylori* infection. Early detection and prompt treatment of the infection

are key to preventing serious complications and improving patient outcomes [9]. It is important to understand the prevalence of *H. pylori* infection in the general population to evaluate the burden of the disease and develop appropriate preventive measures.

In Kazakhstan, according to meta-analysis data published in 2021, *H. pylori* is the number one cause of gastrointestinal disorders in children and adult patients (results of 2012–2019 analyses) [10]. It was shown that *H. pylori* was primarily diagnosed in early childhood and remained a chronic disease, most often as chronic gastritis. Other studies, conducted in 2021 and involving 833 and 166 participants, have published infection prevalence rates of 62.3% and 62.6%, respectively [11].

Although *H. pylori* is a common infection that almost always leads to active gastritis, serious diseases such as gastric and duodenal ulcers, metaplasia and dysplasia of the gastric mucosa, lymphomas, and adenocarcinomas develop in only 10–15% of infected people [12]. One of the most urgent problems in managing patients with this infection is the ability of *H. pylori* to resist antibiotic treatment [13]. Results of studies conducted by Chinese scientists and published in 2019 show that the opponency of *H. pylori* to metronidazole in children was 46%, and to clarithromycin it was 22% [14].

Other investigators have published meta-analyses on antibiotic resistance across all World Health Organisation (WHO) regions. According to the meta-analyses data, the rates of initial and recrudescent insensibility to antibiotic treatment (specifically levofloxacin, clarithromycin and metronidazole) equalled more than 15%. Furthermore, initial resistance to levofloxacin treatment was 11% in European countries [15]. Moreover, because *H. pylori* antibiotic resistance is a global problem, the WHO has included these bacteria in the list of 20 priority infections for which new antibacterial drugs or alternative treatment methods should be developed [16].

Given all the above, a lot of scientific research is being carried out in the world concerning alternative methods for the elimination of *H. pylori*. One of the areas of ongoing research is the involvement of vitamin D and its metabolites in the effectiveness of eradication therapies [17]. The prerequisites for the studies were the results obtained from earlier fundamental scientific works. In several early 21st century studies, antimicrobial peptides, β-defensins, and cathelicidins were found to protect the gastric mucosa against *H. pylori* infection [18]. Further studies showed that vitamin D and its metabolites increased the secretion of β-defensins and cathelicidin, thus having a direct bactericidal effect on *H. pylori* [19, 20]. An important feature of the bactericidal effect of vitamin D is its selectivity, i.e. only *H. pylori* is targeted, whereas the rest of the bacteria are not affected [21].

Material and methods

This scientific research (materials, methods, and design of the study) was approved at a session of the Ethics Committee at Astana Medical University. The investigation involved 128 children aged from 7 to 18 years. After receiving consent from parents or legal representatives of children, endoscopic examinations and biopsies of gastric mucosa were taken from patients to diagnose *H. pylori* status. Depending on the obtained results, participants were divided into 2 groups. The first group (A) included patients who were diagnosed with *H. pylori*. The second group (B) included patients whose analyses for *H. pylori* were negative. To determine vitamin D levels, venous blood was taken from all participants. Considering vitamin D indexes in blood serum, patients were further subdivided into several groups. In the first group (1) indexes were up to 10 ng/ml; in the second (2) – from 10 ng/ml to 20 ng/ml; in the third (3) from 20 ng/ml to 30 ng/ml; and in the fourth (4) – over 30 ng/ml. Standard 3-component eradication therapy was prescribed to all of these groups. Thirty days after the administered treatment all participants underwent breath urease tests to assess the efficiency of eradication therapy.

Criteria for exclusion from the study can be formulated as follows:

1. Lack of informed consent.
2. Antibiotic use within the 3 months preceding participation in the investigation.
3. Chronic diseases of the respiratory, cardiovascular, endocrine, genitourinary, and/or nervous systems.
4. Gastrointestinal surgeries and bowel resections within the past 5 years. Exceptions: cholecyst-/appendectomy.
5. Vitamin D intake within the 3 months prior to participation in the investigation.
6. PPI intake within 3 months before participation in the investigation.

H. pylori-positive patients received eradication therapy: amoxicillin 30 mg/kg daily; clarithromycin 7.5 mg/kg daily; and omeprazole 1.5–2 mg/kg daily. The eradication treatment lasted 14 days.

Endoscopic examination was performed with the help of an Olympus GIF-XPE3 endoscopic apparatus in the Endoscopy Department of the hospital. The procedure was accompanied by a biopsy of the gastric mucosa from 2 sites of the antrum. To examine mucosal biopsy specimens for *H. pylori* invasion, 2 methods were applied. An instant urease testing was performed immediately after the biopsy in the endoscopy room. The urease test was carried out using the AMO RUT Pro selective test system, manufactured by the Association of Medicine and Analytics Limited Liability Com-

pany, Russia. The second biopsy material of the mucous was studied in a laboratory with a cytological method. A patient was included in the study only with positive results from both methods.

A control study after eradication therapy was carried out using the "HELIX" system test, manufactured by the Association of Medicine and Analytics Limited Liability Company, with a sensitivity of 95% and a specificity of 92%.

Vitamin D levels in blood serum were determined through the method of immune chemiluminescence, using apparatus and reagents manufactured by Backman Coulter, USA. After blood sampling and centrifugation, serum was delivered to the laboratory and stored at a temperature of –20°C.

Statistical analysis

The test for the normality of data distribution was carried out by the Shapiro-Wilk method. With continuous variables normally distributed, the mean value, standard deviation, and *p*-value were calculated using a *t*-test or analysis of variance (ANOVA). With continuous variables abnormally distributed, the median, Quartile 1 and Quartile 3, i.e. the interquartile interval and *p*-value were calculated based on Kruskal-Wallis assessment. Alongside categorisation variables, the complete and relative prevalence, percentage (%), as well as *p*-value were obtained, based on chi-squared assessment (χ^2 test) or Fisher's exact assessment in cases when predicted frequencies were lower than 5 in any cell. *P*-value less than 0.05 was taken as statistically significant.

Results

The conducted study involved 128 paediatric participants: 79 female and 49 male patients. Significant variations were discovered according to gender when comparing the groups under investigation; however, there were no significant differences regarding age. Those who were positively tested for *H. pylori* infection at the beginning of the research prevailed in number. If comparing sex indexes, it should be noted that females were more frequently found to have *H. pylori* infection, compared to male patients. This may be because hormonal factors such as oestrogen levels may play a role in causing infection. Other possible factors include differences in immune system function and differences in lifestyle and eating habits between the sexes. An additional valuable index in the chosen group of patients was age. Because the overall age of patients ranged from 10 to 15 years, the patients were not divided additionally into separate age groups for each year to track the statistical difference in the whole group. The average age of clinically managed patients was approximately 13 years, whereas those who tested negative were statistically significantly younger compared to those who had positive test results at the beginning of the study. Thus, the average age for the *H. pylori*-negative cohort was 12 years (Table I). There were no supplementary factors present, such as demographics, comorbidities, or additional treatment intake, that could influence the value of obtained clinical data. This information reflects the features of the matched cohort of the research.

In addition, children who were diagnosed with infection significantly prevailed in the female cohort, as well as in age, especially when compared to *H. pylori*-negative cases. Among females, almost 70% of participants were diagnosed positively, compared to male participants with a result of 30.8%, despite the fact that females prevailed in the total count of candidates (Table I).

When comparing serum vitamin D levels in both studied groups, a numerical valuable difference was found: average levels in Group A were greater than indexes in Group B – 17.1 ng/ml (11.6; 24.0) and 14.0 ng/ml (10.4; 19.5), respectively. At this point in the investigation, a relatively reliable dependence between high indexes of vitamin D in children's serum and the presence of *H. pylori*, approved by urease assessment after the endoscopic investigation, was established. The scale of vitamin D indexes did not fall below 10 ng/ml in either group and did not exceed 32 ng/ml generally.

At the next stage, the pervasiveness of *H. pylori* within the studied groups depending on vitamin D in blood serum levels was analysed. According to the obtained results, *H. pylori* occurred more frequently in Group 3. At this point, it is possible to conclude that vitamin D indexes within the 20–30 ng/ml scale have a direct correlation with the presence of *H. pylori* infec-

Table I. Comparative characteristics of studied groups depending on the sex and age of the participants

Group	Total (*N* = 128)	Diagnosed with *H. pylori* (*N* = 65)	Not diagnosed with *H. pylori* (*N* = 63)	*P*-value*
Female	79 (61.7%)	45 (69.2%)	34 (54.0%)	0.076
Male	49 (38.3%)	20 (30.8%)	29 (46.0%)	0.076
Age of participants	13.0 (10.0, 15.0)	13.0 (11.0, 15.0)	12.0 (10.0, 14.0)	0.189

*n (%); Median (IQR); *Pearson's χ^2 assessment; Kruskal-Wallis assessment. Source: completed by the authors.*

Table II. Prevalence of *H. pylori* depending on vitamin D levels in blood serum before the eradication therapy

Group	Overall (*N* = 128[1])	1 (*N* = 26[1])	2 (*N* = 60[1])	3 (*N* = 37[1])	4 (*N* = 5[1])	*P*-value*
H. pylori negative (B)	65 (50.8%)	16 (61.5%)	35 (58.3%)	10 (27.0%)	4 (80.0%)	0.004
H. pylori positive (A)	63 (49.2%)	10 (38.5%)	25 (41.7%)	27 (73.0%)	1 (20.0%)	0.004

*[1]n (%); *Fisher's exact test. Source: completed by the authors.*

tion. The lesser dependence was observed in the highest vitamin D levels cohort – patients with indexes over 30 ng/ml showed fewer cases with *H. pylori* availability. Besides Group 3, Group 2 with moderate levels of vitamin D in the patient's serum ranked second in *H. pylori* diagnosis. There was only one patient in the vitamin D index over 30 ng/ml cohort who was diagnosed with *H. pylori* infection within the study, whereas in the *H. pylori*-negative cohort 4 children showed elevated indexes in blood serum (Table II).

At the same time, the presence of *H. pylori* was approved by histological methods, specifically by Gimza-stained slides and cytological smears. In the obtained smears, cytologists were looking for the features of exciter, as well as accompanying traits of the gastric mucosa. These complementary signs may include the presence of red blood cells in case of local haemorrhages (numerous/infrequent defects of gastric mucosal lining), the presence of immunological inflammatory and pro-inflammatory cells (segmented neutrophils, eosinophils, rarely – lymphocytes), and normal or hypertrophic simple columnar epithelial cells of the mucosal lining. None of the cases showed the presence of epithelial malignancy. Lining simple columnar epitheliocytes showed features of *H. pylori* invasion: reactive changes, disabled vesicular apparatus, and loss or decreased numbers of apical microvilli. The cytological investigation was done to approve positive cases only at the beginning of the research; no additional biopsies were made.

After combining visual endoscopic changes (obtained during the procedure) of the gastric mucosa together with cytological conclusions (obtained after biopsy material examination), a categorisation of *H. pylori*-positive cases was included in the classification chart. This distribution allowed an understanding of the morphological condition of the digestive mucosa that was further correlated with vitamin D levels in paediatric patients. There was a single case showing haemorrhage changes, represented by a pool of red blood cells. Nineteen per cent of cases were of mixed type – a combination of superficial and hypertrophic variants mostly, without the presence of blood leakage. Thus, the vast majority of positive cases were of the superficial morphological type, invading gastric mucosa without the involvement of the submucosal plate. Superficial type involves oedema of the mucosal lining, increased number of gastric crypts and hyperaemia. Because the haemorrhage type is generally supposed to be more severe in clinical manifestations and management, it was observed that in the present research moderate severeness cases were predominantly involved. One case of haemorrhage type (1.6%) showed the presence of superficial defects of the gastric mucosa without a disturbed external mucosal layer (Table III). None of the cases showed atrophy of the gastric lining.

Vitamin D indexes in patients after eradication therapy were also measured. The data obtained after the eradication therapy in children of all 4 studied groups showed a predominance of *H. pylori*-negative cases if compared to the output data. The indexes of vitamin D in the studies' blood serum samples did not undergo statistically significant swaps (accelerated or decreased indexes), which contradicts some of the recently published studies [22, 23]. It is important to draw atten-

Table III. Endoscopic changes of the gastric mucosa in *H. pylori* approved cases

Group	Total	Superficial type	Hypertrophic type	Haemorrhage type	Mixed type
H. pylori-positive group A	63 (100%)	42 (66.7%)	8 (12.7 %)	1 (1.6%)	12 (19%)

Source: completed by the authors.

Table IV. Vitamin D levels in blood serum after the eradication therapy

Group	Overall (*N* = 128[1])	1 (*N* = 25[1])	2 (*N* = 61[1])	3 (*N* = 37[1])	4 (*N* = 5[1])	*P*-value*
H. pylori positive cases of group A	63 (49.2%)	9 (36.0%)	26 (42.6%)	27 (73.0%)	1 (20.0%)	0.04
H. pylori negative cases of group B	65 (50.8%)	16 (64.0%)	35 (57.4%)	10 (27.0%)	4 (80.0%)	0.04

*[1]n (%); *Fisher's exact test. Source: completed by the authors.*

tion to the stable vitamin D number in patients of all 4 groups even after full-course eradication therapy. These indexes remained in the previously established frameworks, having slight shifts within the outlined group indexes (Table IV).

Summarising the obtained data, the *H. pylori*-positive cases were prevailing over those of negative type. The average age of studied paediatric patients was 13 years, and female patients were found to show a higher incidence of positive *H. pylori* tests. Vitamin D indexes did not exceed 10–32 ng/ml intervals. It was observed that higher indexes of vitamin D in blood serum (20–30 ng/ml biochemical interval) correlated with positive confirmation of *H. pylori* presence, supported by the urease test and morphological assessment. Group A patients of both sexes (*H. pylori*-confirmed cases) showed statistically higher indexes of vitamin D levels in blood serum if compared to those from Group B. Vitamin D indexes that fit 20–30 ng/ml were found to be a reliable indicator for *H. pylori* invasion in patients of Group A, compared to other intervals. The vast majority of examined biopsy cases, supported by visual endoscopic features, were of the superficial type, but almost 19% were of mixed type. Other types of the invasion included hypertrophic (12.7%) and haemorrhage (1.6%) types. The amount of vitamin D after the eradication therapy did not show statistically significant shifts.

Discussion

The objective of the research was to evaluate vitamin D levels in *H. pylori*-confirmed and *H. pylori*-negative 10–15-year-old patients and to determine if *H. pylori* prevalence is affected by vitamin D levels in blood serum. According to the results of the study, blood vitamin D levels were higher in *H. pylori*-positive participants, which contradicts the results of other published studies. In several other scientific studies with the involvement of adult patients, results have shown lower vitamin D indexes in *H. pylori*-confirmed cases compared with *H. pylori*-negative ones [24]. These studies have been held from the preventive medicine point of view, because *H. pylori*-diagnosed patients are thought to have significantly higher risk of stomach adenocarcinoma development [25]. Therefore, they came up with a negative tendency for vitamin D with the presence of *H. pylori* correlation.

The results are analogous to previously mentioned data obtained in other studies with 6–36-month-old children as an investigational group. At the same time, there are studies where no connection between *H. pylori* and blood serum vitamin D levels was found [26]. In these works, 25-hydroxyvitamin D was evaluated by means of radioimmunoassay. Moreover, low indexes of vitamin D were associated with higher likelihood in *H. pylori* presence and development of metabolic syndrome in patients of various age groups [27].

The results of this study were highly influenced by clinical signs, which showed that the vast majority of participants in both groups were vitamin D deficient. The mean average indicators of vitamin D in both groups were lower than 20 ng/ml. Whereas in other studies participants with normal vitamin D ranges were compared to participants with vitamin D deficiencies. It should also be noted that recommendations from practical guidelines for Central Europe, where normal serum vitamin D levels were more than 30 ng/ml, were followed and considered [28]. This guideline suggests obligatory in-hospital monitoring of vitamin D indexes in a list of clinical cases, including malabsorption syndromes and acute or chronic infectious diseases. In the present study, only 5 out of the 128 participants had similar indicators that were evaluated over 30 ng/ml in the blood serum and none of the participants had shown accompanying pathology of the gastro-intestinal tract or other organs.

For discussion of obtained results, it is worth considering another study, where participants were subdivided into 4 groups depending on their serum indexes of 25-hydroxyvitamin D [28]. Clinical data from these 4 groups were analysed depending on *H. pylori*-positive distribution within experimental cases, approved by several testing methods. Therefore, from the obtained data, it becomes evident that *H. pylori* occurs much more frequently in patients with vitamin D levels lower than 30 ng/ml (10–24 ng/ml on average), which correlates with the outcomes of our study. Basically, *H. pylori* were diagnosed in children with maximum indicators ranging from 20 ng/ml to the peak level of 30 ng/ml, which correlates highly with data obtained in paediatric patients in these 4 groups of the investigation. In Group 4 of this research, where vitamin D indexes in blood serum rose to over 30 ng/ml, only one participant (i.e. 20%) tested positive for *H. pylori*.

Several studies showing similar results were published in the last 5-6 years worldwide. In a study carried out in Israel, it was found that in patients having vitamin D serum levels less than 20 ng/ml, *H. pylori* infection confirmation was more common than in patients whose vitamin D levels were above 20 ng/ml [29]. This research suggests that elevated levels of vitamin D in blood serum may benefit better final results of further eradication therapy in patients previously diagnosed with *H. pylori*. The authors also propose the importance of the day of the eradication therapy, when vitamin D levels have been measured that we would like to include in our future studies [29].

Swiss scientists also found that *H. pylor*i prevalence decreased along with increased blood serum vitamin D levels [30]. The proposed cross-sectional study with adult patients considered vitamin D deficiency to be an important factor for possible infection invasion and further successful eradication. For *H. pylori* confirmation, Giemsa-stained histological specimens from the gastric mucosa biopsy material were also used in the present research. It might be admitted that the preparation of such slides is time-consuming because of the obligatory time for tissue fixation, proceeding, and staining. That is why urease tests are considered to be less time-wasting and easy to administer in the endoscopic room immediately after the endoscopy procedure. Histological or cytological (like in this study) methods can be carried out after positive results of urease tests. According to systematic review data, vitamin D concentrations lower than 30 ng/ml may increase the risks of infection propagation in the human body [31]. From the published data it becomes clear that deficiency of this vitamin is associated with higher risks of the chronic inflammatory process and higher indexes of general mortality in patients with sepsis. Vitamin D binding protein is also low in patients with deficiency and makes antimicrobial defence weaker.

Reagrding vitamin D levels after the conducted eradication therapy in patients, a work by El Shahawy *et al*. [32] showed that after a 14-day-long treatment course in *H. pylori*-confirmed cases, the vast majority of adult patients showed negative results for this exciter afterward. Besides eradication, in successfully treated patients, indexes of blood serum 25-OH vitamin D were higher compared to those who failed in the treatment course. Thus, stable vitamin D levels correlated with successfully managed cases, as was shown in the conducted research with paediatric patients. In the conducted experiment, vitamin D levels that fit the 10–25 ng/ml framework could be used as prognostic tools for a higher incidence of *H. pylori* invasion as well as a positive reaction to the full-course eradication therapy. An explanation for such outcomes may be scientifically approved data on vitamin D playing a role of lysosomal activator and antibacterial factor in case of gastric mucosa invasion by *H. pylori* [33]. Even though the research was conducted by means of experimental animals (mice), the results show up unknown pathways of *H. pylori* survival mechanisms in the gastric mucosal lining on the background of chronic gastritis, as well as the influence of vitamin D on autophagy cascades for eradication of the antibiotic-resistant cases.

An additional risk factor for patients with *H. pylori* invasion and different vitamin D indexes is arterial hypertension. In a paper by Salem-Sokhn *et al*. [34], insufficient vitamin D status had a straight dependency on clinically confirmed arterial hypertension. Because vitamin D plays a vital role in the pathogenesis of arterial hypertension in patients of different age groups, its low indexes were connected with lower incidences of *H. pylori* evidence and higher risks for hypertension. As a result, low vitamin D should be an alarm for re-checking the arterial blood status in an examined patient with any type of pathology. Continuing with the theme of risk factors, another study conducted in Germany included patients with diabetes type 2 concerning the impact of vitamin D on effective eradication schemes for *H. pylori* cases [35]. This supplementary pathology should be considered because most cases have re-infection with *H. pylori*, as mentioned in the study. This investigation shows the role of vitamin D in preventing chronic illnesses and influencing probable better results of eradication therapy specifically in patients having both *H. pylori* and diabetes. The results vividly show that lower indexes of vitamin D are connected to dyslipidaemia and worse outcomes in eradication therapy [35]. Evaluating vitamin D before the treatment course together with other general biochemical indexes of the blood serum could predict much of the clinical management, as shown also in our study. These data from patients can either change the method or drugs used in the eradication therapy or demand additional treatment aimed at regulating vitamin D metabolic cascade.

Conclusions

Based on the collected data, among the 128 young patients aged 7 to 18 years, there is a higher incidence of *H. pylori*-positive cases than -negative ones, indicating the need for preventive measures to reduce the prevalence of *H. pylori* infections. *H. pylori*-positive patients in this examination were divided into subgroups depending on their vitamin D indexes in the blood serum. The study established that concentrations of vitamin D in the blood serum that were lower than 30 ng/ml could be one of the predisposing factors of *H. pylori* presence in paediatric patients. This could be because vitamin D concentrations between 10 to 30 ng/ml were highly correlated with *H. pylori* confirmed diagnosis by the urease test and the cytological investigation. As a result, such indexes of vitamin D could be predictive for clinical outcomes of eradication schemes and could possibly correlate with mixed or superficial types of *H. pylori* invasion. Furthermore, adequate levels of vitamin D in the blood serum showed a better result at the end of a full course of the prescribed eradication therapy. At the same time, *H. pylori* prevalence was not dependent on the magnitude of such deficiency. The levels

of vitamin D did not show statistically significant changes after full-course treatment in *H. pylori*-confirmed paediatric patients. The study features restrictions in terms of limited sampling, and future studies involving greater numbers of participants are required. Further investigations of this topic will include groups of patients divided depending on their eradication schemes (different drugs of choice for each cohort).

The scientific significance of the article lies in the analysis of the significance of vitamin D concentration in children as a possible predisposing factor for *H. pylori* infection. The article's results have clinical implications for the prevention and treatment of *H. pylori* infections in children, indicating the importance of maintaining adequate vitamin D levels.

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Ethical approval

Scientific research (its materials, methods and design of the study) was approved at a session of the Ethics Committee at Astana Medical University (approval number: 12-B).

Conflict of interest

The authors declare no conflict of interest.

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