



How to cite: Lezhenko G, Savchenko D. The relationship between the level of surfactant protein D and the development of gastroduodenal diseases associated with helicobacter pylori in children. *East Ukr Med J.* 2026;14(3):828-836. DOI: [https://doi.org/10.21272/eumj.2026;14\(3\);828-836](https://doi.org/10.21272/eumj.2026;14(3);828-836)

ABSTRACT

Gennadiy Lezhenko

<https://orcid.org/0000-0003-0851-4586>

Department of Hospital Pediatrics,
Zaporizhzhia State Medical and
Pharmaceutical University,
Zaporizhzhia, Ukraine

Daria Savchenko

<https://orcid.org/0009-0004-9933-1885>

Department of Hospital Pediatrics,
Zaporizhzhia State Medical and
Pharmaceutical University,
Zaporizhzhia, Ukraine

THE RELATIONSHIP BETWEEN THE LEVEL OF SURFACTANT PROTEIN D AND THE DEVELOPMENT OF GASTRODUODENAL DISEASES ASSOCIATED WITH HELICOBACTER PYLORI IN CHILDREN

Introduction. The prevalence of gastrointestinal pathology, including that associated with *Helicobacter pylori* (HP), remains high in the pediatric population. Given that the development of inflammation in HP-associated diseases is linked to the immune response, studying the mechanisms of this response is important, as the interaction of the mucosal epithelium with immune factors, including antimicrobial peptides, influences the progression of the inflammatory process and the course of the disease. Surfactant protein D (SP-D), considered a component of the mucosal barrier, is one of the antimicrobial peptides (AMPs). Studying SP-D levels in children with gastrointestinal diseases will deepen our understanding of the pathogenesis of the inflammatory process and the role of HP in it.

Purpose: To investigate the possible relationship between the level of surfactant protein D and the development of gastroduodenal diseases associated with *Helicobacter pylori* in children.

Methods: A total of 60 patients aged 10 to 17 years, 11 months, and 29 days. The first subgroup included 30 children (mean age 14.72 ± 1.9 years) with gastroduodenal diseases associated with HP. The second subgroup included 30 children (mean age 14.76 ± 2.5 years) with gastroduodenal diseases not associated with HP. The control group consisted of 20 conditionally healthy children, representative for age and gender. Endoscopic, laboratory, and histological examinations were performed for diagnosis.

Results. Serum SP-D levels in children in the study group were 1.7 times lower than those in the control group ($p < 0.05$). No differences in the levels of the studied antimicrobial peptide were found depending on the presence of HP infection ($p > 0.05$), indicating the absence of an obvious relationship between the level of the SP-D and the presence of HP infection.

In children in the control group with a family history, SP-D levels were significantly lower by almost 1.5 times compared to those in children without a family history ($p < 0.05$). Serum SP-D levels in the observed children were not a constant indicator, but rather evolved over time and corresponded to the degree of chronic inflammation. In subgroup 1, impaired adaptive abilities and more pronounced inflammation were associated with a decrease in SP-D in the blood serum, while in subgroup 2, on the contrary, over time, the level of SP-D in the blood serum of children increased and approached the indicators of the control group.

Conclusions: The development of inflammatory diseases of the gastrointestinal tract in children occurs against a background of immune dysfunction, specifically a deficiency of the antimicrobial peptide SP-D in the serum, regardless of HP contamination. The severity of SP-D deficiency correlated with the degree of epithelial damage, and increased levels of this antimicrobial peptide in damaged epithelium were associated with a lower degree of chronic inflammation.

Keywords: Children, adolescent, SP-D, immune system, *Helicobacter pylori*, gastroduodenal region, diagnostics, peptic ulcer, antimicrobial peptide.

Corresponding author: Hennadii Lezhenko, Department of Hospital Pediatrics, Zaporizhzhia State Medical and Pharmaceutical University, Zaporizhzhia, Ukraine, e-mail: genalezh@gmail.com

РЕЗЮМЕ

Геннадій Леженко

<https://orcid.org/0000-0003-0851-4586>

Кафедра госпітальної педіатрії,
Запорізький державний медико-
фармацевтичний університет,
м. Запоріжжя, Україна

Дар'я Савченко

<https://orcid.org/0009-0004-9933-1885>

Кафедра госпітальної педіатрії,
Запорізький державний медико-
фармацевтичний університет,
м. Запоріжжя, Україна

ВЗАЄМОЗВ'ЯЗОК МІЖ РІВНЕМ СУРФАКТАНТНОГО ПРОТЕЇНУ D ТА РОЗВИТКОМ ЗАХВОРЮВАНЬ ГАСТРОДУОДЕНАЛЬНОЇ ЗОНИ, АСОЦІЙОВАНИХ ІЗ *HELICOBACTER PYLORI* У ДІТЕЙ

Вступ. Поширеність гастродуоденальної патології, в тому числі асоційованої із *Helicobacter pylori* (HP) у дитячій популяції залишається на високому рівні. Враховуючи, що розвиток запалення при захворюваннях, асоційованих із HP пов'язаний з імунною відповіддю, важливим є вивчення механізмів відповіді, адже взаємодія епітелію слизової оболонки з імунними факторами, в тому числі антимікробними пептидами має вплив на прогресування запального процесу і перебіг захворювання. До антимікробних пептидів (АМП) відноситься і сурфактантний протеїн D (SP-D), який розглядається як складова бар'єрного захисту слизових оболонок. Вивчення рівнів SP-D у дітей із захворюваннями гастродуоденальної зони поглибить розуміння патогенезу запального процесу і місце в ньому HP.

Мета. Дослідити можливий взаємозв'язок між рівнем сурфактантного протеїну D та розвитком захворювань гастродуоденальної зони, асоційованих із *Helicobacter pylori* у дітей.

Методи. Під спостереженням перебувало 60 пацієнтів віком від 9 до 17 років. До першої підгрупи увійшли 30 дітей (середній вік $14,72 \pm 1,9$ років) із захворюваннями гастродуоденальної зони, асоційованими з HP. До складу другої підгрупи було включено 30 дітей (середній вік $14,76 \pm 2,5$ років) із захворюваннями гастродуоденальної зони, неасоційованими з HP. Групу контролю склали 20 умовно здорових дітей, репрезентативних за віком і

статтю. Для діагностики було проведено ендоскопічне, лабораторне та гістологічне дослідження.

Результати. Встановлено, що рівень SP-D у сироватці крові дітей основної групи був у 1,7 разів меншим за показники групи контролю ($p < 0,05$). Відмінностей у вмісті досліджуваного АМП в залежності від наявності інфекції *HP* виявлено не було ($p > 0,05$), що вказує на відсутність очевидного взаємозв'язку між рівнем антимікробного пептиду що досліджувався та наявністю інфекції *HP*.

У дітей контрольної групи, що мали обтяжений спадковий анамнез, рівні SP-D були достовірно нижчими майже в півтора рази, порівняно з показниками дітей без обтяженого анамнезу ($p < 0,05$). Вміст SP-D в сироватці крові дітей, що перебували під спостереженням не був сталим показником, що реалізувалось із плином часу і відповідало ступеню хронічного запалення. В 1 підгрупі порушення адаптативних спроможностей і більш виражене запалення асоціювались зі зниженням SP-D у сироватці крові, а у 2 підгрупі – навпаки, з плином часу рівень SP-D у сироватці крові дітей зростав та наближався до показників групи контролю.

Висновки: Розвиток запальних захворювань гастродуоденальної зони у дітей перебігає на тлі порушення в функціонуванні імунної системи, а саме дефіциту антимікробного пептиду SP-D у сироватці крові незалежно від контамінації *HP*. Вираженість дефіциту SP-D корелювала зі ступенем ушкодження епітелію, а підвищення рівню даного антимікробного пептиду ушкодженим епітелієм асоціювалось із нижчим ступенем хронічного запалення.

Ключові слова: Діти, підлітки, SP-D, імунна система, *Helicobacter pylori*, гастродуоденальна зона, діагностика, пептична виразка, антимікробний пептид.

Автор, відповідальний за листування: Геннадій Леженко, кафедра госпітальної педіатрії, Запорізький державний медико-фармацевтичний університет, м. Запоріжжя, Україна, e-mail: genalezh@gmail.com

INTRODUCTION

In recent years, new diagnostic and treatment methods for gastrointestinal diseases have been developed and existing ones have been optimized. However, the prevalence of this pathology, including that associated with *Helicobacter pylori* (*HP*), remains high in the pediatric population [1]. The relevance of studying the pathogenesis of inflammatory processes in diseases of the stomach and duodenum is due to the tendency of these diseases to become chronic, the risk of complications, and often ineffective treatment [2,3].

Considering that the development of inflammation in diseases associated with *HP* is associated with the immune response [4], it is important to study the response mechanisms, including in the gastroduodenal region, since the interaction of the mucosal epithelium with immune factors, including antimicrobial peptides, affects the progression of the inflammatory process and the course of the disease [5]. Antimicrobial peptides (AMPs) also include surfactant protein D (SP-D), which

is considered a component of the barrier protection of mucous membranes, but data on its effect in the gastroduodenal region are limited [6]. It has been described that the synthesis of SP-D occurs mainly in the lungs, but also in the mucosa of the upper gastrointestinal tract, where this peptide is involved in protecting against the development of the pathological process and can interact with the infectious pathogen *HP* [7, 8, 9]. Studying SP-D levels in children with gastroduodenal diseases will deepen our understanding of the pathogenesis of the inflammatory process and the place of *HP* in it.

Purpose: To investigate the possible relationship between the level of surfactant protein D and the development of gastroduodenal diseases associated with *Helicobacter pylori* in children.

MATERIALS AND METHODS

A total of 60 children aged 10 to 17 years, 11 months, and 29 days (25 girls and 35 boys) were observed and hospitalized in 2022-2024 at the

Zaporizhzhia Regional Clinical Hospital. Examination and diagnosis were conducted in accordance with the standards of medical care for "Peptic Ulcer of the Gastric and Duodenal Ulcers in Adults and Children" (Order of the Ministry of Health of Ukraine No. 1514 dated August 25, 2023) [10]. The endoscopic examination was performed using an MTW-Endoskopie W.Haag KG endoscope with the collection of biopsy samples [11]. Using a rapid urease test – a commercial kit *Ure Hp-test* (Erba Lachema, Czech Republic) [12] and histological examination [13] *HP* infection was established.

The determination of the *HP* bacterial load and the density of the lymphoplasmacytic infiltrate to determine the degree of chronic inflammation was performed according to the Sydney System (Updated Sydney System, 1994) using semiquantitative analysis. In the absence of lymphoplasmacytic infiltrate and neutrophils in the biopsy, minimal inflammatory changes were diagnosed [14].

The main group consisted of 60 children who had gastroduodenal diseases. Among them, chronic gastroduodenitis was diagnosed in 34 (56.7%) patients, gastric or duodenal ulcer (DU) and multiple gastric erosions (erosive gastritis) were established in 26 (43.3%) cases. The division of the main group into two subgroups of diseases considering a single *HP* infection. Subgroup 1 included 30 children (17 boys and 13 girls) of average age, who were 14.72 ± 1.9 years old with gastroduodenal diseases associated with *HP*. Chronic gastroduodenitis in subgroup 1 was established in 23 (76.7%) cases, duodenal bulb ulcer was diagnosed in 1 (3.3%) child, erosive gastroduodenitis in 6 (20%) children. According to the results of the histological examination, mild chronic disease was present in 10 patients (33.3%), moderate – in 17 (56.7%) and severe – in 3 (10%) children. Subgroup 2 included 30 children (18 boys and 12 girls), average age 14.76 ± 2.5 years, suffering from diseases of the gastroduodenal region not associated with *HP*. Chronic gastroduodenitis in children of subgroup 2 was established in 11 children (36.7%), gastric or duodenal ulcers (DU) – in 8 (26.7%) patients, erosive gastroduodenitis – in 11 (36.7%) children. Histological examination revealed minimal inflammatory changes in 13 children (43.3%), mild chronicity in 12 children (40%), and moderate chronicity in 5 children (16.7%). The control group included 20 children without gastrointestinal diseases, other inflammatory processes, or chronic diseases in the decompensated stage. All children were representative of the age and gender of the sample.

The level of SP-D in blood serum was determined by ELISA using the commercial Human SP-D ELISA Kit, manufactured by Elabscience Biotechnology, USA.

Mathematical and statistical processing was carried out using the licensed software package Statistic for Windows 13.0, serial number JPZ8041382130ARCN10-J with the determination of the arithmetic mean (M), standard deviation (σ) and average errors (m) for indicators whose distribution corresponded to the criterion.

Relationships between categorical variables were determined using the Pearson χ^2 test, and associations between parameters were assessed using Spearman's rank correlation (r). Student's t-test was used to assess differences between parameters within observation groups, and differences for small samples were assessed using the nonparametric Mann-Whitney U-test. Differences were considered significant at $p < 0.05$. When the distribution deviated from the normal range, data was presented as the median and interquartile range (IQR) (Q25; Q75).

The survey protocol complied with bioethical standards, was developed according to ethical standards and principles for conducting scientific research and was approved by the Bioethics Committee of Zaporizhzhia State Medical and Pharmaceutical University (Protocol No. 2, dated October 22, 2022).

RESULTS

According to the results of the study, it was established that in children of the main group with diseases of the gastroduodenal region, the level of SP-D in the blood serum was 43.1 ± 2.8 ng / ml, which was 1.7 times lower than the indicators of the control group (73.03 ± 3.6 ng / ml, $p < 0.05$). Considering that the children of the main group were divided into two subgroups based on the presence or absence of *HP* infection, a comparison of the indicators of the two subgroups was carried out. The conducted comparisons did not reveal any differences in the content of SP-D in the blood serum of the children under observation. Thus, in subgroup 1, that is, in children with diseases associated with *HP*, the level of SP-D was 42.3 ± 3 ng / ml, in subgroup 2 – in children with diseases not associated with *HP* – 43.9 ± 3.2 ng / ml ($p > 0.05$), which indicates the absence of an obvious relationship between the level of the studied antimicrobial peptide and the presence of *HP* infection.

The observed findings led to the conclusion that one of the possible pathogenetic links in the development of diseases of the gastroduodenal region in children is a disorder in the immune defense system, namely, a deficiency of SP-D.

In the course of further work, we divided the children included in the control group (i.e., the apparently healthy children) based on their family history of gastroduodenal pathology. After calculations, we obtained what we believe to be an

interesting result (the data are presented in Figure 1): in children in the control group who had a family history of gastroduodenal pathology, even in the absence of gastroduodenal diseases, SP-D levels were significantly lower by almost one and a half times compared to children without a family history ($p < 0.05$).

Subsequently, serum SP-D levels were determined in children with gastroduodenal pathology depending on the degree of lymphoplasmacytic infiltrate, which represents chronic inflammation. The results of the SP-D level analysis in children with gastroduodenal diseases based on the degree of chronic inflammation are presented in Table 1.

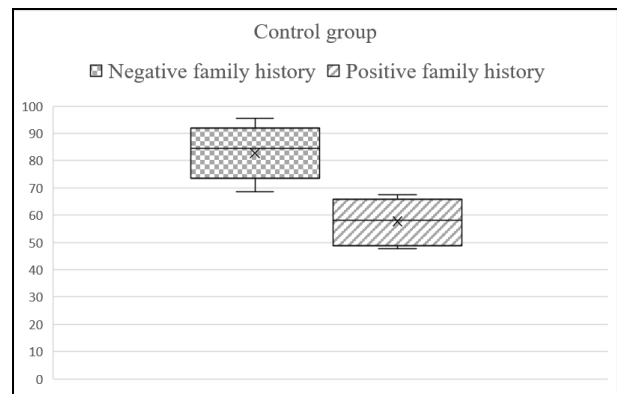


Figure 1 – SP-D content (ng/ml) in the blood serum of children in the control group ($M \pm m$)

Table 1 – The level of SP-D in the blood serum of children with gastroduodenal diseases depending on the degree of chronic inflammation ($M \pm m$)

Parameter	Main group n=60	Subgroup 1 n=30	Subgroup 2 n=30	Control group, n=20
SP-D level ng/ml				
Minimal inflammatory changes	46.5±5.9*	-	46.5±5.9*	73.03±3.6
Chronic inflammation grade 1	44.1±5.1*	42.9±6.7*	52.8±6.5*	73.03±3.6
Chronic inflammation grade 2-3	36.4±4.6*	44.9±5.8*	27.9±3.6**	73.03±3.6

Notes:

* – $p < 0.05$ – compared with the parameters of control group

** – $p < 0.01$ – compared with the parameters of control group

According to the data presented in Table 1, certain peculiarities in the SP-D levels in the blood serum of the children under our observation are observed. Thus, in patients of subgroup 1, the levels of the studied peptide were significantly lower compared to the control group ($p < 0.05$), but did not differ, regardless of the degree of lymphoplasmacytic infiltrate ($p > 0.05$). At the same time, in subgroup 2, a tendency towards an increase in the SP-D level ($p > 0.05$) was observed in children with grade 1 lymphoplasmacytic infiltrate compared to the levels with minimal inflammatory changes, which clearly indicates the possible onset of a response of compensatory mechanisms, namely, the mucosal epithelium. In the absence of *HP*, the development of grade 2-3 chronic inflammation occurred against the background of an almost twofold decrease in SP-D, compared with the SP-D figures in the blood serum of children with established grade 1 lymphoplasmatic infiltrate ($p < 0.05$), which is probably associated with more severe damage to the epithelium. By combining the obtained data with the fact that the SP-D level did not differ on average, regardless of the presence or absence of infection, we conclude that the content of SP-D in the blood serum of children with diseases of the upper gastrointestinal tract can also be used as a marker

of the functional state of the epithelium of the gastroduodenal mucosa.

To confirm the observed associations, an analysis was conducted considering the duration of the disease and the dynamics of SP-D levels in children over time. It should be noted that when dividing the main group based on disease duration, an uneven number of patients was observed. The resulting data are presented in Figure 2.

As shown in Figure 2, with increasing disease duration, the proportion of children with *HP*-associated diseases increased, while the proportion of patients without the bacteria decreased.

We observed certain differences in serum SP-D levels in children with different durations of gastrointestinal diseases (Table 2).

The data presented in Table 2 demonstrate that serum SP-D levels in children under observation are not constant; its synthesis is regulated over time and corresponds to changes in the degree of chronic inflammation.

Children in subgroup 2 showed a dynamic increase in serum SP-D levels, which possibly indicate a restoration of the ability to synthesize AMP in the gastrointestinal mucosa and a reduction in inflammation. In children in subgroup 1, the opposite

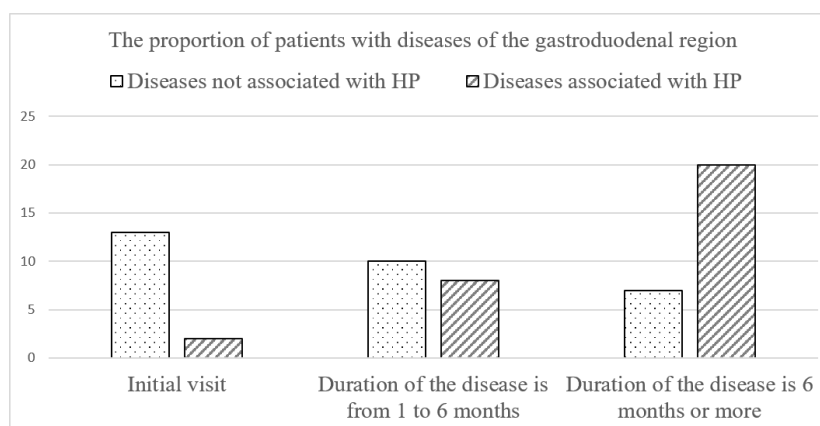


Figure 2 – Number of patients with gastroduodenal diseases associated and not associated with HP, depending on the duration of the disease

Table 2 – Serum SP-D level depending on the duration of the gastroduodenal region in children ($M \pm m$)

Parameter		Main group n=60	Subgroup 1 n=30	Subgroup 2 n=30	Control group, n=20
Initial visit	Chronic inflammation, points	0.88±0.1	-	0.88±0.1	-
	The level of SP-D	27.5±5.5*	-	27.5±5.5*	73.03±3.6
Duration of complaints from 1 to 6 months	Chronic inflammation, points	1.48±0.1	1.75±0.1	1.2±0.1	-
	The level of SP-D	35.3±6*	37.73±6.6*	32.9±4.7*	73.03±3.6
Duration of complaints more than 6 months	Chronic inflammation, points	1.46±0.2	1.92±0.1	1±0.2	-
	The level of SP-D	50.9±6.5*	35.3±2.8*	65.7±6.1	73.03±3.6

Note: * – $p < 0,05$ – compared with the parameters of control group

pattern was observed: an increasing level of inflammation, which could likely be a consequence of the insufficiency of compensatory mechanisms. In this subgroup, serum SP-D levels remained low and were clearly unable to restrain the development of the inflammatory process and HP contamination. Although no association was observed between the severity of inflammatory changes and the level of SP-D synthesis in the main group and subgroup 1 ($r = -0.15$, $p > 0.05$ and $r = 0.17$, $p > 0.05$, respectively), an inverse relationship was obtained in subgroup 2 ($r = -0.55$, $p < 0.05$). This likely indicates epithelial destruction and a decrease in its ability to synthesize SP-D. Consequently, in this subgroup, the degree of chronic inflammation depended on the modulating effect of the peptide and increased with insufficient synthesis of the antimicrobial peptide. No relationship was observed between serum SP-D levels and the bacterial load of HP ($r = -0.08$, $p > 0.05$), indicating the lack of action of this antimicrobial peptide against the bacterium and not confirming the possibility of SP-D synthesis in response to the presence of HP or active colonization.

DISCUSSION

We observed a decrease in the serum level of SP-D in children with upper gastrointestinal tract diseases,

indicating the involvement of this AMP in immune defense. This has been suggested by a number of studies [6-8, 15].

Literature reports indicate that HP infection can increase SP-D synthesis in patients with gastroduodenitis. Furthermore, it is described that the peptide under study binds to HP lipopolysaccharides for subsequent agglutination [9]. Despite this, our results did not confirm a direct interaction between HP and SP-D. No differences in SP-D levels were observed between subgroups ($p > 0.05$), and this pattern rather suggests that SP-D acts as a trigger preventing the development of inflammation in the mucosa, but does not directly influence HP, nor does the bacterium itself alter the synthesis of the studied AMP.

According to the literature, SP-D is known for its ability to modulate inflammation. Thus, the authors point to the suppression of TLR4 activation and the PI3K/Akt and NF- κ B signaling cascades by the peptide, which led to a decrease in pro-inflammatory cytokines and a decrease in the infiltration of macrophages and neutrophils in tissues [16]. According to the results of an experimental model, an increase in SP-D suppressed LPS-induced secretion of pro-inflammatory cytokines (IL-6, TNF- α), which indicated its ability to modulate

the systemic inflammatory response [17]. The associations described by us between the degree of lymphoplasmacytic infiltrate and the SP-D level ($p < 0.05$) are consistent with these data. Indeed, in children with HP, chronic inflammation is, on average, more pronounced, which provokes the mucosal epithelium to a compensatory increase in peptide synthesis. And in the subgroup of children without bacteria, where the degree of inflammation is not limited to high numbers and varies more, we observe an inverse correlation, clearly showing the modulating effect of the peptide on the mucosa and the prevention of the development of a pronounced inflammatory process [16].

We observed differences in SP-D levels with a high degree of chronic inflammation. In children of subgroup 2, that is, those who had diseases not associated with HP, with chronic inflammation of grades 2-3, a decrease in the SP-D level was noted. In this context, a natural question arises. Why does the bacterium not attach with a low SP-D level in children of subgroup 2? It should be emphasized that gastroduodenitis even without the presence of HP can be more severe, with the development of pronounced atrophy and metaplasia [19]. This is why a low level of the antimicrobial peptide did not contribute to easier colonization due to a decrease in the immune barrier [6]. In children of subgroup 1, who had diseases associated with HP, with a similar degree of inflammation, the SP-D level was relatively higher, and this confirms the opinion that HP colonization occurs predominantly on functioning epithelium, albeit with signs of inflammation, retaining the ability to synthesize antimicrobial peptides [20].

In the human body, SP-D synthesis is regulated, and levels of this peptide can change dynamically during the development of a pathological process [6]. We observed that in subgroup 1, impaired adaptive capacity and more pronounced inflammation were associated with a

decrease in serum SP-D. Conversely, in subgroup 2, over time, repair of the gastrointestinal mucosa occurred, the degree of chronic inflammation decreased, and serum SP-D levels in children in this group increased and approached those of the control group.

SP-D has been described in the literature as a component of the innate immune response. A study of SFTPD genotypes in children showed that variants of this gene are associated with various immune parameters and the host's response to inflammation or infection [18]. The role of heredity and its possible influence are confirmed by our findings of differences in SP-D levels in children in the control group, depending on the presence of an adverse family history ($p < 0.05$). This observation suggests that the immune system, rather than the infectious agent, plays a primary role in the development of upper gastrointestinal tract diseases. This assertion is strengthened by dividing children with and without infection, taking into account the duration of the disease. The gradual increase in the proportion of children with HP-associated diseases may indicate the need for specific changes in the gastrointestinal mucosa, an inflammatory process, and the creation of the necessary conditions for the HP bacteria to bind, which does not occur immediately [21, 22, 23].

CONCLUSIONS

1. The development of inflammatory diseases of the gastroduodenal region in children occurs against the background of impaired development of the immune system, namely, a deficiency of the antimicrobial peptide SP-D in the blood serum, regardless of HP contamination.

2. The severity of SP-D deficiency correlated with the degree of epithelial damage, and increased serum SP-D levels corresponded to a lower degree of chronic inflammation in children without HP infection. These alterations were not observed in the subgroup of children with HP-associated diseases.

PROSPECTS FOR FUTURE RESEARCH

In-depth study of the pathogenesis of gastroduodenal diseases associated with HP in children will help improve diagnosis and optimize treatment of these diseases.

AUTHOR CONTRIBUTIONS

Lezhenko G.O. – Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND, Final approval of the version to be published; AND

Savchenko D.S. – Drafting the work or revising it critically for important intellectual content; AND

References, Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

FUNDING

None.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

ETHICAL CONSIDERATIONS

The survey protocol complied with bioethical standards, was developed according to ethical standards and principles for conducting scientific research and was approved by the Bioethics Committee of Zaporizhzhia State Medical and Pharmaceutical University (Protocol No. 2, dated October 22, 2022).

REFERENCES

- Li Y, Choi H, Leung K, Jiang F, Graham DY, Leung WK. Global prevalence of *Helicobacter pylori* infection between 1980 and 2022: a systematic review and meta-analysis. *Lancet Gastroenterol Hepatol*. 2023. doi:10.1016/s2468-1253(23)00070-5
- Nguyen J, Kotileva K, Bontems P, Miendje Deyi VY. *Helicobacter pylori* infections in children. *Antibiotics*. 2023;12(9):1440. doi:10.3390/antibiotics12091440
- Yeh PJ, Chen CC, Chao HC та ін. The trends of pediatric duodenal ulcer and predictors of recurrence. *J Formos Med Assoc*. 2024. doi:10.1016/j.jfma.2024.04.011
- Săsăran MO, Meliș LE, Dobru ED. MicroRNA modulation of host immune response and inflammation triggered by *Helicobacter pylori*. *Int J Mol Sci*. 2021;22(3):1406. doi:10.3390/ijms22031406
- Meliș LE, Mărginean CO, Săsăran MO та ін. Innate immune responses in pediatric patients with gastritis—a trademark of infection or chronic inflammation? *Children*. 2022;9(2):121. doi:10.3390/children9020121
- Shamim A, Abdul Aziz M, Saeed F та ін. Revisiting surfactant protein D: an immune surveillance molecule bridging innate and adaptive immunity. *Front Immunol*. 2024;15. doi:10.3389/fimmu.2024.1491175
- Madsen J, Kliem A, Tornøe I, Skjødt K, Koch C, Holmskov U. Localization of lung surfactant protein D on mucosal surfaces in human tissues. *J Immunol*. 2000;164(11):5866-5870. doi:10.4049/jimmunol.164.11.5866
- Sorensen GL. Surfactant protein D in respiratory and non-respiratory diseases. *Front Med*. 2018;5. doi:10.3389/fmed.2018.00018
- Moran AP, Khamri W, Walker MM, Thursz MR. Role of surfactant protein D (SP-D) in innate immunity in the gastric mucosa: evidence of interaction with *Helicobacter pylori* lipopolysaccharide. *J Endotoxin Res*. 2005;11(6):357-362. doi:10.1179/096805105x76832
- On the Approval of the Unified Clinical Protocol for Primary and Specialized Medical Care: "Peptic Ulcer of the Stomach and Duodenum in Adults and Children." Official Web Portal of the Parliament of Ukraine. Last viewed on February 5, 2026. <https://zakon.rada.gov.ua/rada/show/v1514282-23#Text>
- Products – MTW Endoskopie Manufaktur W. Haag KG. MTW Endoskopie Manufaktur W. Haag KG – Made in Germany. Останній перегляд 5 лютого 2026. <https://en.mtw-endoskopie.com/products/>
- Kim S, Kim K, Joo M та ін. Prospective evaluation of a new liquid-type rapid urease test kit for diagnosis of *Helicobacter pylori*. *Diagnostics*. 2024;14(7):700. doi:10.3390/diagnostics14070700
- Yadav R, Sagar M. Comparison of different histological staining methods for detection of *Helicobacter pylori* infection in gastric biopsy. *Cureus*. 2022. doi:10.7759/cureus.27316
- Dixon MF, Genta RM, Yardley JH, Correa P. Classification and grading of gastritis. *Am J Surg Pathol*. 1996;20(10):1161-1181. doi:10.1097/00000478-199610000-00001
- Murray E, Khamri W, Walker MM та ін. Expression of surfactant protein D in the human gastric mucosa and during *Helicobacter pylori* infection. *Infect Immun*. 2002;70(3):1481-1487. doi:10.1128/iai.70.3.1481-1487.2002
- Jiang H, Zhang Y, Hu G та ін. Innate/Inflammatory bioregulation of surfactant protein D alleviates rat osteoarthritis by inhibiting toll-like receptor 4 signaling. *Front Immunol*. 2022;13. doi:10.3389/fimmu.2022.913901
- Mierke SK, Rapier KL, Method AM, King BA, Kingma PS. Intravenous Surfactant Protein D inhibits lipopolysaccharide-induced systemic inflammation. *Ann Anat Anat Anz*. 2023;152048. doi:10.1016/j.aanat.2023.152048
- Ishii T, Hagiwara K, Kamio K та ін. Involvement of surfactant protein D in emphysema revealed by genetic association study. *Eur J Hum Genet*. 2011;20(2):230-235. doi:10.1038/ejhg.2011.183
- Arevalo F, Rayme S, Rolando R та ін. Autoimmune gastritis: clinical and histological study in a Peruvian population. *BMC Gastroenterol*. 2025;25(1). doi:10.1186/s12876-025-04363-3
- Xavier Costa ND, da Costa Sigris G, Schalch AS, Belotti L, Dolhnikoff M, da Silva LF. Lung tissue expression of epithelial injury markers is associated with acute lung injury severity but does not discriminate sepsis from ARDS. *Respir Res*. 2024;25(1). doi:10.1186/s12931-024-02761-x
- Koc S, Senturk KC, Cetinkaya S та ін. Is Altered Surfactant Protein Gene Expression in Peripheral Blood Associated with COVID-19 Disease

- Severity? *Diagnostics*. 2025;15(13):1690.
doi:10.3390/diagnostics15131690
22. Elbehiry A, Marzouk E, Aldubaib M та ін. Helicobacter pylori infection: current status and future prospects on diagnostic, therapeutic and control challenges. *Antibiotics*. 2023;12(2):191.
doi:10.3390/antibiotics12020191
23. Sijmons D, Collett S, Soliman C та ін. Probing the expression and adhesion of glycans involved in Helicobacter pylori infection. *Sci Rep*. 2024;14(1).
doi:10.1038/s41598-024-59234-w

Received: 05.02.2026

Accepted for publication: 01.10.2026

Published: 30.09.2026