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GASTROINTESTINAL RISK FACTORS FOR ANEMIA IN CHILDREN WITH CELIAC DISEASE

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With oral intake, iron absorption in patients with celiac disease (CD) is reduced due to the decreased absorption surface of the atrophic small intestine mucous membrane. Besides, there are additional risk factors for anemia whose mechanisms are unclear. *The aim* of this study was to evaluate gastrointestinal risk factors for anemia in children. **Materials and methods.** The first group consisted of 58 children with newly diagnosed CD who did not adhere to the gluten-free diet (GFD). The second group included 49 children with CD who hasn't been adhering to the GFD. The third group included 69 children with chronic gastritis (CG) without CD. In addition to the standard examination, which includes the determination of antibodies to tissue transglutaminase and histological examination of the duodenum mucous membrane, a histological evaluation of the gastric mucosa, determination of pepsinogen 1 and 2 and their ratio, antibodies to Castle's intrinsic factor were performed. **Results.** The mean level of hemoglobin in the group 1 – $_{114,71}120,10_{125,50}$ g/l, in the group 2 – $_{124,37}128,74_{133,10}$ g/l, in the group 3 – $_{130,12}133,78_{137,43}$ g/l ($p_{1,2}$ = 0.013; $p_{1,3}$ = 0,000; $p_{2,3}$ = 0.083). A correlation analysis of the hemoglobin level and morphological parameters of the duodenal mucosa among the studied patients revealed an inverse moderate correlation between the hemoglobin level and the degree of the small intestinal atrophy according to Marsh r = –0.331, p = 0,000, crypt depth r = –0,439, p = 0,000, and a moderate direct with the ratio of villi:crypt r = 0.417, p = 0.000, with the height of the villi r = 0.366, p = 0,000. Additionally, a moderate direct correlation between the level of hemoglobin and the number of parietal cells was found to be r = 0.354, p = 0.037. In group 1, a significant inverse correlation between the level of hemoglobin and the level of antibodies to Castle's factor r = –0.529, p = 0.006, was obtained for the level of antibodies in the Castle's factor. **Conclusion.** Autoimmune gastritis may be an additional risk factor in combination with malabsorption, as a possible cause of anemia in children with CD.

Keywords: anemia; hemoglobin; celiac disease; antibodies to Castle intrinsic factor; children.

ГАСТРОИНТЕСТИНАЛЬНЫЕ ФАКТОРЫ РИСКА РАЗВИТИЯ АНЕМИИ У ДЕТЕЙ С ЦЕЛИАКИЕЙ

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При пероральном приеме всасывание железа у пациентов с целиакией снижено за счет уменьшения абсорбционной поверхности атрофичной слизистой оболочки тонкой кишки. Помимо этого, существуют дополнительные факторы риска анемии, механизмы которых остаются неясными. *Целью* данного исследования была оценка гастроинтестинальных факторов риска анемии у детей. **Материалы и методы.** Первую группу составили 58 детей с впервые выявленной целиакией, не соблюдающие безглютеновую диету (БГД). Во вторую группу вошли 49 детей с целиакией, находящиеся на БГД. В третью группу вошли 69 детей с хроническим гастритом без целиакии. Кроме стандартного обследования, включающего определение антител к тканевой трансглутаминазе, и гистологического исследования слизистой оболочки двенадцатиперстной кишки (СОДПК) выполнено гистологическое исследование слизистой оболочки желудка, определен пепсиноген I и II и их соотношение, определены антитела к внутреннему фактору Кастла.

Результаты. Средний уровень гемоглобина в группе 1 – $_{114,71}120{,}10_{125,50}$ г/л, в группе 2 – $_{124,37}128{,}74_{133,10}$ г/л, в группе 3 – $_{130,12}133{,}78_{137,43}$ г/л ($p_{1,2}$ = 0,013; $p_{1,3}$ = 0,000; $p_{2,3}$ = 0,083). Корреляционный анализ уровня гемоглобина и морфологических показателей СОДПК среди исследуемых больных выявил обратную умеренную корреляционную связь уровня гемоглобина со степенью атрофии СОДПК по Marsh r = –0,331, p = 0,000, глубиной крипт r = –0,439, p = 0,000, и умеренную прямую с отношением ворсина: крипта СОДПК r = 0,417, p = 0,000, с высотой ворсин СОДПК r = 0,366, p = 0,000. Дополнительно, обнаружена умеренная прямая связь между уровнем гемоглобина и количеством париетальных клеток в слизистой оболочке дна желудка r = 0,354, p = 0,037. В группе 1 для уровня антител к фактору Кастла получена значительная обратная корреляционная связь между уровнем гемоглобина и уровнем антител к фактору Кастла r = –0,529, p = 0,006. **Заключение.** Возможной причиной анемии у детей с целиакией помимо мальабсорбции может являться аутоиммунный гастрит, выступая дополнительным фактором риска.

Ключевые слова: анемия; гемоглобин; целиакия; антитела к внутреннему фактору Кастла; дети.

INTRODUCTION

The onset of celiac disease can manifest as anemia; therefore, pediatric patients with chronic iron deficiency anemia (IDA) are at risk for celiac disease and should be screened [7]. According to the literature, the incidence of anemia among celiac disease patients who do not receive a gluten-free diet (GFD) ranges from 12% to 69% [9]. However, the mechanism of the relationship between these two diseases remains unclear. A 2017 study by Rajalahti and Mäki showed that GFD for 1 year resulted in the resolution of anemia in 92% of pediatric patients with celiac disease. However, their hemoglobin levels were even lower after cure than in the control group of children without celiac disease [22].

Iron is a critical trace element that deficiency can be noted both with a typical manifestation of celiac disease and in the absence of diarrhea and weight loss [4]. It is obvious that with oral administration, iron absorption in celiac disease is reduced because of decreased absorption surface of the atrophic mucous membrane of the small intestine, which is the main factor in anemia. In addition, erosive processes and neoplasms of the gastrointestinal tract in the complicated course of celiac disease can become an additional etiological factor in anemia during the development of bleeding [8, 17, 19]. Also, with celiac disease, there may be a disorder of expression of proteins significant for iron absorption, namely, divalent metal transporter-1 (DMT-1), ferroportin, hephaestin, and ferritin receptor mRNA. Thus, a decrease in serum iron and an increase in the expression of ferritin are registered both in patients with celiac disease and in the control group with iron deficiency [5], and the expression of DMT-1 and ferroportin is increased in patients with celiac disease with and without iron deficiency [20]. These factors may be significant in the pathogenesis of celiac disease itself. It was revealed that gluten can penetrate the body using transferrin receptors on enterocytes, in which expression is increased with iron deficiency [10]. Celiac disease is an autoimmune disease that is characterized by chronic inflammation of the mucous membrane of the small intestine in the active phase. Acute phase cytokines and proteins play an important role in the pathogenesis of anemia of the chronic disease. Changes in iron metabolism through hepcidin and ferritin molecules can contribute to both IDA and chronic inflammation anemia additionally.

Anemia associated with autoimmune gastritis (AG) has not been described for celiac disease. At the same time, there are few reports of AG in patients with celiac disease [1, 2].

This study aimed to evaluate gastrointestinal risk factors for anemia in children.

MATERIALS AND METHODS

A total of 176 children from 3 to 16 years old were examined. Group 1 consisted of 58 pediatric patients with newly diagnosed celiac disease, who were not on a GFD. Group 2 included 49 patients with celiac disease on GFD. For comparison, Group 3 included 69 pediatric patients with chronic gastritis without celiac disease.

All patients were examined according to a single protocol. The diagnosis of celiac disease was established based on the federal clinical guidelines for the medical care of children with celiac disease of the Ministry of Health of the Russian Federation and the Union of Pediatricians of 2015 [14] and the guidelines for celiac disease of the European Society for Paediatric Gastroenterology Hepatology and Nutrition of 2012 [15]. The analysis of clinical and anamnestic data was performed, and the presence of positive specific antibodies (IgG and IgA) against deamidated gliadin peptides and tissue transglutaminase-2 was taken into account. Human leukocyte antigen genotyping was performed to detect celiac disease-associated *DQ2* and *DQ8* genes. All patients underwent a morphometric examination of the duodenal mucous membrane (DMM). Detection of atrophy to a degree not less than Marsh 3a proved the presence of celiac disease. Also, based on all the above conciliation documents [15], the

diagnosis of celiac disease was ruled out in patients of the comparison group. The diagnosis of chronic gastritis was verified morphologically for all study participants. Biopsy samples of the mucous membrane of the fundus and antrum of the stomach were obtained with esophagogastroduodenoscopy performed using an Evis Exera II OLYMPUS apparatus of the HGi 180 type (Japan) using a standard technique. The endoscopic and histological evaluation of the gastric mucosa was performed according to the Sydney system. Determination of the levels of hemoglobin (g/L), red blood cells (10^{12} L), mean corpuscular volume (MCV; fl), mean corpuscular hemoglobin (MCH; units), and mean cell hemoglobin concentration (MCHC; pg) was included in the general clinical examination. Antibodies (IgG) to Castle's intrinsic factor were determined in the blood plasma by enzyme-linked immunosorbent assay on a standard photometer using the kits manufactured by EUROIMMUN Medizinische Labordiagnostica AG, Germany, from 140 children. According to the instructions, the negative result was 0–20 au/mL, and a positive result is >20 au/mL.

Statistical analysis was performed using the IBM SPSS Statistics 23. The average antibody level was calculated with a 95% confidence interval (CI), indicating the upper and lower limits, median, and mean square deviation. For comparison of means, the Student's *t*-test was used for independent samples (two-tailed significance level, $p < 0.05$), as well as Mann–Whitney *U*-test. The Livin dispersion equality criterion, Kolmogorov–Smirnov test, and Shapiro–Wilk test were taken into account. To analyze endoscopic and morphological studies in groups, the Fisher's exact test was used (significance $p < 0.05$).

RESULTS

Anemia in Group 1 was diagnosed in 18.9 cases, while in group 2, it was registered in 2.0% and did not occur in Group 3 (0.0%; $p_{1,2} = 0.017$; $p_{1,3} = 0.001$; $p_{2,3} = 0.261$). Among patients with anemia, hypochromic and microcytic anemia was noted, mainly of mild severity, with an average hemoglobin level of 97.88 ± 8.6 g/L. Only one patient in Group 1 had moderate anemia with a hemoglobin level of 74 g/L. This child had atypical celiac disease with a single complaint of recurrent IDA. The average level of red blood cells among anemia patients was $3.66 \pm 0.52 \cdot 10^{12}$ L; MCV was 77.63 ± 1.09 fl; MCH was 26.50 ± 0.77 units; MCHC was 32.00 ± 0.89 pg.

The average hemoglobin level was the lowest in Group 1 with statistically significant differences compared with that in Groups 2 and 3 and the highest in Group 3 with a statistically significant difference relative to Groups 1 and 2. The data are presented in Table 1.

The average erythrocyte count was significantly different in all groups and was lower in Group 1, with a statistically significant difference related to Groups 2 and 3. The data are presented in Table 2.

The average erythrocyte MCV levels did not differ statistically significantly; they were 83.60 ± 0.90, 83.95 ± 1.70, and 85.13 ± 1.73 fl in Groups 1, 2, and 3, respectively ($p_{1,2} = 0.848$; $p_{1,3} = 0.180$; $p_{2,3} = 0.416$). The average level of MCH did not differ in the groups, as it was 28.24 ± 0.61 units in Group 1, 28.51 ± 0.58 units in Group 2, and 28.05 ± 0.45 units in Group 3 ($p_{1,2} = 0.864$; $p_{1,3} = 0.663$; $p_{2,3} = 0.835$). The average level of MCHC differed statistically significantly for Groups 1 and 3; it was 32.51 ± 0.44 units in Group 1, 33.31 ± 0.57 pg in Group 2, and 33.56 ± 0.53 pg in Group 3 ($p_{1,2} = 0.051$; $p_{1,3} = 0.007$;

Table 1 / Таблица 1

The mean level of hemoglobin in groups
Средний уровень гемоглобина в группах

Groups / Группы	Hemoglobin g/l* / Гемоглобин г/л*	Standard deviation / Ср. кв. отклонение	*t*** Student's *t*-test / Коэффициент Стьюдента
Group 1 / Группа 1	$_{114.71}120.10_{125.50}$	16.64	$p_{1.2} = 0.013$ $p_{1.3} = 0.000$ $p_{2.3} = 0.083$
Group 2 / Группа 2	$_{124.37}128.74_{133.10}$	14.01	
Group 3 / Группа 3	$_{130.12}133.78_{137.43}$	10.80	

Note. The hemoglobin level is represented in mean value with upper and lower limits, a standard deviation with a 95% confidence interval. Levene's Test for equality of variances and Student's *t*-test for paired comparison were used.

Примечание. *Уровень гемоглобина представлен средним значением с указанием верхней и нижней границ, среднеквадратичного отклонения с 95 % доверительным интервалом. **Равенство дисперсий проверено критерием Ливиня, при парном сравнении использовался критерий Стьюдента.

$p_{2,3} = 0.6$). Correlation analysis of the hemoglobin level and morphological indicators of DMM among the patients studied revealed an inverse moderate correlation between the hemoglobin level and DMM atrophy degree according to Marsh, the crypt depth, and a moderate direct correlation with the ratio of the villus: DMM crypts and DMM villi height. The data are presented in Table 3.

When analyzing the linear correlation between the hemoglobin level and gastric mucosa indices, a moderate direct relationship was found between the level of hemoglobin and the number of parietal cells in the mucous membrane of the gastric fundus. The data are presented in Table 4.

When analyzing a linear correlation between the level of hemoglobin and indicators of the peptic function of the stomach in the groups, no statistically significant relationship was obtained. A significant inverse correlation was obtained between the level of hemoglobin and the level of antibodies to Castle's factor in Group 1. The analysis of all groups revealed a weak, direct, and statistically significant correlation between the level of hemoglobin and pepsinogen I and a weak, negative, inverse statistically significant correlation with the level of antibodies to Castle's factor. The data are presented in Table 5.

At that, the average levels of antibodies to Castle's factor in the groups did not statistically differ; they were $_{2.53}4.06_{5.54}$ in Group 1, $_{1.83}3.12_{4.41}$ in Group 2, and $_{1.37}8.03_{17.42}$ in Group 3 ($p_{1,2} = 0.347$; $p_{1,3} = 0.464$; $p_{2,3} = 0.368$). Increased level was noted in 4.76% in Group 1 and 4.4% in Group 3, and in Group 2, there were no such patients (0%; $p_{1,2} = 0.083$; $p_{1,3} = 0.945$; $p_{2,3} = 0.096$). The frequency of helicobacteriosis detection was histologically equal in all the studied groups (63.8% in group 1, 53.1% in group 2, and 68.1% in group 3; $p_{1,2} = 0.387$; $p_{1,3} = 0.954$; $p_{2,3} = 0.420$).

Table 2 / Таблица 2

The mean level of erythrocytes in groups
Средний уровень эритроцитов в группах

Groups / Группы	Erythrocytes 10^{12} l* / Эритроциты 10^{12} л*	Standard deviation / Ср. кв. отклонение	Mann–Whitney *U*-test / *U*-критерий** Манна–Уитни
Group 1 / Группа 1	$_{3.97}4.16_{4.35}$	0.59	$p_{1.2} = 0.002$
Group 2 / Группа 2	$_{3.38}4.54_{4.70}$	0.50	$p_{1.3} = 0.000$
Group 3 / Группа 3	$_{4.67}4.82_{4.97}$	0.36	$p_{2.3} = 0.016$

Note. *The hemoglobin level is represented in maen value with upper and lower limits, a standard deviation with a 95% confidence interval. **Levene's Test for equality of variances and Mann–Whitney *U*-test for paired comparison were used.
Примечание. *Уровень гемоглобина представлен средним значением с указанием верхней и нижней границ, среднеквадратичного отклонения с 95 % доверительным интервалом. **Равенство дисперсий проверено критерием Ливиня, при парном сравнении использовался критерий Манна–Уитни.

Table 3 / Таблица 3

Analysis of the linear correlation of hemoglobin level and morphological parameters of the duodenal mucosa
Анализ линейной корреляционной связи уровня гемоглобина и морфологических показателей слизистой оболочки двенадцатиперстной кишки

Parameter / Показатель	Pearson's coefficient / Коэффициент Пирсона	*p**	Spearman's coefficient / Коэффициент Спирмена	*p**
The Marsh degree of duodenal mucosa atrophy / Степень атрофии слизистой оболочки двенадцатиперстной кишки по Marsh	–	–	–0.331	0.000
Villus height / Высота ворсин	0.354	0.000	0.366	0.000
Crypt depth / Глубина крипт	–0.380	0.000	–0.439	0.000
Ratio villus: crypt / Отношение ворсина: крипта	0.413	0.000	0.417	0.000

Note. Pearson's linear coefficient Spearman's rank correlation coefficient were used. *p — bilateral significance. The values of the modulus of the correlation coefficient and Linear quality characteristic: $|r| \le 0,3$ weak, $0,3 < |r| \le 0,5$ moderate, $0,5 < |r| \le 0,7$ significant, $0,7 < |r| \le 0,9$ strong, $0,9 < |r| \le 1$ very strong.
Примечание. Использованы выборочный коэффициент Пирсона и ранговый коэффициент Спирмена. *p — значимость двусторонняя. Значения модуля коэффициента корреляции и качественная характеристика линейной связи. $|r| \le 0,3$ — слабая, $0,3 < |r| \le 0,5$ — умеренная, $0,5 < |r| \le 0,7$ — значительная, $0,7 < |r| \le 0,9$ — сильная, $0,9 < |r| \le 1$ — очень сильная.

Table 4 / Таблица 4

Analysis of the linear correlation of hemoglobin level and indices of the gastric mucosa
Анализ линейной корреляционной связи уровня гемоглобина и показателей слизистой оболочки тела желудка

Parameter / Показатель	Pearson's coefficient / Коэффициент Пирсона	*p**	Spearman's coefficient / Коэффициент Спирмена	*p**
Parameters of the gastric fundic mucous membrane / Показатели слизистой оболочки дна желудка				
The thickness of the gastric mucosa / Толщина слизистой оболочки желудка	0.089	0.543	0.091	0.583
The depth of gastric pits / Глубина ямок	–0.112	0.492	–0.174	0.284
The glands length / Длина желез	0.197	0.222	0.159	0.328
The height of the integumentary epithelium / Высота покровного эпителия	0.230	0.154	0.201	0.214
The height of glandular epithelium / Высота железистого эпителия	–0.101	0.535	–0.141	0.385
The number of parietal cells / Число париетальных клеток	0.304	0.056	0.281	0.079
Parameters of the gastric fundic mucous membrane / Показатели слизистой оболочки дна желудка				
The thickness of the gastric mucosa / Толщина слизистой оболочки желудка	0.227	0.227	0.183	0.334
The depth of gastric pits / Глубина ямок	0.038	0.840	0.059	0.753
The glands length / Длина желез	0.085	0.650	0.114	0.543
The height of the integumentary epithelium / Высота покровного эпителия	–0.039	0.836	0.061	0.746
The height of glandular epithelium / Высота железистого эпителия	0.088	0.642	–0.046	0.807
The number of parietal cells / Число париетальных клеток	0.354	0.037	0.339	0.046

Note. Pearson's linear coefficient Spearman's rank correlation coefficient were used **p* bilateral significance. The values of the modulus of the correlation coefficient and Linear quality characteristic: $|r| \le 0.3$ weak. $0.3 < |r| \le 0.5$ moderate. $0.5 < |r| \le 0.7$ significant. $0.7 < |r| \le 0.9$ strong. $0.9 < |r| \le 1$ very strong.
Примечание. Использованы выборочный коэффициент Пирсона и ранговый коэффициент Спирмена. **p* — значимость двусторонняя. Значения модуля коэффициента корреляции и качественная характеристика линейной связи. $|r| \le 0.3$ — слабая. $0.3 < |r| \le 0.5$ — умеренная. $0.5 < |r| \le 0.7$ — значительная. $0.7 < |r| \le 0.9$ — сильная. $0.9 < |r| \le 1$ — очень сильная.

Table 5 / Таблица 5

Analysis of the linear correlation between the level of hemoglobin and parametrs of peptic function of the stomach and the level of antibodies to Castle's intrinsic factor
Анализ линейной корреляционной связи уровня гемоглобина и показателей пептической функции желудка, уровня антител к фактору Кастла

Parameter / Показатель	Pearson's coefficient / Коэффициент Пирсона	*p**	Spearman's coefficient / Коэффициент Спирмена	*p**
Group 1 / Группа 1				
Pepsinogen I / Пепсиноген I	0.276	0.172	0.268	0.186
Pepsinogen II / Пепсиноген II	0.001	0.998	–0.216	0.289
Pepsinogen I/Pepsinogen II / Пепсиноген I/Пепсиноген II	0.276	0.172	0.271	0.181
Antibodies to Castle's intrinsic factor / Антитела к фактору Кастла	–0.529	0.006	–0.418	0.034

Table 5 (continued) / Продолжение табл. 5

Parameter / Показатель	Pearson's coefficient / Коэффициент Пирсона	*p**	Spearman's coefficient / Коэффициент Спирмена	*p**
Group 2 / Группа 2				
Pepsinogen I / Пепсиноген I	0.273	0.177	0.328	0.102
Pepsinogen II / Пепсиноген II	0.222	0.276	0.349	0.081
Pepsinogen I/Pepsinogen II / Пепсиноген I/Пепсиноген II	–0.140	0.494	–0.146	0.477
Antibodies to Castle's intrinsic factor / Антитела к фактору Кастла	–0.238	0.242	–0.385	0.052
Group 3 / Группа 3				
Pepsinogen I / Пепсиноген I	0.076	0.662	–0.056	0.748
Pepsinogen II / Пепсиноген II	0.211	0.224	0.101	0.563
Pepsinogen I/Pepsinogen II / Пепсиноген I/Пепсиноген II	–0.229	0.185	–0.255	0.139
Antibodies to Castle's intrinsic factor / Антитела к фактору Кастла	0.042	0.813	–0.052	0.768
In all studied patients / Среди всех исследуемых больных				
Pepsinogen I / Пепсиноген I	0.243	0.024	0.190	0.078
Pepsinogen II / Пепсиноген II	0.133	0.218	0.109	0.316
Pepsinogen I/Pepsinogen II / Пепсиноген I/Пепсиноген II	0.049	0.650	–0.040	0.710
Antibodies to Castle's intrinsic factor / Антитела к фактору Кастла	–0.012	0.913	–0.280	0.009

Note. Pearson's linear coefficient Spearman's rank correlation coefficient were used. **p*, bilateral significance. The values of the modulus of the correlation coefficient and Linear quality characteristic: $|r| \le 0{,}3$ weak, $0{,}3 < |r| \le 0{,}5$ moderate, $0{,}5 < |r| \le 0{,}7$ significant, $0{,}7 < |r| \le 0{,}9$ strong, $0{,}9 < |r| \le 1$ very strong.

Примечание. Использованы выборочный коэффициент Пирсона и ранговый коэффициент Спирмена. **p* — значимость двусторонняя. Значения модуля коэффициента корреляции и качественная характеристика линейной связи: $|r| \le 0{,}3$ — слабая, $0{,}3 < |r| \le 0{,}5$ — умеренная, $0{,}5 < |r| \le 0{,}7$ — значительная, $0{,}7 < |r| \le 0{,}9$ — сильная, $0{,}9 < |r| \le 1$ — очень сильная.

DISCUSSION

Iron malabsorption in patients with celiac disease, who do not follow GFD, is known to lead to anemia [9]. In our study, the prevalence of anemia among pediatric patients who did not receive GFD was 18.9% and was significantly higher when comparing pediatric patients with celiac disease who received GFD for at least a year with the control group. Compared with other studies, the incidence of anemia was low, but not the least among those described in the literature. This indicator is close to that among Finnish children, according to the study in 2017 (prevalence of 18%) [22]. The highest incidence of anemia of up to 85% has been registered in India [16, 21], while in the developed countries of Europe and the USA, this indicator is 20% [11, 18]. The authors note that this indicator depends on the economic situation, and the incidence of anemia reflects the differences in the clinical presentation of celiac disease. In developing countries, the prevalence of severe forms of celiac disease is higher, and mainly typical forms of gastrointestinal symptoms are detected, whereas in developed countries, the atypical forms predominate. Studies have shown that patients with celiac disease combined with anemia (both adults and children) show a higher level of autoantibodies and a more pronounced degree of atrophy of DMM than patients without anemia [3, 22]. Our study demonstrates the correlation between the level of hemoglobin and the degree of DMM atrophy, as well as with all the key indicators characterizing atrophy, namely, the height of the villi and the depth of the crypts and their ratio. The data obtained confirm the importance of malabsorption in the development of anemia.

It is known that celiac disease is accompanied by autoimmune lesion of the stomach [1, 2, 23–25]. AG is a known cause of pernicious anemia in middle-aged and elderly people and is usually manifested by cobalamin deficiency and megaloblastic anemia. However, the role of IDA has recently been described as a recognized complication of achlorhydria. The relationship of helicobacteriosis with IDA has also been described [26]. It was revealed that IDA is more com-

mon in pediatric patients with AG, while pernicious anemia is the most common hematological condition for adults and elderly patients [6, 12, 13]. At the same time, population studies on the prevalence of AG among pediatric patients with celiac disease have not been conducted. Although celiac disease is a systemic autoimmune disease, the incidence of AG in our study did not exceed the control group. However, among patients with newly diagnosed celiac disease, a statistically significant inverse correlation was revealed between the level of antiparietal antibodies and the level of hemoglobin. In addition, the hemoglobin level showed a direct correlation with the count of parietal cells. The incidence of helicobacteriosis was histologically the same in all studied groups.

CONCLUSION

Thus, in addition to malabsorption, AG may be a possible cause of anemia as an additional risk factor in pediatric patients with celiac disease. Further studies are required with a large number of participants, the determination of various types of antiparietal antibodies, and indicators of iron metabolism to assess the severity of the iron deficiency and normalization of its indicators when following the diet.

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