by 28-37% relative to intact animals.

3. Induction of LPO processes under in vivo conditions by hyperthermia and PMF LF leads to a more stable state of the LPO/AOS system in dynamics from 7 to 21 days of the experiment, according to which, when assessing the values of the main parameters, it is possible to ascertain the formed oxidative stress.

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# M.V. Shubina, S.Yu. Tereshchenko, N.N. Gorbacheva, L.V. Lapteva

# PREVALENCE OF FUNCTIONAL GASTROINTESTINAL DISEASES IN SCHOOLCHILDREN OF KRASNOYARSK BY ROME IV CRITERIA

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The prevalence of functional gastrointestinal diseases (FGDs) in adolescents of 11-18 years old in school (500 individuals) and in a specialized gastroenterology unit (141 individuals), identified by questioning the Russian-language version of the QPGS - RIV questionnaire (Questionnaire on Pediatric Gastrointestinal Symptoms, Rome IV Version) was analyzed. As a result, the prevalence of FGDs in school was as follows: functional dyspepsia (FD) - 5.3%, irritable bowel syndrome (IBS) - 0.6%, abdominal migraine (AM) - 1.0%, functional abdominal pain syndrome (FAPS) - 0.2%, functional constipation (FC) - 5.3%. In the study profile of recurrent abdominal pain (RAP) among children in hospital, FD was 73.6%, IBS - 22.6%, FAPS - 3.8%, 17% of children had both FD and IBS. Compared to the previous version, according to the new criteria, instead of IBS, the FD diagnosis prevailed (due to a decrease of the criterion for the prevalence of pain syndrome, as well as the inclusion of postprandial distress syndrome (PDS) for diagnosis), and the IBS incidence rate decreased threefold (due to the new limiting criteria).

Keywords: adolescents, recurrent abdominal pain, functional gastrointestinal diseases, prevalence, ROME IV.

**Introduction:** The new Rome criteria of FGDs for revision IV (ROMEIV) were introduced in May 2016 (Table 1).

Significant changes mainly affected functional dyspepsia (FD) and irritable bowel syndrome (IBS). Currently, FD is divided into two independent forms: postprandial distress syndrome (PDS) and epigastric pain syndrome (EPS) both in adults and in children. The criteria for diagnosing IBS have been corrected, i.e. in the previous version, along with abdominal pain, two more conditions should have occurred: amelioration after bowel move-



ments and a change in stool frequency or consistency, now just one of them is enough. However, there appeared to be new IBS criteria, which didn't occur in the previous version, namely the absence of association with food (i.e. pain in IBS should not occur during meals or immediately after eating) and lack or infrequent relief from constipation medication, and lack of association with menstruation for girls.

Taking into account all the changes added to the Rome criteria for FGDs, as well as a lack of current specific epidemiological data on FGDs in Russian children (in the official statistical reports of most hospitals, the diagnoses such as chronic gastritis and gastroduodenitis are in the first place [1]). The purpose of our study was: to determine the prevalence of FGDs in schoolchildren, according to the new Rome IV revision, and also to find out the profile of RAP in children admitted to inpatient care in the gastroenterology unit.

Materials and methods: To establish the prevalence of FGDs in children, according to ROMEIV, 500 schoolchildren (217 boys and 283 girls) aged 11-18 years were examined in secondary school № 153 in Krasnoyarsk. All children filled out screening questionnaires to identify complaints from the gastrointestinal tract over the past month, i.e upper abdominal pain, heartburn, discomfort after eating a normal-sized meal, inability to finish the

usual portion of food, pain in the lower abdomen and around the navel, intense pain around the navel area for the last year, nausea, belching and stool frequency forcing to interrupt all activity. If a complaint was defined with incidence of 4 or more days a month, the child was asked to fill out the Russian version of QPGS-RIV to determine the specific FGDs. To clarify nosological structure of RAP (in accordance with ROMEIV), 141 children (60 boys and 81 girls) aged 11-18 years were examined in children in hospital, who were admitted for in-patient care in the gastroenterology unit of the Hospital of RIMPN in Krasnoyarsk. The study results of qualitative parameters in the experimental groups are presented as P (CI)%, where P is incidence, CI -95% (confidence interval). The statistical significance of differences in qualitative traits was analyzed using the Difference test between two proportions.

**Results and discussion.** According to the classical criteria identified by J. Apley and N. Naish, clinically significant RAP should be understood as "3 or more episodes of abdominal pain in the last 3 months, disrupting the child's daily activity." On the other hand, in the protocol of the expert meeting on FGDs (ROME IV criteria, 2016, [7]) there is only a sign of RAP incidence ("at least once a week for the last 2 months"), and the subjective pain severity is not included in diagnosing FD, IBS and FAPS.

According the data we obtained in the school sample, only 9.7 (6.5-14.4) % of children matched the J. Apley and N. Naish criteria. There was sure to be more such children in hospital - 29.1 (22.2-37.1) %. Even less number of children in school sample had RAP according to the ROME IV criteria, i.e. "More often than once a week for 2 months" - 4.3% (2.8-6.5) %. As to the hospital, on the contrary, there were slightly more individuals than those who met the J. Apley and N. Naish criteria - 35.7 (28.3-44.0) % (Table 2). Thus, we can conclude that the RAP incidence in the population of Russian schoolchildren does not differ from the median of RAP prevalence in children in other countries, determined by the results of numerous foreign population studies (8.4 (5.7-11.8) %) [5]. Girls can also be noted to have 2 times more often clinically significant RAP, whatever how it was assessed. Similar data indicating a higher prevalence of RAP in adolescent girls, compared to boys, were obtained by other researchers [4].

The analysis results of the nosological structure in children sample with RAP, as well as the general prevalence of FD, IBS, and FAPS, in accordance with the ROME IV criteria, are given in Table 3.

As can be seen from the data obtained, in school-age children, the incidence of clinical signs of FGDs is ranged from 0.4 (0.1-1.5) % for FAPS to 5.3 (3.7-7.7) % for FD. As expected, complaints more

#### Table 1

Diagnostic criteria for the main nosological causes of recurrent abdominal pain (RAP) in children. All criteria were developed for children aged 4-18 years. It is based on the pediatric section of the "Rome IV Criteria"

Functional dyspepsia	Irritable bowel syndrome	Functional abdominal pain	Abdominal migraine			
• Symptoms sho	• 2 episodes or more in the last 6 months					
<ol> <li>Postprandial distress syndrome (PDS):</li> <li>Discomfort, feeling of full stomach, nausea, or bloating after eating a normal-sized meal</li> <li>Inability to finish the usual portion of food due to a feeling of fullness in the stomach</li> <li>Epigastric pain syndrome (EPS):</li> <li>Pain above the navel and/or a burning sensation behind the breastbone</li> <li>Lack of association with defecation (alleviation, onset or aggravation of symptoms, as well as association with a change in stool frequency or consistency</li> <li>Lack of association with a change in stool frequency or consistency</li> </ol>		<ul> <li>Abdominal pain</li> <li>Lack of association with defecation (alleviation, onset or aggravation of symptoms, as well as association with a change in stool frequency or consistency</li> <li>The patient does not meet the criteria for other GIT disorders</li> </ul>	<ul> <li>Paroxysmal episodes of intense acute umbilical pain that lasts an hour or more</li> <li>Attack-free intervals of a normal health condition last from several weeks to several months</li> <li>Painful episodes accompanied by disruption of the normal child's activity (cannot play, do daily activity);</li> <li>Pain attacks accompanied by at least two of the following features: <ul> <li>a) anorexia</li> <li>b) nausea</li> <li>c) vomiting</li> <li>d) headache</li> <li>e) photophobia</li> <li>f) pallor</li> </ul> </li> </ul>			
• Symptoms, after appropriate medical assessment, cannot be attributed to another health condition.						

\*All criteria are developed for the age group of 4-18 years on the basis of the pediatric section of the Roman Criteria IV.

often correspond to a specific diagnosis according to the ROME IV criteria in children sent to a gastroenterological hospital. It is noteworthy that the dominant nosological unit, both in school and in inpatient sample, is FD. This contradicts the results of our previous study [3], as well as similar studies of foreign authors using the previous version of the Roman criteria ROME III for the nosological structure of FGDs to be assessed, whereby IBS was the leading cause of RAP in children [2]. That is mainly due to two reasons. The first one is that the diagnostic criteria for FD have been expanded (by adding PDS and lowering the threshold for pain incidence), and the second one is that the diagnostic criteria for IBS have been reduced (due to the emergence of new more differential requirements for the diagnosis). Indeed, the increase in FD was mainly due to the PDS, with the prevalence being 4.5 (3.0-6.7) % in school and 36.4 (28.9-44.7) % in hospital, while EPS was at the same low level both in school (1.2 (0.6-2.6)%) and in hospital (3.6 (1.6-8.1)%). Along with that, the requirements for IBS have increased, in particular, excluding the concept of discomfort from the definition of IBS, adding new conditions for the lack of association with food intake and menstruation, as well as the lack of relief after taking laxatives. Such findings were also noted in the first population study in English-speaking countries, where the ROMEIV criteria were used, with the prevalence of IBS in adults being halved compared to the ROME III criteria: from 11% to 6.1% in the United States; from 11.7% to 5.8% in Canada and from 10.6% to 5.5% in Great Britain [10].

The prevalence of FAPS in schoolchildren in accordance with the ROME IV criteria should be expected to decrease from 2.9 (2.0-4.2) % in 2008 [3] to 0.2 (0.05-1.1) %, and in hospital from 2.3 (0.8-6.6)% [3] to 1.4 (0.4-5.0)%, given that both for FAPS and IBS, additional conditions of lack of association with food intake or menstruation were added in the ROME IV criteria. Moreover, children who met the EAPS criteria according to the previous version of the questionnaire are likely to be in the FD group.

The prevalence of FD with switching to the ROMEIV criteria, on the contrary, increased from 4.5 (2.9-6.7) % to 5.3 (3.6-7.7) % in school and from 12.1 (7.7 -18.6) % to 22.1 (16.1-29.7) % in hospital. This appeared to be influenced by the fact that some of the children with IBS-like symptoms, with a gain after taking laxatives, have currently moved into this group. According to foreign studies, functional Prevalence of RAP in Krasnoyarsk adolescents according to J. Apley and N. Naish. and ROMEIV criteria. % (95% CI)

РБЖ	Total sample	Boys	Girls	Р	Age 11-14 years old	Age15-18 years old	Р		
School sample									
D. I. I. 1	N=216	N=91	N=125		N=125	N=91			
By J. Apley and N.Naish criteria *	9.7 (6.5-14.4)	6.6 (3.1-13.7)	12.0 (7.4-18.9)	0.187	8.8 (0.5-15.1)	11.0 (6.1-19.1)			
By ROME IV criteria	N=491	N=214	N=277		N=300	N=189			
	4.3 (2.8-6.5)	1.4 (0.5-4.0)	6.5 (4.2-10.0)	0.036	5.7 (3.6-8.9)	2.1 (0.9-5.3)	0.056		
Inpatient sample									
	N=141	N=60	N=81		N=64	N=77			
By J. Apley and N.Naish criteria *	29.1 (22.2-37.1)	15.0 (8.2-26.2)	39.5 (29.6-50.4)	0.002	31.3 (21.2-43.4)	27.3 (18.6-38.2)			
By ROME IV criteria	35.7 (28.3-44.0)	23.3 (14.5-35.5)	44.4 (34.1-55.3)	0.011	29.7 (19.9-41.8)	40.3 (30.0-51.5)			

Note: \* - To diagnose RAP according to J. Apley and N. Naish was slightly changed (pain with incidence of 1 or more times a month limiting daily activity, instead of 3 episodes in the last 3 month limiting daily activity, i.e. excluding the time factor, was taken into account).

Table 3

The general prevalence of FGDs and nosological structure of RAP in school and inpatient samples, according to ROME IV criteria, % (95% CI)

	Scl	nool sample	Inpatient sample		
FGDs	General school sample	RAP children by ROMEIV criteria	General inpatient sample	RAP children by ROMEIV criteria	
	N=500	N=27	N=140	N=53	
FD	5.3 (3.7-7.7)	59.2 (40.6-75.5)	38.6 (30.9-46.9)	73.6 (60.3-83.5)	
IBS	0.6 (0.6-1.8)	11.1 (4.0-28.2)	8.6 (5.0-14.4)	22.6 (13.5-35.6)	
FAPS	0.2 (0.05-1.1)	0	1.4 (0.4-5.0)	3.8 (1.2-12.7)	
FD+IBS	0.4 (0.1-1.5)	7.4 (2.3-23.5)	6.4 (3.5-11.8)	17.0 (9.3-29.3)	

disorders are detected in almost every fourth child, i.e. 15.3% [6], 24.9% [8], 0.7-29.6% [9].

The prevalence of AM in schoolchildren, determined by ROME IV, when compared with the results obtained by ROME III, remained at the same level and amounted to 1.0%, predominantly in girls, being consistent with the results of foreign studies [6]. However, in hospital, AM significantly decreased from 8.1% by the ROME III criteria to 2.9 (1.2-7.1) % by the ROME IV, which can be explained by a 2-fold increase in attack frequency required for the AM diagnosis according to the new version of ROME IV, compared to ROME III (earlier 2 episodes in a year, today 2 episodes in half a year).

### Conclusion:

1. The incidence of RAP in the population of Russian schoolchildren (11-18 years old) does not differ from the median of the RAP prevalence, determined by the results of foreign population studies, and ranges from 4.3%, according to the ROME IV criteria, to 9.7%, according to J Apley and N. Naish, predominantly in girls.

2. The overall prevalence of FD, IBS, FAPS, AM and FC according to the ROME IV criteria in children of the unbiased school sample was 5.3%, 0.6%, 0.2%, 1.0% and 5.3%, respectively.

3. In most cases the complaints correspond to the diagnosis of FD (73.6%), IBS (22.6%) according to the ROME IV criteria in children sent to inpatient examination and treatment for RAP. A combination of FD and IBS symptoms occurred in 17.0% of children in inpatient sample with non-cyclic RAP.

 According to the ROMEIV criteria, as contrasted with the previous version, the nosological structure of RAP has sig-

Table 2



nificantly changed, with the FD diagnosis prevailing (due to the inclusion of PDS for diagnosis), and the IBS incidence rate decreasing threefold (due to the new limiting criteria).

5. Particular attention should be paid to the high prevalence of PDS among children observed in almost half of children with RAP in-school sample (44.4 (27.5-62.8) and in 66.7 (53.3-77.8)% of cases of RAP in hospital, since it is the PDS that indicates an evacuation disorder from the stomach, congestion in the intestine, thereby encouraging the development of peptic ulcer disease and GERD.

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# E.A. Balashova, M.Yu. Gavryushin, I.L. Shadrina PHYSICAL AND SEXUAL DEVELOPMENT OF BOYS WITH LATENT IRON DEFICIENCY WITHOUT ANEMIA

The aim of the study was to analyze the possible impact of iron deficiency (ID) without anemia on physical and sexual development of adolescent boys

**Materials and methods.** 46 adolescent boys with ID without anemia (serum ferritin (SF) level <15  $\mu$ g/l in the absence of inflammation defined by normal level of C-reactive protein) and 99 healthy peers were recruited in the study. All the participants were without underlining chronic illness. Average age was 14.8±0.9 years.

**Results.** Physical development of adolescent boys with ID without anemia did not differ from that of their healthy peers. We found no correlation between anthropometric indicators and SF level. The SF level was significantly higher in overweight or obese children as determined by bioelectrical impedance then in normal weight children (35.15 (20.8; 48.6) vs. 18.8 (16.4; 20.0), p<0.001) and more so in obese children (40.8 (19.4; 56.3) vs. 18.8 (16.4; 20.0), p=0.012). Body fat (rs = 0.210 p = 0.013), visceral fat (rs = 0.208 p = 0.014) and body fat percentage (rs = 0.239 p = 0.005) correlated with SF level. Sexual development of boys with ID without anemia was within the age norm, but it was generally on the earlier stage then in the control group and correlated with the level of SF: for pubic hair rs = 0.186, p = 0.028 and for genitalia development rs = 0.224, p = 0.008.

**Conclusion.** ID without anemia did not altered physical development of adolescent boys. Obesity or excess weight is associated with a higher level of SF, which should be considered when diagnosing ID. ID is associated with sower sexual development in boys.

Keywords: bioelectrical impedance, iron deficiency, adolescents, sexual development, physical development

**Introduction.** Iron deficiency (ID) is one of the most common metabolic disorders. Results of the meta-analysis have

shown a global rate of 16.42% of iron deficiency anemia and 17.95% of iron deficiency without anemia among children under the age of five, who are at the highest risk of this condition [15]. The frequency of iron deficiency (ID) in adolescents is significantly lower and subjected to gender differences. For example, according to Zakharova I.N., iron deficiency in adolescent girls occurs 1.6 times more often than in boys [8]. Another study in the Stavropol Region has shown that in the age group of 12-18 years, 70% of patients who received inpatient treatment for IDA were girls [7]. However, some studies suggest a relatively high incidence of ID without anemia in adolescent boys. For example, according to Sharuko G.V., the frequency of ID without anemia is 20.6% in boys under 14 years and increases to 32.1% in adolescence [2].

ID developing during the first 1000 days of life, that is, from conception and up to 2 years of age, has multiple detrimental effects on children's health, including changes in immunological reactivity and increased infectious morbidity [19], delayed cognitive [12] and psychomotor development [26], as well as a delay in linear growth and body weight [10]. At the same time, the effects of ID, especially without anemia, developing later in life

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