

Features of the Functional Activity of Immunocompetent Cells in Children with High Infectious Index

EA Tepper, TE Taranushenko* and AA Savchenko

Federal State Budgetary Educational Institution of Higher Education "Krasnoyarsk State Medical University named after Professor V.F. Voyno-Yasenetsky" of the Ministry of Health of the Russian Federation, RF, Krasnoyarsk, Russia



*Corresponding author: Tatyana Taranushenko, Federal State Budgetary Educational Institution of Higher Education "Krasnoyarsk State Medical University named after Professor V.F. Voyno-Yasenetsky" of the Ministry of Health of the Russian Federation, RF, Krasnoyarsk, Russia

ARTICLE INFO

Received: 📅 April 11, 2022

Published: 📅 April 25, 2022

Citation: EA Tepper, TE Taranushenko, AA Savchenko. Features of the Functional Activity of Immunocompetent Cells in Children with High Infectious Index. Biomed J Sci & Tech Res 43(3)-2022. BJSTR. MS.ID.006901.

Keywords: Children; Schoolchildren's Health; Morbidity; Metabolic Parameters of Leukocytes

ABSTRACT

Frequent illnesses with acute respiratory infections contribute to the maladjustment of children to school conditions, create difficulties in teaching Frequently Ill Children (FIC) can be transformed into a chronic somatic pathology. An analysis of the dynamics of assessing the state of work in accordance with the health of a cohort of schoolchildren, calculating for a 10-year period of training a group and studying some metabolic parameters of blood leukocytes, showed that the proportion of children with respiratory diseases increases in the process of schooling. The proportion of children with ARVI frequency rate of 3 or more episodes per year in different periods of observation exceeds 40% and does not have significant gender differences. Frequent respiratory diseases are accompanied by changes in laboratory immunological parameters indicating an increase in the functional activity of immunocompetent cells, mainly by the end of schooling.

Abbreviations: ARIs: Acute Respiratory Infections; FIC: Frequently Ill Children; SDH: Succinate dehydrogenase; APL: Acid Phosphatase in Lymphocytes; APN: Acid Phosphatase in Neutrophils; AP: Acid Phosphatase

Introduction

Acute Respiratory Infections (ARIs) occupy a leading place in the structure of child morbidity in terms of attendance to the polyclinic for medical advice [1,2]. Over 60% of children of elementary school age suffer from respiratory diseases more often than 4-6 times a year and approximately 20% of the children suffer from ARI up to 8-10 times a year. Frequent ARIs contribute to maladjustment of children to school environment, create difficulties in teaching to Frequently Ill Children (FIC) and may transform into chronic somatic pathology [3-5]. Along with this, the reasons why acute respiratory infections remain high in frequency and/or become recurrent in children at school age remain a matter

of debate. It is known that the period of schooling is accompanied by emotional stress for a significant number of children, which is especially likely in the first year of schooling, as well as later during transition to subject-based education and later in adolescence (new requirements, relationships, challenges and rules that must be observed while building relationships with teachers and peers). It is important that stress reactions in the child's body may lead to disturbances inducing adverse changes in tissues and organs, including the systems responsible for the adequate metabolic, immune and hormonal response. A significant indicator of the body's adaptation to important/unpleasant/significant events that invariably cause an inevitable reaction (even in cases of predictable

situations) is the response of the immune system, which is the most sensitive one and which subtly reacts to adverse changes in the environment [6-8].

A number of authors have shown that short-term exposure to stressful psychosocial factors stimulates immune responses, while chronic exposure to stress inhibits these. Of informational value while studying the activity of immune system cells are the cytochemical indicators of the activity of enzymes of immunocompetent cells [9, 10]. Succinate Dehydrogenase (SDH) is an enzyme sensitive to changes in regulatory parameters, and a significant increase in enzyme activity can be a marker of high intensity of adaptive processes. An increase in SDH activity in first graders at the beginning of the school year has been described in a number of works and explained by the activation of enzyme systems [11,12]. Acid Phosphatase (AP) is a hydrolytic enzyme of lysosomes involved in cellular defence responses (phagocytosis), stages of immunogenesis as well as in formation of autoimmune processes. When exposed to a damaging factor, lysosomes are among the first to be included in the body's responses: the number and size of lysosomes increase, their localisation in the cell as related to the nucleus changes, membrane permeability increases, and hydrolytic enzymes are activated. According to the literature, an increase in the activity of acid phosphatase has been noted during the activation of immunocompetent cells and its significant decrease in a number of pathological conditions [11,13]. The purpose of this study is to assess the health status of a cohort of schoolchildren in a 10-year observation group (during periods of high risk of stress situations) from the standpoint of analysis of the nature and detection rate of respiratory diseases and the characteristics of certain metabolic parameters of blood leukocytes.

Organisation and Methods of the Study

Examination of the schoolchildren was carried out in standard-type schools in different districts of the city of Krasnoyarsk. The schooling process (the morning shift, the daily and the total academic load, the duration of lessons and breaks as well as the amount of academic days per week) had no significant differences in learning conditions and programmes. A total of 437 schoolchildren were examined. The dynamic assessment of the students' health status was carried out over 10 years consisting of the following of observation stages:

- a. Before entering school
- b. Upon completion of the first year of study
- c. Upon graduation from elementary school
- d. Upon completion of school education

Analysis of the students' health condition was carried out at the end of the academic year (April-May) in accordance with the

orders on preventive health screening for the child population. The complex assessment of the children's health was based on clinical examinations, conclusions by specialist physicians, data on medical histories from questionnaires filled in by the parents as well as child's development history (f.112) and the child's medical record (f.026). Determination of cytochemical activity of leukocyte enzymes. The activity of succinate dehydrogenase (SDH) was determined using the method by R.P. Narcissov (1969). Acid Phosphatase in Lymphocytes (APL) and Neutrophils (APN) were measured via the method by A.F. Goldberg, T. Barka, (1962) using naphthol As-E phosphate. This section of the work was carried out jointly with the staff of the Laboratory of Cytochemical Research Methods "Federal Research Center" of the Krasnoyarsk Scientific Centre of the Siberian Branch of the Russian Academy of Sciences" of the separate subdivision "The Research Institute of Medical Problems of the North" (director: Doctor of Medical Sciences, Professor E.V. Kasparov). Statistical processing was carried out using the STATISTIKA 6.0 and BIOSTATISTIKA software packages. All values were calculated as absolute numbers and percentages characterising the proportion of children with a certain symptom.

Results and Discussion

It has been shown that infectious diseases of the upper respiratory tract are the most common pathology in childhood (see Table 1). The distribution of students according to the absence or presence of a certain number of episodes of acute respiratory infections per year at all stages of education showed the lowest proportion of such subjects (less than 10%) among relatively healthy children ($p \leq 0.05$). An important circumstance is the predominance of schoolchildren who had 3 or more cases of acute respiratory infection per academic year throughout the entire 10-year observation period with the proportion of such children ranging from 41.9% to 50.2% at stages I-IV of observation. There were no significant gender differences in the surveyed cohort. According to our data, the distribution of the examined children accounting for gender characteristics and the frequency of respiratory diseases within the 10-year observation period has made it possible to determine some features related to the nosological structure and the frequency of respiratory pathology in schoolchildren at the designated stages of observation in different periods of study (see Table 2). At the first stage (before entering school): the proportion of those surveyed who did not have respiratory diseases during the first year before entering school among girls and boys was 76.2% and 74.2%, respectively. At the same time, adenoid hypertrophy diagnosed in the indicated gender groups was predominant in the diseases structure with 7.1% and 8.8%, respectively. Acute otitis media was noted in 5.9% of the cases among the girls and in 4.5% of the boys. Inflammation of the palatine tonsils is set in the same percentage of 3.8-3.9%. However, acute pharyngitis was the most common nosology among the schoolboys (6.6%).

Table 1: The distribution of schoolchildren depending on the upper respiratory tract pathology within the 10-years period of education, abs, (%) ±m.

Study period	Nosology	Abs, (%)	
		Female	Male
I. before entering school	Total	255 (100)	182 (100)
	Without pathology	191 (74.9)±2.7	135 (74.2)±3.2
	Adenoid hypertrophy	18 (7.1)±1.6	16 (8.8)±2.1
	Acute sinusitis	2 (0.8)±0.5	1 (0.5)±0.5
	Acute otitis media	15 (5.9)±1.5	8 (4.5)±1.5
	Acute tonsillitis	3 (1.2)±0.7	7 (3.8)±1.4
	Acute pharyngitis	7 (2.7)±1.0	12 (6.6)±1.8
	Allergic rhinitis	9 (3.5)±1.1	1 (0.5)±0.5
	Chronic tonsillitis	10 (3.9) 1.2	2 (1)±0.8
II. upon completion of the first year of study	Total	237 (100)	171 (100)
	Without pathology	164 (69.1)±3.0	127 (74.3)±3.3
	Adenoid hypertrophy	18 (7.6)±1.7	11(6.4)±1.9
	Acute sinusitis	9 (3.8)±1.2	2 (1.2)±0.8
	Acute otitis media	12 (5.1)±1.4	8 (4.6)±1.6
	Acute tonsillitis	5 (2.1)±0.9	7 (4.1)±1.5
	Acute pharyngitis	7 (2.9)±1.1	5 (2.9) ± 1.3 $p_{II,III}=0.198$
	Allergic rhinitis	14 (5.9)±1.5	9 (5.3)±1.7
	Chronic tonsillitis	4 (1.7)±0.8	2 (1.2)±0.8
III. upon graduation from elementary school	Total	169 (100)	166 (100)
	Without pathology	92 (54.4) ±3.8	109 (65.7)± 3.7 $p_{III,III}=0.523$
	Adenoid hypertrophy	18 (10.6) ±2.4	18 (10.8)±2.4
	Acute sinusitis	6 (3.6) ±1.4	4 (2.4)±1.2
	Acute otitis media	6 (3.6) ±1.4	4 (2.4)±1.2
	Acute tonsillitis	18 (10.6) ±2.4	10 (6.0)±1.8
	Acute pharyngitis	-	-
	Allergic rhinitis	11 (6.6) ±1.9	13 (7.8)±2.1
	Chronic tonsillitis	18 (10.6) ±2.4 $p_{III,III}=0.000$	8 (4.8)±1.7
IV. upon completion of school education	Total	153 (100)	150 (100)
	Without pathology	114 (74.5) ±3.5	104 (69.3)±3.8
	Adenoid hypertrophy	6 (3.9) ±1.6 $p_{I,IV}=0.000$	7 (4.7)±1.7
	Acute sinusitis	8 (5.2) ±1.8	6 (4)±1.6
	Acute otitis media	4 (2.6) ±1.3	9 (6)±1.9
	Acute tonsillitis	7 (4.6) ±1.7	8 (5.3)±1.8
	Acute pharyngitis	-	-
	Allergic rhinitis	4 (2.6) ±1.3 $p_{I,IV}=0.000$	7 (4.7)±1.7
	Chronic tonsillitis	10 (6.5) ± 2.0 $p_{III,IV}=0.033$	9 (6)±1.9 $p_{I,IV}=0.037$

Note: *significance of differences according to the c2 test

Table 2: The distribution of schoolchildren depending on the number of ARVI, abs, (%) \pm m.

Study period	Number of cases	Abs, (%)	
		Female	Male
I. before entering school	Total	255(100)	182(100)
	No pathology	23 (9.0) \pm 1.8	13 (7.1) \pm 1.9
	1 episode	23 (9.0) \pm 1.8	30 (16.5) \pm 2.8
	2 episodes	73 (28.6) \pm 2.8	56 (30.8) \pm 3.4
	3 episodes or more	136 (53.3) \pm 3.1	83 (45.6) \pm 3.7
II. upon completion of the first year of study	Total	237 (100)	171 (100)
	No pathology	20 (8.4) \pm 1.8	13 (7.6) \pm 2.0
	1 episode	37 (15.6) \pm 2.4	30 (17.5) \pm 2.9
	2 episodes	85 (35.8) \pm 3.1	52 (30.4) \pm 3.5
	3 episodes or more	95 (40.1) \pm 3.2	76 (44.4) \pm 3.8
III. upon graduation from elementary school	Total	169 (100)	166 (100)
	No pathology	8 (4.7) \pm 1.6	24 (14.4) \pm 2.7
	1 episode	32 (18.9) \pm 3.0	43 (25.9) \pm 3.4
	2 episodes	44 (26.0) \pm 3.4	38 (22.8) \pm 2.9
	3 episodes or more	85 (50.3) \pm 3.8	61 (36.8) \pm 3.9 ($p_{III}=0.326$)
IV. upon completion of school education	Total	153 (100)	150 (100)
	No pathology	10 (6.5) \pm 2.0	20 (13.3) \pm 2.8
	1 episode	33 (21.6) \pm 3.3	37 (24.7) \pm 3.5
	2 episodes	44 (28.8) \pm 3.7	25 (16.7) \pm 3.0
	3 episodes or more	66 (43.1) \pm 4.0 $p_{IV}=0.280$	68 (45.3) \pm 4.1

Note: *significance of differences according to the c2 test

At the second stage (upon completion of the first year of study), the study showed a slight decrease in the proportion of healthy girls to 69.1% in the absence of any dynamics in the detection of respiratory diseases in the boys. No significant changes were found in the structure of upper respiratory tract infections. However, in both gender groups, the proportion of children with allergic rhinitis slightly increased. Hypertrophy of the nasopharyngeal tonsil was still of the highest frequency. At the third and the fourth stages of the survey, the above indicated trends with a decrease in the proportion of healthy children persisted. Thus, there were no diseases in only 54.4% of the girls and in 65.7% of the boys after graduation from primary school. The most common pathologies were tonsillitis, hypertrophy of the nasopharyngeal tonsil and allergic rhinitis. It is important that the proportion of children with chronic tonsillitis was significantly larger by the end of primary school. The specified dynamics with an increase in diagnosed cases of chronic inflammation of the palatine tonsils persisted until the end of schooling. Along with the above features of various pathologies of the upper respiratory tract, the dynamics of the

number of respiratory viral infections during the whole learning period is of significant interest (see Table 2).

At the first stage, there was reliable predominance of both boys and girls with the frequency of acute viral infections of 3 or more episodes per year: 45.6% and 53.3%, respectively. The proportion of preschool children with unregistered infections in these groups was 7.7% and 9%. At the second stage, the proportion of children with ARVI manifestations during the year of observation did not change significantly and amounted to 7.1% and 8.4%. The proportion of children who had 3 or more episodes of ARVI was the largest and comparable with the previous stage. At the third and the fourth stages of the survey (by the end of the primary school and the completion of school education), the above-marked peculiarities persisted. We noted an approximately similar percentage in both gender groups of both healthy schoolchildren and children with an ARVI value of more than 40%. It has been suggested that the revealed features in the dynamics of structure and frequency of acute respiratory diseases may have different

causes. However, the assessment of the state of immunocompetent cells from the standpoint of enzyme systems activity characterising the regulatory mechanisms of the immune response is of scientific interest. It has been suggested that the revealed dynamic features of the structure and frequency of acute respiratory diseases may have different causes, however, the assessment of the state of immunocompetent cells from the standpoint of the activity of enzyme systems that characterize the regulatory mechanisms of the immune response is of scientific interest. We have conducted a study of the activity of enzymes in blood leukocytes at certain (indicated above) stages of schooling. The method of correlation analysis established a stable positive correlation between the AP of lymphocytes and neutrophilic granulocytes.

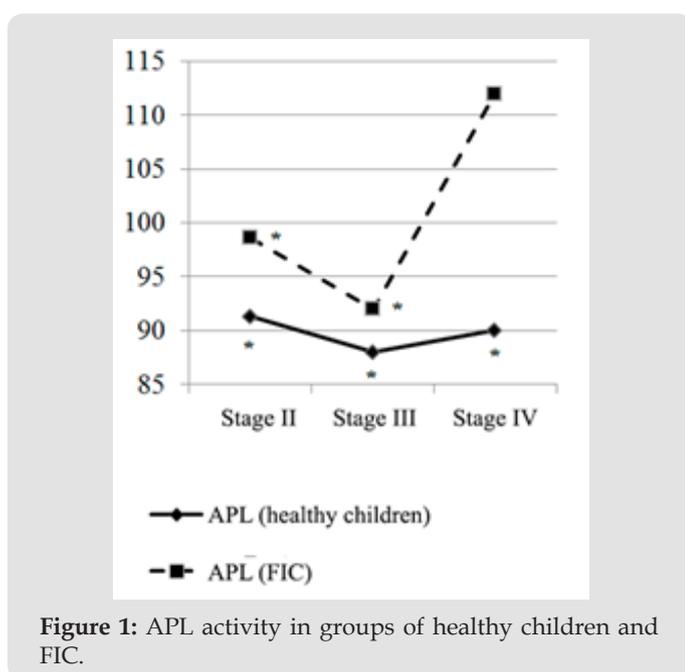


Figure 1: APL activity in groups of healthy children and FIC.

This relationship characterises the co-direction of regulatory-metabolic and functional processes in immune system cells and does not depend on the period of schooling. A more detailed dynamic assessment of the studied laboratory parameters was performed in a group of schoolchildren with frequent and long-term illnesses. The group of children with frequent and long-term illnesses was revealed to have unidirectional (as in the control group of healthy children) dynamic trends in enzyme activity at all stages of school education. In children with recurrent respiratory diseases, higher values of intracellular enzyme activity were noted, which should be considered a relatively unfavorable sign indicating the involvement of immunocompetent cells in increased respiratory morbidity. At the stage of the first year of study, the level of AP activity of lymphocytes and neutrophils were comparable, both in the study (FIC) and in the control (healthy children) groups. At the next stage of graduation from primary school, lymphocyte AP in frequently ill

children decreased at the stage of transition to subject education. However, APL activity was restored to its original level by the end of schooling. It is important that AP activity in lymphocytes in the process of schooling remains higher than in healthy children (see Figures 1 & 2).

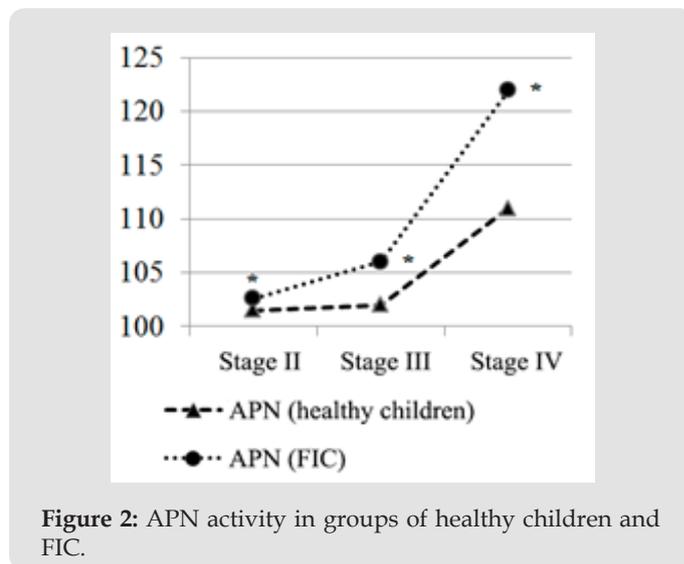


Figure 2: APN activity in groups of healthy children and FIC.

The levels of APN and SDH showed an increase in activity of blood leukocytes, both relative to the level detected within the period after the end of the 1st grade, and to the indicators determined upon elementary school completion. Statistical significance of changes in the values of the studied indicators in schooling dynamics in the FIC group was confirmed by the Kruskal-Wallis ANOVA test: $H=28.654$ for APL, $p<0.001$; $H=21.563$ for APN, $p<0.001$; $H=21.397$ for SDH, $p<0.001$. Drawing on the results obtained, it can be concluded that frequently ill children have certain features of enzymatic activity of immunocompetent cells which have similar age-related dynamics (without significant differences from the control group) but are characterised by higher values by the end of schooling in schoolchildren with recurrent respiratory infections. Increased activity of APN and SDH show the unidirectionality of changes in functional-regulatory and energy processes. The marked increase in AP activity in the blood leukocytes of frequently ill schoolchildren indicates the predominance of catabolic processes, indicates an increased functional activity of cells, and possibly reflects a higher level of maladjustment reactions in this category of the examined by the end of schooling.

Conclusion

In the process of schooling, the proportion of children with respiratory diseases increases with predominance of acute and chronic infections (tonsillitis, otitis media, pharyngitis) in the pathology structure. The number of cases of allergic rhinitis and chronic inflammation of the palatine tonsils increases upon

graduation from elementary school. The proportion of children with ARVI frequency rate of 3 or more episodes per year exceeds 40% in different observation periods and does not have significant gender differences. It is important that frequent respiratory diseases are accompanied by changes in laboratory immunological parameters (increased activity of the studied parameters of the enzymatic status of blood leukocytes), indicating an increase in the functional activity of immunocompetent cells, mainly by the end of schooling. The established deviations in the state of health, both at the organ and cellular levels, may negatively affect the educational process, knowledge mastering, school adaptation and relationships with peers. Cytochemical studies of blood cells are highly informative, subtly reflect the state of metabolism, and can reveal early preclinical signs of protective-compensatory reactions and adaptive processes. In healthy children (with rare cases of diseases), the results of cytochemical studies of peripheral blood lymphocytes and neutrophils indicate adequate maintenance of adaptation processes by immunocompetent cells. An increase in the activity of acid phosphatase in both lymphocytes and neutrophils indicates "tension" of the immunological response with "excitation" of cells. Considering our own and literature data, the most likely causes of these changes may be recurrent infectious processes as well as stressful situations that initiate deterioration of adaptation in the process of schooling. This combination of factors forms a "vicious circle" that determines the need for a joint solution of the problem by teachers and medical workers.

References

1. Avezova GS, Kosimova SM (2017) Frequently ill children: prevalence and risk factors. *European Research T* 5(8): 79-80.
2. Baranov AA, Namazova Baranova LS, Ilyin AG (2014) Preserving and strengthening the health of adolescents is the key to the stable development of society and the state (state of the problem). *Bulletin of the Russian Academy of Medical Sciences* 69(5-6): 65-70.
3. Babayan ML (2014) Frequently ill children: problems in the treatment of acute respiratory infections in children. *Medical Council* 14: 11-13.
4. Bokova TA (2016) Acute respiratory viral infections in children with aggravated allergic background: modern aspects of therapy. *Attending physician* 4: 70-72.
5. Tepper EA, Taranushenko TE, Grishkevich N Yu, Kiseleva NG (2013) Characteristics of the health status of school-age children by individual groups of somatic pathology. *Mother and Child in Kuzbass* 4: 9-13.
6. Kolosova NG (2014) Acute respiratory infections in frequently ill children. *rational etiotropic therapy BC* 3: 204-206.
7. Mazankova LN, Grigoriev KI (2013) Infectious diseases in children: a role in the formation of somatic pathology. *Children's infections* 12(3): 3-8.
8. Morozov SL (2019) Frequently ill children. A modern view of a pediatrician. *Russian Medical Journal. Medical review* 3(8): 7-9.
9. Gordiets AV (2013) Features of mitochondrial metabolism of blood lymphocytes in children during the period of adaptation to school education. *Bulletin of the Krasnoyarsk State Agrarian University* 5: 123-128.
10. Kashirskaya EI, Dzhumagaziev AA, Ilyenko TL (2009) and other Age features of some indicators of the enzymatic status of lymphocytes. *Questions of biological medical and pharmaceutical chemistry* 7(6): 33-35.
11. Idova GV, Alperina EL, Cheido MA (2010) Neuroimmune interactions in psycho-emotional stress (experimental study). *Siberian Scientific Medical Journal* 30(4): 31-37.
12. Fefelova VV, Struch SV, Ovcharenko ES (2014) Dependence of different nature of changes in morbidity and metabolic parameters of cells of the immune system on the form of education traditional or innovative in first graders. *International Journal of Applied and Fundamental Research* 11(4): 684-687.
13. Khaibullina GM (2015) Blood cell enzymes as an indicator of adaptive processes in a newborn with iron deficiency anemia in the mother. *Kazan Medical Journal* 96(2): 177-181.

ISSN: 2574-1241

DOI: 10.26717/BJSTR.2022.43.006901

TE Taranushenko. Biomed J Sci & Tech Res



This work is licensed under Creative Commons Attribution 4.0 License

Submission Link: <https://biomedres.us/submit-manuscript.php>



Assets of Publishing with us

- Global archiving of articles
- Immediate, unrestricted online access
- Rigorous Peer Review Process
- Authors Retain Copyrights
- Unique DOI for all articles

<https://biomedres.us/>