

# EXTERNAL RESPIRATORY FUNCTION IN THE MODERN SCHOOL-AGED CHILDREN TAKING INTO ACCOUNT THEIR PHYSICAL DEVELOPMENT

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In the article the age and gender features of physical development and respiratory function in healthy school-aged children are examined. There are pointed out the average values of height, weight, chest volume, spirometry data and their features according to the children's age and sex at the present stage.

**Key words:** children, physical development, respiratory function, spirometry.

## Introduction

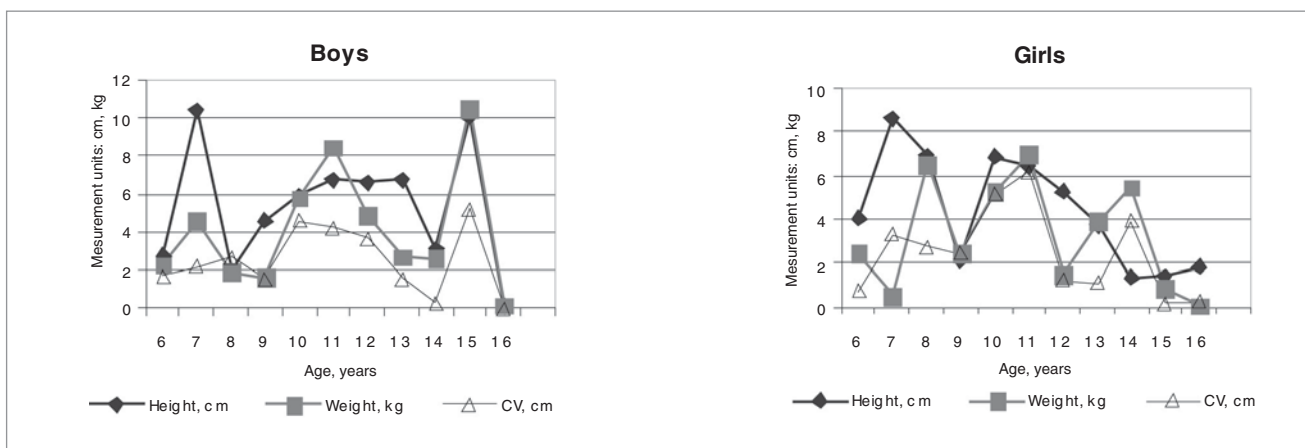
Today the actual issue of Pediatrics is the study of health state of younger generation, the definition of criteria for its evaluation, identification of the normal range and pathology of action of the certain parts of system or organism in whole taking into account age-specific physiology, individual-typological characteristics, ethnicity, region of residence and influence of environmental factors under existing conditions and so on.

One of the most objective criteria for evaluation of children's population health for today is their physical development – a set of morphological and functional features in base of which are biological processes caused by inherited genetic factors, environmental conditions and education and which are describing the process of maturation and functioning of the body [7,11]. Morphological parameters characterize the

size, area, body proportions, its structure and typology features. Functional indicators point to the state of functions of various body systems at the moment of observation.

Functional respiratory system occupies an important place in the complex of physiological processes. During the ontogenesis occur morphological changes of respiratory system which are affects on its function. A lot of works were devoted to the study of functional state of the respiratory system but scientific information to the features of respiratory system in healthy children of different ages and sex are limited, contradictory and standards of respiratory function criteria in Ukraine actually are absent today [2,4,5,10].

Development of functional respiratory system complies with all common factors peculiar to other systems of organism which in the concept of systemo-



**Fig. 1.** Average increase in physical development values in boys and girls in the age of 6–17 years

Table 1

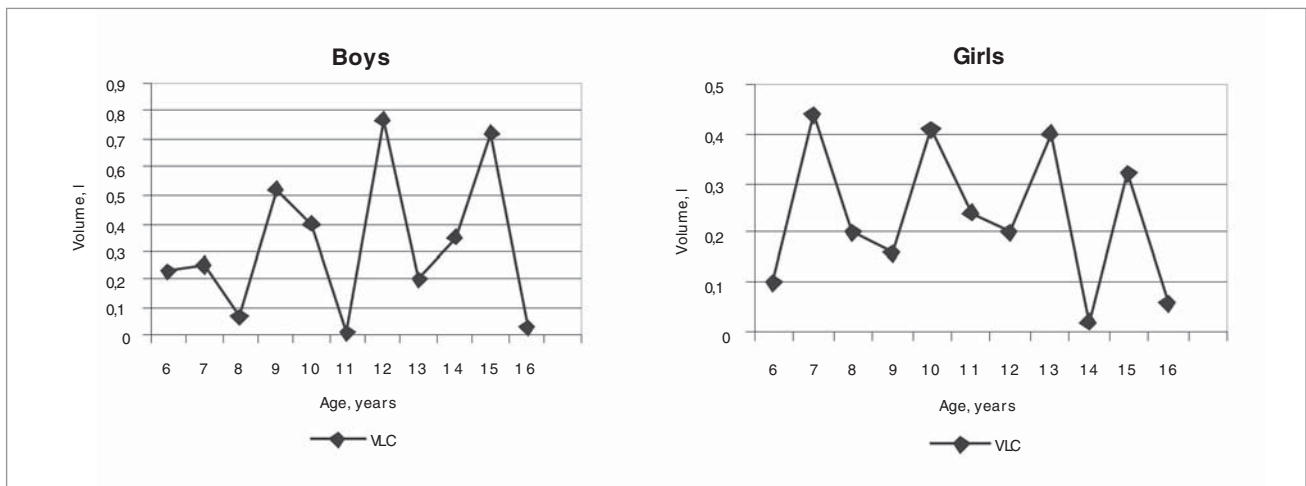
## Average mean values of physical development and external respiratory function and its increase in girls in the age of 6–17 years

Indices	Age, years																
	6	7	8	9	10	11	12	13	14	15	16	17					
Height, cm Increase	117.91±1.0 2	121.92±1.1 3	130.55±1.3 8	137.46±1.28	139.80±0.91	146.65±1.15	153.06±1.0 9	158.31±1.00	162.00±1.27	163.32±0.62	164.74±1.06	166.58±1.5 2					
Weight, kg Increase	4.01	8.63	6.91	2.34	6.85	6.41	5.25	3.69	1.32	1.42	1.84	-					
	20.8±0.63	23.21±0.63	23.73±1.58	30.23±1.17	32.70±0.8	37.94±1.38	44.89±2.01	46.38±1.38	50.25±1.79	54.83±2.34	55.68±1.21	55.73±1.27					
	2.41	0.52	6.5	2.47	5.24	6.95	1.49	3.87	4.58	0.85	0.05	-					
CV, cm Increase	57.73±0.61	58.42±0.74	61.73±0.98	64.46±1.01	66.90±0.66	72.00±1.12	78.17±1.65	79.41±0.88	80.50±1.16	84.41±1.33	84.58±0.96	84.84±1.15					
	0.69	3.31	2.73	2.44	5.1	6.17			4.91			-					
FVC Increase	1.23±0.04	1.45±0.04	1.67±0.05	1.80±0.07	2.24±0.04	2.38±0.05	2.84±0.07	3.09±0.06	3.28±0.08	3.64±0.07	3.94±0.13	3.94±0.08					
	0.22	0.22	0.13	0.44	0.14	0.46	0.25	0.19	0.36	0.3	0	-					
FEV <sub>1</sub> Increase	1.17±0.03	1.37±0.04	1.55±0.04	1.75±0.04	2.00±0.04	2.13±0.04	2.53±0.06	2.87±0.06	3.05±0.07	3.31±0.06	3.44±0.10	3.51±0.07					
	0.2	0.18	0.2	0.25	0.13	0.4	0.35	0.18	0.26	0.13	0.07	-					
FEV <sub>1</sub> /FVC	95.12±0.79	94.48±0.64	92.81±0.75	97.22±1.18	89.28±0.66	89.49±0.69	89.08±0.84	92.88±0.64	92.99±0.85	90.93±0.67	87.31±1.10	89.09±1.27					
PEF Increase	2.55±0.07	2.94±0.10	3.42±0.08	3.94±0.11	4.17±0.13	4.95±0.13	5.58±0.12	6.00±0.10	6.02±0.13	6.76±0.11	7.12±0.16	7.73±0.12					
	0.39	0.48	0.52	0.23	0.78	0.63	0.42	0.02	0.74	0.36	0.61	-					
FEF <sub>2575</sub> Increase	1.78±0.07	1.99±0.07	2.24±0.08	2.46±0.12	2.60±0.11	3.04±0.14	3.25±0.09	3.63±0.10	3.72±0.13	4.02±0.09	4.08±0.14	4.28±0.11					
	0.21	0.25	0.22	0.14	0.44	0.21	0.38	0.09	0.3	0.06	0.2	-					
FEF <sub>25</sub> Increase	2.40±0.06	2.66±0.11	3.11±0.08	3.59±0.11	3.83±0.13	4.36±0.14	4.73±0.10	5.12±0.10	5.16±0.09	5.82±0.11	5.94±0.16	6.25±0.11					
	0.26	0.45	0.48	0.24	0.53	0.37	0.39	0.04	0.66	0.12	0.31	-					
FEF <sub>50</sub> Increase	1.74±0.07	2.03±0.07	2.32±0.07	2.47±0.10	2.63±0.14	3.11±0.13	3.27±0.09	3.69±0.10	3.80±0.13	3.99±0.08	4.02±0.15	4.3±0.11					
	0.29	0.29	0.15	0.16	0.48	0.16	0.42	0.11	0.19	0.03	0.28	-					
FEF <sub>75</sub> Increase	1.20±0.04	1.27±0.04	1.29±0.07	1.31±0.05	1.35±0.05	1.64±0.10	1.75±0.07	2.09±0.08	2.21±0.11	2.26±0.07	2.29±0.06	2.30±0.08					
	0.07	0.02	0.02	0.04	0.29	0.11	0.34	0.12	0.05	0.03	0.01	-					
FVC Increase	1.17±0.05	1.32±0.05	1.67±0.04	1.94±0.06	2.07±0.06	2.36±0.06	2.58±0.06	2.88±0.07	3.12±0.08	3.25±0.09	3.34±0.11	3.38±0.08					
	0.15	0.35	0.27	0.13	0.29	0.22	0.30	0.24	0.13	0.09	0.04	-					
FIV <sub>1</sub> Increase	1.11±0.05	1.23±0.04	1.59±0.04	1.80±0.04	1.92±0.04	2.10±0.07	2.33±0.07	2.54±0.07	2.88±0.10	2.97±0.08	3.12±0.12	3.13±0.08					
	0.12	0.36	0.21	0.12	0.18	0.13	0.21	0.34	0.09	0.15	0.01	-					
FIV <sub>1</sub> /FVC	94.87±1.21	93.18±0.86	95.21±1.29	92.78±1.15	92.75±1.80	88.98±1.21	90.31±1.35	88.19±2.04	92.31±1.21	91.38±1.34	93.41±1.83	92.60±2.54					
VC Increase	1.39±0.07	1.49±0.04	1.93±0.09	2.13±0.09	2.29±0.07	2.70±0.06	2.94±0.07	3.14±0.05	3.54±0.09	3.56±0.08	3.88±0.13	3.94±0.07					
	0.10	0.44	0.2	0.16	0.41	0.24	0.2	0.4	0.02	0.32	0.06	-					
FEV <sub>1</sub> /VC	84.17±2.15	91.95±1.70	80.31±2.16	82.16±1.97	87.34±2.51	78.89±1.81	86.05±1.44	91.40±1.45	86.16±2.08	92.98±0.86	88.66±1.21	89.09±1.06					
ERV Increase	0.25±0.04	0.33±0.02	0.45±0.04	0.55±0.05	0.73±0.07	0.88±0.10	1.00±0.09	1.02±0.07	1.20±0.11	1.22±0.11	1.31±0.05	1.55±0.04					
	0.08	0.12	0.10	0.18	0.15	0.12	0.02	0.18	0.02	0.09	0.24	-					
IC Increase	1.12±0.06	1.13±0.06	1.51±0.06	1.77±0.10	1.79±0.05	1.85±0.19	2.08±0.12	2.15±0.12	2.34±0.09	2.48±0.20	2.56±0.06	2.63±0.19					
	0.01	0.38	0.26	0.02	0.06	0.23	0.07	0.19	0.14	0.08	0.07	-					

Table 2

## Average mean values of physical development and external respiratory function and its increase in boys in the age of 6–17 years

Indices	Age, years																
	6	7	8	9	10	11	12	13	14	15	16	17					
Height, cm	120.07±1.19	122.81±0.83	133.25±0.92	135.19±1.17	139.74±1.24	145.67±1.47	152.44±0.90	159.00±1.25	165.71±0.86	168.81±1.32	178.79±0.79	178.82±1.39					
Increase	2.74	10.44	1.94	4.55	5.93	6.78	6.56	6.71	3.1	10.08	0.03						
Weight, kg	21.00±0.54	23.26±0.58	27.83±0.98	29.69±1.03	31.32±0.83	37.07±1.65	45.52±1.54	50.38±1.83	53.08±1.51	55.67±1.62	66.21±1.50	66.36±1.56					
Increase	2.26	4.57	1.86	1.63	5.75	8.45	4.86	2.7	2.59	10.54	0.15						
CV, cm	58.7±0.73	60.41±0.46	62.58±0.72	65.25±0.64	66.79±0.69	71.40±1.18	75.63±1.05	79.29±1.18	80.79±1.10	81.05±1.04	86.29±1.09	86.30±0.61					
Increase	1.71	2.17	2.67	1.54	4.61	4.23	3.66	1.5	0.26	5.24	0.01						
FVC	1.51±0.06	1.55±0.04	1.77±0.06	1.99±0.08	2.41±0.07	2.60±0.09	2.98±0.05	3.39±0.10	3.73±0.08	4.32±0.12	5.04±0.12	5.18±0.15					
Increase	0.04	0.22	0.22	0.42	0.19	0.38	0.41	0.34	0.59	0.72	0.14	-					
FEV <sub>1</sub>	1.38±0.04	1.47±0.03	1.69±0.05	1.83±0.06	2.28±0.08	2.32±0.07	2.61±0.04	2.99±0.09	3.35±0.06	3.82±0.11	4.52±0.08	4.57±0.11					
Increase	0.09	0.22	0.14	0.45	0.04	0.29	0.38	0.36	0.47	0.7	0.05	-					
FEV <sub>1</sub> /FVC	91.39±0.71	94.84±0.48	95.48±1.39	91.96±1.24	94.61±1.38	89.23±1.14	87.58±0.68	88.20±1.93	89.81±1.03	88.43±0.71	89.68±1.06	88.22±1.10					
PEF	2.79±0.10	3.00±0.07	3.24±0.13	3.70±0.09	4.45±0.10	4.62±0.14	5.48±0.07	5.93±0.16	7.08±0.13	7.71±0.19	8.61±0.68	9.29±0.21					
Increase	0.21	0.24	0.46	0.75	0.17	0.86	0.45	1.15	0.63	0.9	0.68	-					
FEF <sub>25/75</sub>	1.87±0.08	2.09±0.06	2.24±0.10	2.42±0.09	2.54±0.09	2.76±0.08	3.11±0.07	3.54±0.12	4.09±0.12	4.39±0.15	4.99±0.12	5.24±0.17					
Increase	0.21	0.15	0.18	0.12	0.22	0.35	0.43	0.55	0.30	0.60	0.25	-					
FEF <sub>25</sub>	2.52±0.08	2.72±0.06	2.97±0.15	3.16±0.10	3.31±0.31	3.89±0.11	4.60±0.07	4.94±0.14	5.89±0.12	6.44±0.18	7.09±0.13	7.15±0.17					
Increase	0.2	0.25	0.19	0.15	0.58	0.71	0.34	0.95	0.55	0.65	0.06	-					
FEF <sub>50</sub>	1.96±0.07	2.19±0.06	2.30±0.10	2.54±0.08	2.74±0.09	2.81±0.08	3.15±0.07	3.71±0.13	4.16±0.14	4.50±0.15	5.14±0.14	5.37±0.17					
Increase	0.23	0.11	0.24	0.20	0.07	0.34	0.56	0.45	0.34	0.64	0.23	-					
FEF <sub>75</sub>	1.14±0.05	1.38±0.05	1.45±0.07	1.56±0.08	1.56±0.33	1.57±0.06	1.58±0.04	1.96±0.07	2.24±0.09	2.25±0.09	2.73±0.11	3.19±0.18					
Increase	0.24	0.07	0.11	0.01	0.01	0.01	0.38	0.28	0.01	0.48	0.46	-					
FIVC	1.37±0.06	1.42±0.05	1.65±0.08	1.88±0.08	2.28±0.07	2.42±0.08	2.74±0.05	3.23±0.10	3.59±0.08	3.81±0.13	4.57±0.16	4.90±0.13					
Increase	0.05	0.23	0.23	0.40	0.14	0.32	0.49	0.36	0.22	0.76	0.33	-					
FIV <sub>1</sub>	1.26±0.05	1.33±0.04	1.61±0.06	1.78±0.06	1.96±0.07	2.12±0.08	2.39±0.05	2.85±0.11	3.30±0.09	3.36±0.12	4.14±0.18	4.41±0.15					
Increase	0.07	0.28	0.17	0.18	0.16	0.27	0.46	0.45	0.06	0.78	0.27	-					
FIV <sub>1</sub> /FIVC	91.97±1.89	93.66±0.94	97.58±1.30	94.68±0.97	85.96±1.65	87.60±1.62	87.23±1.31	88.24±1.72	91.92±1.28	88.19±1.45	90.59±1.80	90.00±2.24					
VC	1.54±0.06	1.77±0.06	2.02±0.09	2.09±0.07	2.61±0.12	3.01±0.16	3.01±0.06	3.78±0.11	3.98±0.08	4.33±0.11	5.05±0.10	5.08±0.12					
Increase	0.23	0.25	0.07	0.52	0.40	0	0.77	0.20	0.35	0.72	0.03	-					
FEV <sub>1</sub> /VC	89.61±1.61	83.05±1.60	83.66±3.14	87.56±1.98	87.36±2.55	77.08±2.16	86.71±0.99	79.10±1.41	84.17±1.65	88.22±0.85	89.50±1.37	89.96±1.43					
ERV	0.33±0.03	0.37±0.03	0.51±0.05	0.62±0.03	0.88±0.10	0.89±0.07	0.97±0.12	1.38±0.08	1.54±0.08	1.64±0.03	1.75±2.59	1.76±0.04					
Increase	0.04	0.14	0.11	0.26	0.01	0.08	0.41	0.16	0.10	0.11	0.01	-					
IC	1.22±0.09	1.41±0.05	1.73±0.09	1.79±0.05	1.99±0.12	2.24±0.08	2.26±0.14	2.88±0.14	3.01±0.13	3.09±0.13	3.42±0.07	3.50±0.11					
Increase	0.19	0.32	0.06	0.20	0.25	0.02	0.62	0.13	0.08	0.33	0.08	-					



**Fig. 2.** Average increase in biometric indicator values of physical development of vital lung capacity in boys and girls of 6–17 years

genesis were found by P.K. Anokhin [1]. In the interpretation of the scientific community the main morphofunctional segments of the respiratory system are formed before the moment of birth. At every stage of ontogenesis of healthy children their respiratory system is functionally complete, in the intersystem and interorgan compliance and age-related changes of respiratory function irregular [3].

**Work objective** – To study the physical development and condition of respiratory function in school-aged children (6–17 years) at the modern stage.

## Materials and methods

The complex clinical, laboratory and instrumental examination of 1698 children in the age of 6–17 years of the I–II groups of health were conducted for the reason of solution those targets. Children were divided into groups according to their age and sex.

Spirography was conducted with the use of Spirograph Spirolab II by MIR Company (Italy). All measurement functions were done with the use of WinspiroPRO software, which gives a graphic representation of the number of parameters of respiratory function of person. Spirography is carried out on an empty stomach or two hours after a meal in a well-ventilated room at a temperature of  $20 \pm 1^\circ\text{C}$ . Anthropometric indices of physical development were determined according to the standard methods [9].

Processing of digital data was held on a computer of Intel P III type with the use of software packages Statistica 6.0 for Windows.

## Results of study and its discussion

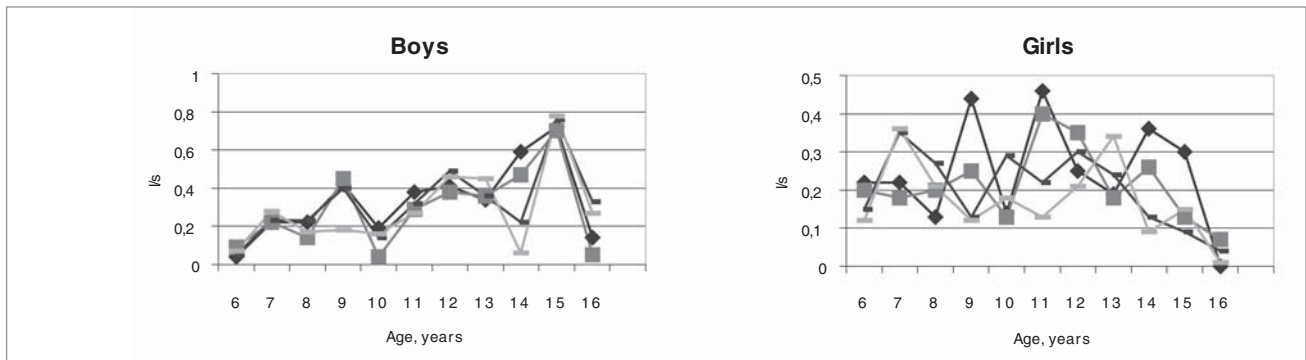
The data of average values of the main anthropometric indicators of physical development (weight,

height, chest value (CV)) and parameters of external respiratory function in school-aged children taking into account their gender and age development were reflected in the tables 1 and 2.

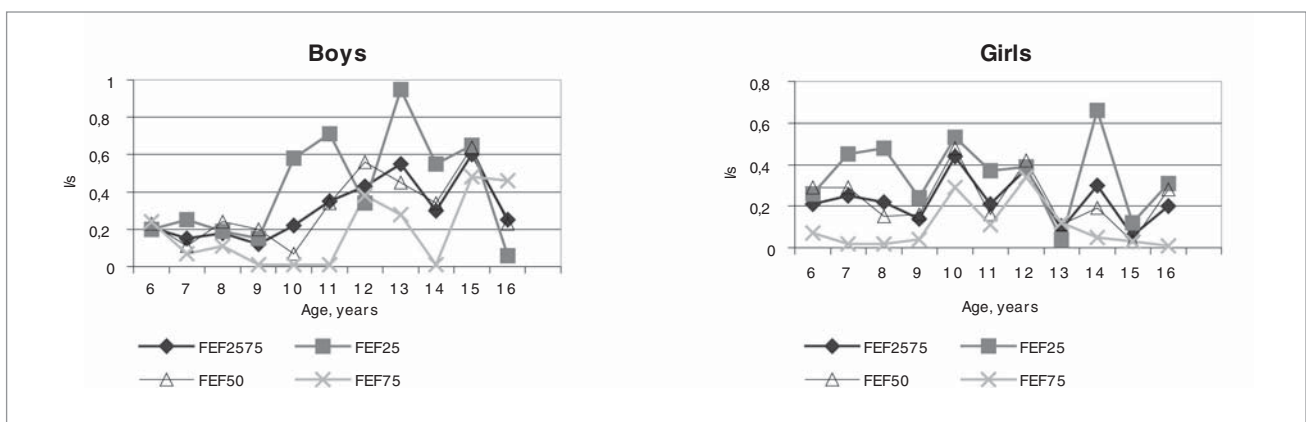
Analyzing the data of the tables 1 and 2 is evident, that the parameters of physical development and functional parameters of respiratory system are changed with a tendency of age increasing in both groups of boys and girls.

A detailed study and evaluation of physical development that is reflecting the process of growth and development of the young organism is one of the most objective criteria for assessing of children's health condition. That is also shown that physical development of boys and girls at the present stage has its own features. About what is suggest the analysis of average increase of the main values of anthropometric parameters (weight, height, chest value), (Fig. 1): a significant growth increase in boys is observed in 7 (+10.44 cm), 11 (+6.78 cm), 12 (+6.56 cm), 13 (+6.71 cm), 15 (+10.08 cm) years, in girls – in 7 (+8.63 cm), 8 (+6.91 cm), 10 (+6.85 cm), 11 (+6.41 cm), 12 (+5.25 cm) years; significant weight increase in boys is observed in 7 (+4.57 kg), 10 (+5.75 kg), 11 (+8.45 kg), 12 (+4.86 kg), 15 (+10.54 kg) years, in girls – in 8 (+6.5 kg), 10 (+5.24 kg), 11 (+6.95 kg), 13 (+3.87 kg), 14 (+5.48 kg) years; a significant chest value increase in boys is observed in 8 (+2.67 cm), 10 (+4.61 cm), 11 (+4.23 cm), 12 (+3.66 cm) and 15 (+5.24 cm) years, in girls – in 7 (+3.31 cm), 10 (+5.1 cm), 11 (+6.17 cm), 14 (+4.91 cm) years.

Thus, the largest anthropometric increase in physical development values in boys was observed in 7, 11–12 and 15 years and in girls – in 7–8, 10–11 and



**Fig. 3.** Average increase of the rapid indices of external respiratory function values in boys and girls in the age of 6–17 years



**Fig. 4.** Average increase of the rapid indices of external respiratory function values in boys and girls in the age of 6–17 years

13–14 years, whereas, according to the literature data, the first period of «overgrowing» accounted for the age of 5–7 years, the second – in 12–17 years in boys and 10–14 in girls [9]. According to the data of 2000 year, the «spurt» of growth processes and the volume sizes of child body mostly determined in 7–9 and 10–12 years in girls and in boys in 8–10 and 11–13 years [11], according to the data of 2005 year, – the biggest «spurt» of growth processes observed in 8–9-years [6].

That is also reflected in biometric parameters of physical development, including the largest vital lung capacity (VLC) increase that is observed in boys at 9–10, 12 and 15 years, and in girls-in 7, 10, 13 and 15 years (Fig. 2).

Analysis of result of spirometry study (Tables 1,2) had shown that the average values of the functional parameters of external respiratory function in children for today are characterized by a tendency to age increase in both groups of boys and girls.

Analyzing gender features of functional state of apparatus of external respiration in the different peri-

ods of ontogenesis of child population according to the Table 1 and 2 is shown that the average absolute values of all studied parameters of external respiratory function at 6 and 7 years in boys are more higher than in girls, with the exception of FEF75, which in girls is  $1.20 \pm 0.04$  l, and in boys –  $1.14 \pm 0.05$  l. This, though small, difference of patency of airways may indicate about prevalence of enlargement of the bronchial tree at the small bronchi and the better development of respiratory muscle in girls at the 6 years in comparison with the boys of the same age, in which is probably dominated the growth of the length of distal bronchial tree, and only up to 7 years their diameter increases.

This is evidenced by a significant increase of FEF75 (+0.24 l) index in boys at the age of 6 years, the average value of which is  $1.38 \pm 0.05$  l up to 7 year, while in girls at slight increase of FEF75 (+0.07 l) this index get average value  $1.27 \pm 0.05$  l. As a part of study is found significant increase in anthropometric characteristics of physical development in boys of 7 years

and in girls-in 7–8 years that is reflected in the indices of the respiratory system. The parameters of PEF (+0.48 l), FEF<sub>25</sub>(+0.45 l), FEF<sub>50</sub> (+0.29 l), FIVC (+0.35 l), FIV<sub>1</sub> (+0.36 l), VC (+0.44 l), IC (+0.38 l) in 1.5–2 times higher in 7 years old girls than in boys of the same age- PEF (+0.24 l), FEF<sub>25</sub> (+0.25 l), FEF<sub>50</sub>(+0.11 l), FIVC (+0.23 l), FIV<sub>1</sub> (+0.28 l), VC (+0.25 l), IC (+0.32 l). This means that the best development of respiratory muscles and more intense increase in the diameter of large and medium bronchi in this period of ontogeny is observed in females. That is why the average absolute values of a such indices of spirometry as PEF (3.24±0.13 l – in boys, 3.42±0.08 l – in girls), FEF<sub>25</sub> (2.97±0.15 l – in boys, 3.11±0.08 l – in girls), FEF<sub>50</sub> (2.30±0.10 l – in boys, 2.32±0.07 l – in girls), FIVC (1.65±0.08 l – in boys, 1.67±0.04 l – in girls) in girls of 8 years slightly higher than in boys. In girls were also more high average absolute values of PEF (3.70±0.09 l – boys, 3.94±0.11 l – girls), FEF<sub>2575</sub> (2.42±0.09 l – in boys, 2.46±0.12 l – in girls), FEF<sub>25</sub> (3.16±0.10 l – in boys, 3.59±0.11 l – in girls), FIVC (1.88±0.08 l – in boys, 1.94±0.06 l – in girls), FIV<sub>1</sub> (1.78±0.06 l – in boys, 1.80±0.04 l – in girls), as well as VC (2.09±0.07 l – boys, 2.13±0.09 l – girls) – in 9 years. This can be explained by earlier processes of differentiation of bronchopulmonary apparatus with formation of new elements and increasing of the alveoli volume in girls than in boys.

In girls of ten years observed a significant increase of PEF indices (+0.78 l – in girls, 0.17 l – in boys), FEF<sub>2575</sub> (+0.44 l – girls, 0.22 l – in boys), FEF<sub>25</sub> (+0.53 l – in girls, 0.58 l – in boys), FEF<sub>50</sub> (+0.48 l – in girls, 0.07 l – in boys), FEF<sub>75</sub>(+0.29 liters – in girls, 0.01 l – in boys), FIVC (+0.29 l – in girls, 0.14 l – in boys) and also VC (+0.41 l – in girls 0.40 l – in boys), that is explained by intensive processes of extension and expansion of the bronchi of different sizes, by morphological improvement of the structural units of the lungs, the airway improvement and the development of respiratory muscles caused by biological maturation and hormonal changes in the girls body. The result is an prevalence of average absolute values of PEF indices (4.95±0.13 l – in girls, 4.62±0.14 l – in boys), FEF<sub>2575</sub> (3.04±0.14 l – in girls 2.76±0.08 l – in boys), FEF<sub>25</sub> (4.36±0.14 l – in girls, 3.89±0.11 l – in boys), FEF<sub>50</sub> (3.11±0.13 l – in girls, 2.81±0.08 l – in boys), FEF<sub>75</sub> (1.64±0.10 l – in girls, 1.57±0.06 l – in boys) in girls of 11 years in comparison with their peers of opposite sex. Increased growth and develop-

ment of the respiratory system lasts up to 15 years. In the 11th year of life in both gender groups observed a significant increase of FVC indices (+0.46 l – in girls, +0.38 l – in boys), FEV<sub>1</sub> (0.40 l – in girls, 0.29 l – in boys), PEF (+0.63 l – in girls, +0.86 l – in boys), in boys – FEF<sub>25</sub> (+0.71 l) in girls – IC (+0.23 l). At the age of 12 years in boys was marked a significant increase in all parameters of external respiration. In girls of the same age observed a significant increase of FEV<sub>1</sub> (0.35 liters – in girls, 0.38 l – in boys), PEF (+0.42 l – in girls, +0.45 l – in boys), FEF<sub>2575</sub> (+0.38 l – in girls +0.43 l – in boys), FEF<sub>25</sub> (+0.39 l – in girls, +0.34 l – in boys), FEF<sub>50</sub> (+0.42 l – in girls, +0.56 l – in boys), FEF<sub>75</sub> (+0.34 l – in girls, +0.38 l – in boys) FIVC (+0.30 l – in girls, 0.49 l – boys), FIV<sub>1</sub> (+0.21 l – in girls, 0.46 l – in boys), in 13 years – a significant increase of FIVS (0.24 l – in girls, 0.36 l – in boys), FIV<sub>1</sub> (+0.34 l – in girls, 0.45 l – boys), VC (+ 0.40 l – girls, + 0.20 l – boys), ERV (+0.18 l – in girls, 0.16 l – in boys). At the same time the average absolute value of such spirometry indices as PEF (5.93±0.16 l – in boys, 6.00±0.10 l – in girls), FEF<sub>2575</sub> (3.54±0.12 l – boys, 3.63±0.10 l – girls), FEF<sub>25</sub> (4.94±0.14 l – boys, 5.12±0.10 l – the girls) are greater in girls of 13 years than in boys. The age of 13 years is the peak rate in the group of boys for such indicators as PEF (+0.02 l – in girls, 1.15 l – in boys), FEF<sub>25</sub> (+0.04 l – in girls, 0.95 l – in boys), during the reasonably high increase of other indicators, while in the group of girls the increase of these parameters is observed at the age of 14 years: PEF (+0.74 l – in girls, 0.63 l – in boys), FEF<sub>25</sub> (+0.66 l – in girls, 0.55 l – in boys). Such change of indices is probably associated with growth increasing and diameter of tracheobronchial tract against large bronchi.

It is needs to be noted, that in 14–17 years the average absolute value of all observed spirometry indices are higher in boys than in girls. In the age of 15 years in the group of males was marked rapid growth of all, without exception, parameters of external respiratory function and maximum increase of FEF<sub>75</sub> was observed in 15 years (0.48 L) and 16 years (0.46 liters) that is characterized by increased diameter of the distal bronchial tree against the background of the completion of the bronchopulmonary system due to the peculiarities of puberty period.

In the Fig. 3 and 4 graphically represented the increase of average values of the rapid indices of external respiratory function in boys and girls in the age of 6–17 years.

It is found, that the greatest increase of the rapid indices of FVC, FEV<sub>1</sub>, FIVC, FIV<sub>1</sub>, FEV<sub>25</sub>, FEF<sub>75</sub>, predominantly observed in boys of 15 years, whereas in girls unequally – in 7–14 years (Fig. 3–4). This may be due to the sexual characteristics of the length growth process of the bronchial tree with increase of its diameter and development of respiratory muscles in different age periods.

These features of the physical condition may be related to the individual rate of morphofunctional development (dislocation of spurt growth), by the rate of biological maturation, heterohronia, uneven growth and development of the child's body, sexual dimorphism, peculiarities of developmental physiology of child's body under the influence of the environment and so on.

## Conclusions

Thus, in children of both gender in the age of 6–9 years average absolute values of external respiratory function is characterized by low amplitude variability within a given age group, where significant differences between the spirometry indices of boys and girls are not observed ( $p > 0.05$ ). In comparison with the data of the group of primary school children group the range of spirometry indices in boys and girls is increased in the period of 10–14 years.

Significant difference between the indices of external respiratory function is found in heterosexual groups of children in the age 15–17 years ( $p < 0.05$ ).

Development of relatively stable values of external respiratory function in boys and girls in the age of 16–17 years can be explained by formed tracheo-bronchial tree during the arrest of body growth development. This stage is one of the most important in the development of the body, because just in the puberty period skeleton stopped its development, neuro-psychological field changed significantly that is associated with study and many other general emotional factors that are physiologically reasonable.

By comparison of ventilation lung function values in school-aged children with similar anthropometric data, better values of external respiratory function observed in children with greater excursion of the chest that is caused physiologically.

Based on the studied mean values of spirometry indices were found standards values of external respiratory function separately for boys and girls according to the age (6–17 years) in tabular form of percentile distribution, taking into account that during the process of ontogenesis the dynamics of morphological changes of lungs reflected on functional characteristics of the respiratory system [8].

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