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INDICATORS OF EXTERNAL RESPIRATION IN CHILDREN WITH DISORDERS OF POSTURE

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Abstract:

Among occurring variations in health status and physical development of pupils, a significant place is taken by a variety of functional disorders of posture and deformation of the arch. The frequency of such disorders among school children from 50 to 65% of the surveyed children. Known connection of advanced forms of posture with the state of operation of other systems that have a negative impact on their activities. The article discusses the state of the external breathing in primary school children, depending on the degree of sagittal curves of the spine. It shows a correlation of external breathing in children with different types of carriage. Our data suggests that the type of bearing children determines the functionality of the external breathing.Along with the increase of cervical lordosis, the mobility of the upper thoracic spine decreases, as a consequence, leads to a reduction of pulmonary volume. The increase of umbar lordosis affects the tone of the anterior abdominal wall, the diaphragm is lowered, the respiratory rate increases, the indicators characterizing the bronchial patency of the lungs decrease.

Keywords: *posture, incorrect posture, sagittal bends, external respiration, children of primary school age.*

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INTRODUCTION:

The human respiratory system in different age periods has quantitative and qualitative differences, which are based on the processes of continuous development of morphological structures and functional change of external respiration [1, 11].During the younger school age (7-10 years) there occur lung enlargement, differentiation of the lung tissue and increased expansion of the bronchial tree. The increase in volume velocities has a certain periodicity connected with the development of respiratory muscles, change in elasticity of the lungs and chest.Uneven growth and maturation of individual pulmonary structures and imperfection of the neurohumoral regulation of respiration leads to functional instability and determines the high sensitivity of the respiratory system of children of primary school age to the influence of unfavorable factors [8, 12, 15].

One of such factors, in our opinion, is the educational process, for most of which children spend in postural static tension in the sitting position. When sitting, the lumbar lordosis is smoothed, the thoracic kyphosis increases, which creates conditions that impede the normal activity of the cardiovascular and respiratory systems, as well as the functioning of a number of internal organs. Evena slight tilt of the trunk forward makes diaphragmatic and costal breathing difficult, thorax grows difficult[4, 10]. The vital capacity of lungs decreases, especially in a sitting position with a front bend, namely, this posture in most children is the main working posture. The negative working postures retained for a long time cause asymmetry in the tone of the muscles holding the vertebra in the vertical position and deflecting its sagittal bends. Ultimately, this leads to the formation of poor posture and contributes to the development of pathological forms. Many authors have shown a reduction in the reserves of adaptation of the external respiration system in patients with scoliosis caused by deformity of the thorax.[2, 3, 5, 6].Some researchers note an increase in hyperventilation parallel to the severity of deformation, which is explained by the compensatory response of the body to the reduction in chest and lung respiration [9, 13]. With the initial forms of deformation of the spine, the character of the functional state of the respiratory organs remains little-studied. In this regard, theresearchesthat aimed,from our point of view,at further studying the features of the state of the most important physiological systems of the organism, depending on the state of posture, are very important.

METHODS:

Estimate of the state of the bearing of children in the frontal and sagittal planes was carried out by the method of kyphoscoliosometry, using a device that makes it possible to obtain a characteristic of its state in the initial positions of standing and sitting. The length of the spine was measured by a curvimeter (in mm) from the atlas (I cervical vertebra) to the end of the coccyx along the line of spinous processes. Using qualitative evaluation scales of the state of sagittal flexures of the vertebra, namely the cervical and lumbar regions, we developed a classification of the types of posture of children 7-10 years old. It is based on the average values (M) and sagittal deviations (G) of the depth of cervical and lumbar lordosis [14].

To study the functional state of the external respiration system, an automated cardio-pulmonological complex was used, which makes it possible to analyze the state of pulmonary ventilation by computer flowmetry, that is, computation and interpretation of the parameters of the air-breathing “flow-volume” loop. The use of this technique enabled us to estimate the ventilation function of the lungs, including the main lung volumes, breathing mechanics, pulmonary gas exchange, and analyze about 40 parameters of the function of external respiration.

The subjects were 1104 children aged 7-10 yearswho took partin the study of external indicators of posture. The states of external respiration were assessed in 355 boys and girls with different posture types. The obtained results of the research were statistically processed.

RESULTSANDDISCUSSION:

Studying the age-sex characteristics of the posture of children of primary school age, we obtained a characteristic of the state of sagittal flexures of the spine, taking into account its linear dimensions in different initial positions. The average data for the indicators of the cervical and lumbar flexures of the spine are shown in Table 1.

Table 1: Age-sex indicators of sagittal spinal curvature of children of 7-10 years old

Form	Sex	N	Cervical lordosis when		Lumbar lordosis when standing	
			M±т	P	M+т	P
1	Girls	239	35,65±0,52	< 0,01	23,95±0,37	>0,05
	Boys	256	37,23±0,49		22,25±0,53	
2	Girls	143	33,24±0,62	<0,001	27,08±0,79	< 0,01
	Boys	166	37,35±0,70		24,57±0,61	
3	Girls	136	35,72±0,64	>0,05	28,49±0,85	< 0,01
	Boys	159	36,81±0,66		25,91±0,70	
Form	Sex	N	Cervical lordosis when sitting		Lumbar lordosis when sitting	
			M±т	P	M±т	P
1	Girls	239	36,79±0,55	<0,001	9,84±0,37	>0,05
	Boys	256	39,62±0,52		9,71±0,34	
2	Girls	143	35,76±0,73	<0,001	10,43±0,51	>0,05
	Boys	166	39,74±0,65		9,66±0,41	
3	Girls	136	35,95±0,75	< 0,001	11,12±0,58	>0,05
	Boys	159	39,64±0,75		11,79±0,49	

Note: P –authenticity of sex differences

The data presented illustrate that the magnitude of the spinalcurvature increases with the age of the children. It has been established that the average depth of cervical lordosis significantly prevails over the depth of bending in the lumbar region (P<0,001).Thus, in the first-former girls, the average cervical lordosis in the standing position is 35,65 ± 0,52 mm, and the lumbar lordosis is 23,95 ± 0,37 mm. These curvaturesin boys are characterized by 37,23 ± 0.49 mm and 22,25 ± 0.53 mm, respectively. The size of cervical lordosis is more pronounced in boys, and of lumbar lordosis, on the contrary, in girls. Significant differences of cervical lordosis between boys and girls are especially pronounced in the sitting position (P<0,001). In the age aspect, there is a tendency for a significant enlargementof lumbar lordosis (P <0,01-0,001) and uneven development of cervical flexure. The annual increase in the depth of lumbar lordosis varies in girls within the range from 1,41 to 4,93 mm, in boys - from 1,34 to 2,32 mm (P<0,01-0,001). When analyzing the results of the study of posture in different initial positions, the tendency of cervical enlargement and smoothing of lumbar lordoses at the transition from the vertical position to the initial position (sitting) (P<0,001)was disclosed.

Our study of the state of posture in children of primary school age showed a variety of revealed deviations in the external indicators of posture in the sagittal plane. In this connection, there was a need to systematize the possible deviations of posture.

According to this classification, we considered it possible to include all children with mean values of spinal curvature (M ± 0,75G) to the group with no posture abnormalities in the sagittal plane (mean posture type). The children of eight other types, whose indicators of the cervical and lumbar lordoses exceed the limits of average values, are referred to as having functional disorders of posture in the sagittal plane. All children who have increased or decreased physiological curvatures more than ± 1,5G from mean values (M), were conditionally assigned to the group with persistent or abnormal spinal abnormalities in the sagittal plane.

Fig. 1 reflects the prevalence of the classified types of posture in schoolchildren aged 7-8 years old. It has been established that the most common type of posture (28,6-31.3%) in children is in primary school age. Another part of the students (more than 70%) needs close attention and control, the state of sagittal flexures of the spine.

Common cervical disorders include the cervical-unbend type (6-15%) and the cervical-lordotic type (5-14%), characterized by a corresponding decrease or increase in the natural curvature of the spine in the cervical region, with a normal lumbar state.

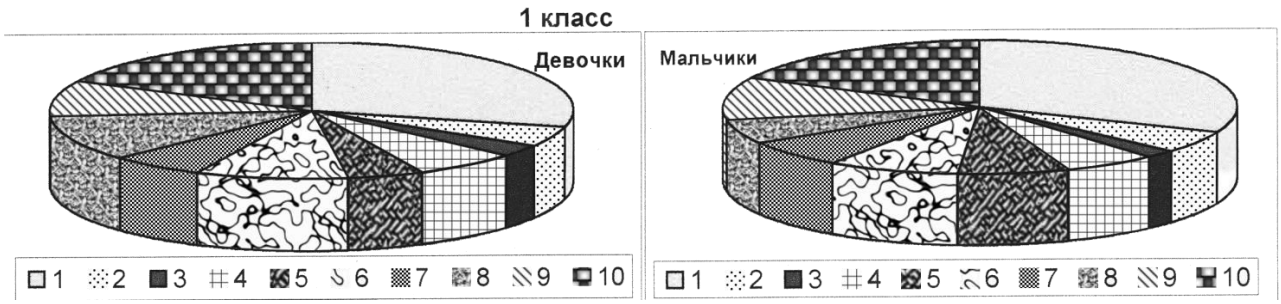


Fig.1 The distribution of children 7-8 years according to their type of posture.
1. medium 2. unbend 3. kyphotic 4. lordotic, 5. round-shouldered 6. lumbar-erect 7. lumbar-lordotic 8. cervical-erect 9. cervical-lordotic 10. pathological.

Reduction of natural curvatures of the spine, in both cervical and lumbar spines (straight type) has been s found in the first form in 4,6% ofthe girls and 5,5% of theboys. Often there are children who have persistent abnormalities of posture in the form of very pronounced or too smoothed sagittal flexures of the spine, which we conditionally call pathological (17,6 %.)

The high prevalence of abnormalities of posture among schoolchildren, identified over a period of dozens of years, as well as the well-known relations of advanced cases of postural disorders to the functioning of other body systems, confirms the importance of further research.

In our work, we drew attention to the age and sex characteristics of the external respiration of children with impaired postureand studied the influence of the development of the spinal curvatures in the sagittal plane on the process of ventilation of the lungs, lung volume.

The data on the parameters of external respiration in children aged 7-8 years old with different states of sagittal flexures of the spine are presented in Table 2.

The most informative valuethatshows the functional capacity of the lungs is the vital capacity of the lungs (VCL). Average VCL in the first-form children with different types of posture ranges from 1,37 to 2,07 liters, the lowest index of VCL was found in the girls with a kyphotic type of posture, the average value of which was only 1,62 liters. Significant differences in this indicator were found in the girls aged 7-8 years old who had cervical straight, lordotic and lumbar-straight type of posture (P <0,05-0,001), as well as in the boys with medium, lordotic and lumbar-straighttypes of posture (P<0,02-0,001).The results of our study have shown that the children of primary school age there have often a decrease in VCL by 4-14% of the due (D), and the percentage of such children is much higheramong the children with impaired posture. Reduction of this value in comparison with the due is more typical for children with stooped shoulders (62,5%), cervical-erect (52,6%) and lordotic (50%) types of posture.

Qualitative features of the ventilation function of the lungs are judged by the maneuver of the forced vital capacity of the lungs, which is a kind of functional loading test. Functionally, the most valuable part of FVCL is the air that is exhaled during the first second of exhalation (FEV1). Reduction of this value indicates a violation of bronchial patency. The one-second forced expiratoryvolume (FEV1) was significantly reduced in boys with impaired posture compared with the peers who do not have these abnormalities. The values of this indicator were 1,65 ± 0,08 liters against 1,73 ± 0,66 liters, respectively. The deviation of FEV1 from the proper value by more than 20% was recorded in the girls with straightened (33%), cervical-straightened and kyphotic types of posture (50%).

In children with impaired posture, we found an increase in RV of inspiration and RVof expiration in comparison with the schoolchildren with a normal state of sagittal spinal curvatures.

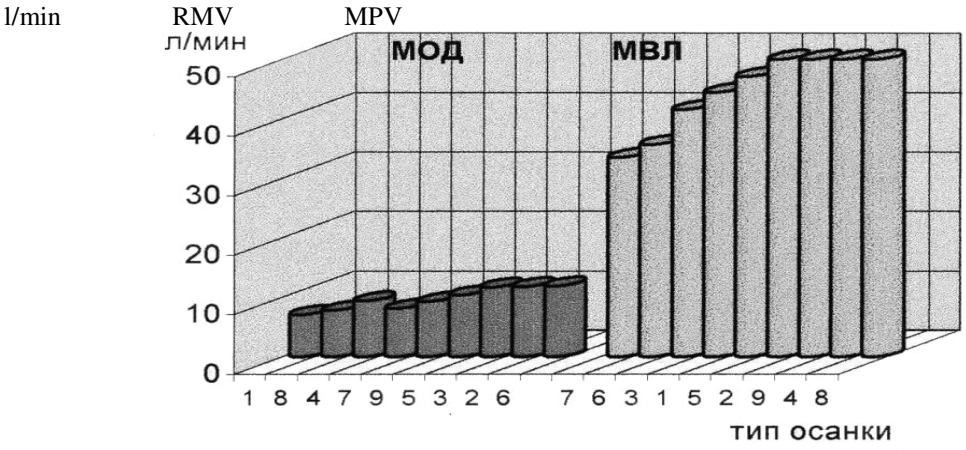
Table 2: The indicators of external respiration in children aged 7-10 years old with different states of sagittal spinal curvature

Indicators of external respiration	Postural condition in the girls aged 7-8			Postural condition in the boys aged 7-8.		
	No disorders	Functional abnormalities	Pathological abnormalities	No disorders	Functional abnormalities	Pathological abnormalities
RR (pulse/min)	16,17±1,48	17,87±1,00*	16,38±1,88	16,28±1,19	16,0±1,05	15,78±1,43
RC (l)	0,55±0,02	0,53±0,02	0,56±0,02	0,54±0,01	0,52±0,01	0,51±0,03*
RMV (l/min)	7,44±0,60	9,33±0,58 *	7,89±0,88	8,56±0,53	7,70±0,58	8,98±1,13
SVCL (l)	1,93±0,19	1,86±0,10	1,74±0,09	1,85±0,06	1,85±0,07	1,71±0,11*
FVCL (l)	1,52±0,10	1,46±0,04	1,59±0,11	1,81±0,06	1,69±10,08	1,63±0,10
IRV (l)	0,65±0,04*	0,62±0,03	0,72±0,11	0,77±0,37	0,71±0,07	0,57±0,07*
ERV (l)	0,32±0,03	0,47± 0,04 *	0,34±0,07	0,36±0,06	0,42±0,06	0,45±0,08
FEV_1 (l)	1,40±0,06	1,43±0,04	1,52±0,11	1,73±0,06	1,65±0-08*	1,64±0,10*
MPRBC (l/min)	44,4±1 ,74	44,3±2,56	42,0±2,46	46,5±1,79	46,74±3,22	47,3±3,54
IPFR_25 (l/s)	3,4±0,17	3,53±0,14	3,47±0,20	3,57±0,13	3,68±0,16	3,99±0,27
IPFR_75 (l/s)	1,66±0,12	1,41±0,07	0,40±0,17	1,77±0,10	1,62±0,12	1,59±0,18
AEFR_25-75 (l/s)	2,38±0,20	2,48±0,14	2,31±0,22	2,63±0,11	2,52±0,14	2,62±0,13
AEFR_75-85 (l/s)	1,50±0,11	1,17±0,06	1,13±0,14*	1,48±0,10	1,36±0,11	1,28±0,19

Notes: SVCL- slowvitalcapacityoflungs; RC- respiratorycapacityofthelungs; RR - respiratoryrate; RMV-respiratoryminutevolume;ERV–expiratoryreservevolume;IRV–inspiratoryreservevolume;FVCL –forcedvital capacity of lungs of expiration; FEV 1 - forced expiratory volume per second. MPRBC -maximal pulmonary rapidbreathing capacity; IPFR 25 –instantaneous peak flow rate after 25% expiration at spirometry test:IPFR75 – instantaneous peak flow rate after 75%expiration of FVCL, it is measured at forced expiration;AEFR 25-75 – average forced expiratory flow rate from 25% to 75% of FVCL; AEFR 75-85 –average expiratory flow ratefrom 75% to 85%.

In some cases, this difference is significant (P <0,02). RV of inspiration in the first-form girls was 0,32 + 0,03 l, and it increased in the girls with functional impairment of posture to 0,47 + 0,04 l (P <0,01). It is explained by the extended use of the first reserves of the respiratory system in normal life activity, as well as certain differences in the functional state of the ground of muscles that provides the act of respiration.

Another indicator of the reserve capacity of the ventilation process (MPV) was significantly lowered compared to other children in boys with a lumbar-lordotic type of posture and in girls with a stooped and kyphotic type of posture (P <0,001), the mean value of which ranged from 32,1 to 44 , 2 l / min (Fig. 2). Maximal pulmonary ventilation shows how much ventilation can be further increased with the increased requirements of organism.If it is remembered that the average due MPVfor girls at this age is in the range from 50 to 60 l / min, it becomes obvious thatit is reduced by 20-40% of the due onein children with the above-listed faults in posture. Apparently, it can be assumed that enlargement of cervical and lumbar lordosis of the spine leads to the depressed thorax, lowed muscle tone and complicates the function of external respiration.



type of posture

Fig.2 Indicators of RMV and MPV in the 7-8 years old children with different types of posture

In the considered age group RR, RMV was slightly higher in the children with functional and pathological deviations of sagittal spinal curvatures compared to children who do not have such ones. The increase of the RMV in these children was mainly due to the acceleration of RR, i.e. with irrational functioning of the breathing apparatus, which, apparently, under certain conditions can cause hyperventilation of the lungs.The increase ofRMV in the rest was found in the first-form girls with erected and cervical-lordotic type of posture, which was 11,8 l / min, and exceeded such one in the children with lumbar-lordotic, lordotic, cervico-erected, lumbosacral and normal type of posture (P<0,01-0,001).

In general, the analysis of the results of the study of external respiration of the 7-8-year-old children with different types of posture has shown that the most unfavorable are those in which the cervical lordosis of the spine is significantly enlarged or reduced.

SUMMARY:

1. When considering the results of the investigation of posture in different initial positions, the tendency of cervical enlargement and smoothing of the lumbar lordosis at the transition from the vertical position to the initial position (sitting)(P<0,001) was revealed.
2. In general, the analysis of the results of the study of external respiration of children at the age of 7-8 years with different types of posture showed that the most unfavorable are those in which the cervical lordosis of the spine is significantly enlarged or reduced.
3. With a pronounced enlargement of cervical lordosis (lumbar-lordotic type of posture), the connection with the pneumotachometry indicators becomes even closer, i.e. approach or equal 1,0. Thus, with the increase in lumbar lordosis, the value of indicators characterizing the bronchial patency of the lungs decreases.

CONCLUSIONS:

According to our data, the type of posture of children predetermines the functionality of external respiration. With the increase in cervical lordosis, the motility of the upper thoracic spine decreases and, as a consequence, leads to a reduction in pulmonary volume. The increase in lumbar lordosis affects the tone of the anterior abdominal wall, the diaphragm is lowered, the respiratory rate increases, and the indicators characterizing the bronchial patency of the lungs decrease.

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