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PHYSIOLOGICAL-HYGIENIC SUBSTANTIATION OF THE OPTIMUM RATIO OF BODY PROPORTIONS AND CLASSROOM FURNITURE OPTIONS

A comparative, study concerning a better accommodation of the students posture during classes (with the ratio between the body's proportions and classroom furniture height varying) has been conducted by physiological (spirometry, plethysmography) and anthropological methods, as well as by the biochemical analysis of posture. The optimal classroom furniture height values appropriate for institutes have been established

Keywords: students, anthropometry, parameters of classroom furniture

Introduction. As is known, the main criteria for rationing furniture are comfortable working pose, its ergonomic and physiological rationale. For the normal functioning of various organs and body systems at work sitting, the main parameters of the furniture should be in a specific ratio to the value of the anatomical features. In this context, the development of standards at mass use of the furniture must be installed within range of anatomical differences in the ratio of features and furniture options. When developing standards for school furniture, it has been proven that the size mismatch of furniture anatomical values within $M \pm 1\delta$ (± 2 sm) does not effect on your posture and does not cause abnormalities in the functional status of the student body as including younger ages.

In this study, there was a task to determine what magnitude of mismatch between anthropometric parameters and features of the students of high school furniture does not cause them adverse changes of physiological functions. To solve this problem conducted complex investigations in the following areas: changing the growth (at 1 199 people) to determine the grafting differences growth among groups of students; Applied anthropometry to 22 indicators (height above seat of eyes line, line of angles, shoulder blades depth, lumbar bends, shin, thigh length and etc. at 345 people). Study of the functional state of several body systems, external breathing function (100 spirogramm).

Materials and methods. Based on actual 1 199 student growth data was constructed curve percentage distribution of this trait. From the data presented in the figure can be seen that the growth rates in 96.3% surveyed fall within the range from 160 to 185 cm, in 0.4% below - 160 cm and 3.9% - above 185 sm. The average rise surveyed contingent of 174.6 cm.

Results and discussion. Based on the current practice of school furniture rationing obtained anthropometric data were grouped into two groups of growth at intervals of 15 sm, growth taken as normalized for school furniture. The first group included students with 161-176 sm. growth, the second - 177-192sm. Since extreme variants of growth occurred in a small percentage of cases, and to the ends 18-26 years body growth and development of the main systems of the organism, including ensuring posture stability and regulation, the third group has been allocated, comprising the totality of the growth range (161-191cm). Dimensions of furniture made to determine, based on the average values of body parts in each of the groups of growth as middle and close to them the cases are found in large number of cases.

The formation of posture most affected by the size of tall furniture - seat height and height of table anthropometric criterion that determines the height of the seat is the length of the lower leg with the foot in the shoe, that is, the distance from the floor to the soft tissues of the human thigh dimples in a sitting position. Height of the table is made up of seat height and differentiation - the distance from the seat to the elbow, close to the body.

I.V. Mihaylova and G.A. Sharshatkina established that the value of differentiation for pupils equal to the height of the elbow close to the body of the seat, with the addition of convenience pose 6 cm. According to our data, the convenience provided by students pose with the addition of 8 cm to the average height of the elbow (24,3sm). Mean values of anthropometric indicators that determine the size of tall furniture on these groups are presented in Table 1. From the table 1 it seen that at students of first and second groups the difference between the average values of the length of the lower leg with the foot in the shoe is 2,1sm. The average value of this antropometrical marks for all studied population of students (3 group) is 46.6 sm and diffirentiate from average value of the 1st and 2nd groups only on ± 1 sm.

These differences should be recognized as irrelevant according to L.V. Mikhailova mismatch of furniture and said anthropometric trait within ± 2 sm ergonomic and physiologically insignificant even for students. The difference between the average values of the height of the elbow on the seat of the students of the first and second groups, compared with the third group also is insignificant and is 1 - 0.8 cm, respectively.

Table 1-Average values of anthropometric characteristics are determined by the dimensions of the furniture at the students of different growth groups

Anthropometric sign	Growth, sm			the difference between the average values		
	1-group 161-176	2 - group 176-191	3-group 161-191	1-2	1-3	2-3
the length of the lower leg with the foot in the shoe	45,6 \pm 1,6	47,7 \pm 1,5	46,6 \pm 2,0	-2,1	-1,0	+1,0
	23,3 \pm 1,8	25,1 \pm 1,6	24,3 \pm 2,0	-1,8	-1,0	+0,8

The lack of the meaningful difference of average fearuteogf these ergonomical values are expressed by many reasons. For the same length of the size of the body parts of it in different individuals may be different (V.V. Bunakand others). For example, within the study of M.N. Korsunskaya and L.N. Zagluhinskaya lower leg length of 34 cm met in groups surveyed with an increase from 127 to 148 cm and the height of the elbow on the seat 18 cm. - people with growth of 91 to 142 cm In our observations tibia length 46 cm found in individuals with growth ranging from 161 - 186 sm.

Another reason is that the length of the lower leg has a significant impact and the height of the heel shoes. We surveyed students it varied from 2.5 to 11 cm, with an average of 5.6 sm. Moreover, in patients with an increase up to 165 cm is equal to an average of 7.6 cm and in patients with an increase of more than 180 cm -3.2 cm. This is to some extent eliminates the differences in the length of the lower leg with the foot in the shoes of students of different heights.

The size of the elbow height of seat 24 cm met students with growth ranging from 165 to 183 cm. This is consistent with the results of SV Investigation Ermakova and al.authors, according to which the difference in average growth of students to 10 cm difference of averages compared to only 0.5 cm for men and 0.4 cm for men.No significant differences in the averages of the height of the elbow on the seat due to the fact that on the one hand human growth largely depends on the leg length than the length of the body on the other so that a change in shape of the spine in sitting posture helps smooth out differences in the length of the body from different heights persons.

Thus, the insignificance of the difference between the average values of the main anthropometric features in the two groups does not give grounds for classroom furniture offers two sizes for schools. Provided classroom furniture and equipment of two sizes in accordance with the average growth of anthropometric features two groups for the vast majority of students will be equally convenient to use for seating furniture both rooms.

In order to clarify the need for the number of dimensions of the furniture was held physiological-hygienic substantiation of the optimum ratio of body proportions and parameters of classroom furniture for the indicators mentioned above. Under experimental conditions, the ratio of simulated seat height and length of the lower leg, desk height and differentiation within $M \pm 1\delta$, or 2 sm, (T.Sh. Minnibaev) and $M \pm 1.5\delta$ ($\pm 3sm$), the quantities of anthropometric characteristics for the entire population.

It is possible to evaluate the convenience of working postures and for students with extremes anthropometric features. Comparative analysis of biomechanical parameters of working postures (Table 2) showed that the discrepancy between the size of the furniture values lower leg length DSO foot in the shoe, and the height of the elbow in the range $\pm 1.5\delta$ (± 3 cm) from the average feature has no significant effect on the biomechanics of students poses. Thus, the average value of the angles parts of the body at a value mismatch within ± 3 changed only 2-5° on the data discrepancy with the value received ($\pm 2cm$). In both cases, your feet are on the floor and lean percentage asymmetric postures range but about the same level from 17 to 24. According to L.V.Mihaylovoaya and G.A. Sharshatkinoya mismatch parameters tall furniture tibia length and height of the elbow at around ± 3 to ± 4 cm in schoolchildren of different ages and does not cause significant changes in the angles of bending parts of the body (3-5). The study of the electrical receptacles lower limbs, body microvibrations amplitude, frequency and nature of complaints of the students did not reveal revealed no significant changes in these indicators for non-compliance seat height and lower leg length of between ± 2 and ± 3 cm. Bearing in mind that among the surveyed contingent are persons who have the length of the lower leg with the foot in the shoe extends beyond - 1.5 δ (undersized), It conducted a series of experiments using steps 5 sm feet tall while the students showed no adverse hemodynamic changes, and there were no complaints about the feeling of squeezing, pain, numbness in the legs.

Thus, data analysis of physiological reactions of biomechanical characteristics of the item and the frequency of complaints indicates that the seat height is equal to the average length of the whole population of the lower leg (46cm) is optimal for people with lower leg length in the range of $M \pm 1.5\delta$ and the presence of steps in furniture design - and for people with the length of the lower leg goes beyond $M - 1.5\delta$.

Table 2-Angles parts of the body at different ratios of seat height and lower leg, desk height, and differentiation

Biochemical characterization of the working dose	the value of non-compliance of anthropometric characteristics and dimensions of the furniture				
	M \pm 2 sm for 2 parameters	Seat Height		the value of differentiation	
		above the tibia 3 cm	above the tibia 2 cm	L* + 3 sm	L* - 3 sm
inclination of the head relative to the torso	14,8 \pm 0,1	12,0 \pm 0,1	15,4 \pm 0,1	12,6 \pm 0,1	15,1 \pm 0,1
The slope of the body from the vertical					
The angle of sight	14,4 \pm 0,1	10,9 \pm 0,1	18,4 \pm 0,1	11,2 \pm 0,1	19,2 \pm 0,1
The angle of the hip joint					
The angle of knee joint	69,0 \pm 0,2	72,2 \pm 0,3	74,0 \pm 0,2	72,4 \pm 0,3	66,4 \pm 0,1
The angle of the ankle joint					
The distance from the eyes to the Working surface	82,1 \pm 0,2	88,0 \pm 0,2	79,2 \pm 0,2	83,4 \pm 0,2	86,5 \pm 0,2
poses	92,3 \pm 0,2	88,1 \pm 0,3	97,0 \pm 0,2	90,1 \pm 0,2	98,1 \pm 0,3
Asymmetry					
The position of the feet when the feet are all based on the floor	98,4 \pm 0,2	93,4 \pm 0,3	96,8 \pm 0,2	95,5 \pm 0,2	103,1 \pm 0,3
	35,1 \pm 0,2	29,1 \pm 0,2	31,4 \pm 0,2	32,9 \pm 0,2	34,1 \pm 0,2
	19,7	17,3	24,1	23,4	18,4
	100	100	100	100	100

It is seen from the table 3, that delay on average equal to the value of the height of the elbow of the forearm in a position comfortable for writing (32cm) for the entire population does not cause significant subjective complaints and shifts the

physiological reactions of the organism studied at the value of non-compliance as ± 2 ($\pm 1.5\delta$) cm and 3 cm ($\pm 1.5\delta$). For more evidence of that delay on within the $M \pm 1.5\delta$ is optimal, has conducted a series of studies at the value of differentiation within $\pm 2\delta$ $\pm 2.5\delta$ material adverse changes in the functional state of an organism of students have been identified in these cases.

Table 3 - Changes in the frequency of complaints and indicators of the functional state of an organism of students with different ratio values of differentiation, and the height of the table

The value of differentiation	Complaints%									
	fatigue	numb	the pain	poses an inconvenience	breathing capacity, ml		MBC, l		LCL, l	
					boys	girls	boys	girls	boys	girls
M+4-5sm M	19.1	17.0	22.6	58.4	842.7	656.1	17.2	16.7	3.48	2.80
±m	5.0	6.0	6.0	6.0	59.8	23.8	1.7	1.4	0.11	0.08
t	2.48			9.0	3.97	3.9	2.9	0.7	1.8	2.8
P	<0.05			<0.001	<0.001	<0.001	<0.01	>0.5	>0.5	<0.01
M+3sm M	9.4	3.8	3.8	6.7	1170.0	840.0	25.0	18.5	3.80	3.16
±m	4.0	2.0	2.0	4.0	52.0	41	1.5	1.3	0.08	0.09
t	0.9			1.1	0.4	0.07	0.3	0.2	0.07	0.2
P	>0.5			>0.5	>0.5	>0.5	>0.5	>0.5	>0.5	>0.5
M-3sm M	7.5		7.5	8.0	1100	854	25.3	17.9	3.71	3.24
±m	3.0		3.0	4.0	58.0	39.2	1.8	1.0	0.08	0.09
t	0.66			1.4	1.1	0.2	0.4	0.1	0.06	0.8
P	>0.5			>0.5	>0.5	>0.5	>0.5	>0.5	>0.5	>0.5
M-4-5sm M	23.2	15.1	9.4	78.6	716.1	519.1	15.1	15.2	3.40	2.75
±m	4.0	5.0	4.0	5.0	43.8	29.9	1.5	1.4	0.02	0.10
t	3.7			12.2	6.0	6.3	4.0	1.5	2.3	2.9
P	<0.001			<0.001	<0.001	<0.001	<0.001	>0.5	>0.5	<0.01

Conclusion.

1. Inconsistency basic parameters tall sizes of classroom furniture respective values of anthropometric characteristics within $M \pm 1.5\delta$ ($\pm 3sm$) covering the 90% students surveyed, does not cause adverse changes in the functional state of the organism.
2. With the standardization of functional dimensions of classroom furniture as raw averages of anthropometric characteristics for the population without division into growth group optimum value of the seat height to be taken shall be 46 cm, Differ -32sm, the height of the table top, facing the sitting - 78cm (46 ± 32).

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**АУДИТОРИАЛЫҚ ЖИНАЗДАР ПАРАМЕТРЛЕРІ МЕН ДЕНЕ ПРОПОРЦИАЛАРЫН
ФИЗИОЛОГИЯЛЫҚ-ГИГИЕНАЛЫҚ ТҰРҒЫДА НЕГІЗДЕУ**

Түйін: Білім алушылардың денсаулығын сақтау және жұмыс қабілеттілігін арттыру мемлекет тарапында басты роль атқарады. Келесі бағыттар бойынша кешенді зерттеу жұмыстары жүргізілді: студенттердің әртүрлі топтағы бой ерекшеліктері бойынша бойының ұзындықтарын өлшеу, қолданбалы антропометрия, жұмыс қалпына кейбір ағзаның тұрақтылығын зерттеу, сыртқы тыныс алу қызметі, сонымен қатар арнайы құрастырылған сауалнама бойынша субъективті қалыпты бағалау. Гигиеналық негіздеу мен қалыпты сабақ кестесінің болмауы, жұмыс орны мен оқу жағдайын дұрыс ұйымдастырмау жұмыс қабілеті мен оқу белсенділігін төмендетіп студенттер арасында аурушаңдылықтың жоғарлауына әкеліп соғады.

Түйінді сөздер: студенттер, антропометрия, аудиториалық жиназдар параметрі

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**ФИЗИОЛОГО-ГИГИЕНИЧЕСКОЕ ОБОСНОВАНИЕ ОПТИМАЛЬНОГО СООТНОШЕНИЯ ПРОПОРЦИИ
ТЕЛА И ПАРАМЕТРОВ АУДИТОРНОЙ МЕБЕЛИ**

Резюме: Сохранение здоровья, повышение работоспособности учащихся имеют большую актуальность и являются общегосударственной задачей. Проведено комплексное обследование в следующих направлениях: измерение роста для определения распространённости различных ростовых групп среди студентов; прикладная антропометрия, изучение некоторых систем организма устойчивости рабочей позы, функции внешнего дыхания, а так же субъективную оценку удобства позы с помощью специально разработанной анкеты. Отсутствие гигиенического обоснования и норму занятий, организации рабочего места и условиям обучения приводят к учебной перегрузке, снижению работоспособности и учебной активности и повышению заболеваемости студентов.

Ключевые слова: студенты, антропометрия, пропорции тела параметры аудиторной мебели