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Morphofunctional, Hematological and Biochemical Indicators of First-Year Students Who Came to Study from Urban and Rural Areas

Aigul S. Dinmukhamedova[1], Saule M. Bazarbaeva[1*], Roman I. Aizman[2], Zhanat M. Mukataeva[1] and Gulnara S. Tleubergenova[3]

[1]*Department of General Biology and Genomics, Gumilyov Eurasian National University, Nur-Sultan, Republic of Kazakhstan*

[2]*Department of Anatomy, Physiology and Life safety, Novosibirsk State Pedagogical University, Novosibirsk, Russia*

[3]*Department of Biology, Manash Kozybaev North Kazakhstan University, Petropavlovsk, Kazakhstan*

Abstract

Adaptation of students is a complex process of dynamic restructuring of functional and psychophysiological mechanisms. The purpose of this study was to investigate the morphofunctional, hematological and biochemical indicators of first-year students who came to an educational institution from urban and rural areas. The study involved 400 first-year 17-18 year old students of both sexes; they arrived to study at different faculties of the University both from rural and urban areas. Morphofunctional indicators, adaptive potential and the level of physical health were assessed using standard, generally accepted methods. The students who came to study from the village had a higher level of health than their urban peers. A comparative assessment of the morphofunctional, hematological and biochemical parameters in students revealed that the size of the body, the type of constitution, the functional reserves of the cardiorespiratory system differ depending on the gender and previous place of residence. The obtained data can be used to draw up standards for the physical development of young people from different regions and to develop wellness programs to reduce the stress caused by adaptation to university studies.

Keywords: Adaptation • Biochemical characteristics • Hemoglobin • Physical health level

Introduction

The health status of any social group, including students, is a problem requiring comprehensive consideration in conjunction with environmental factors and socio-economic status [1,2]. The initial period of study at the university is a very important stage in the student's life both socially and physiologically. The student age is a period when human biological maturation ends and all morphological and functional indicators reach their definitive values [3]. It is the age to establish harmonious interaction of various links within and between physiological systems. Therefore, the data on the morphological and functional status reflect not only one of the main informative criteria of the organism individual development, but also the state of the human health, the formation of which is largely determined by environmental, climatic and socio-economic factors [4-6].

Consequently, the level of morphological and functional development of the body can indicate the effectiveness of the entire system of medical and hygienic measures for the existing lifestyle and determine further activities aimed to improve the health of the younger generation [7]. In addition, in connection with the problems of human adaptation to various climatic and geographical living conditions and new social conditions, it becomes relevant to study morphofunctional reserve capabilities of students in the process of adapting to university training, since new living conditions and a high total academic load impose increased requirements on the student's organism [8,9].

The residents of different climate and geographic zones differ in their morphological status, as well as metabolic processes characteristics that are specific for each region [10-13]. Since the works on students' health during adaptation are not comprehensive, it is of interest to analyze the morphofunctional, hematological and biochemical parameters of young people who arrived from cities and villages to study at the University.

Methods

Study design and participants

The participants of this study were 400 first-year students (200 young men and 200 girls) aged 17-18 years. From the moment of birth to admission to the university, all of them lived either in the village or in the city. Written informed consent was obtained directly from the participants.

Data collection

The participants were monitored for one academic year. Anthropometric and functional examinations were carried out at the beginning of their first year, in the first semester (September-October) and hematological studies- in the second semester of the same academic year (February-March). The collected data included anthropometric, functional, hematological and biochemical indicators of the students' health status.

Anthropometric indicators

The evaluated anthropometric parameters were: Body Height (BH), Body Mass (BM), Chest Circumference (CC). The BH, BM, and CC data was used to calculate the Quetelet Indices (QI), Sthenic Indices (SI) and Pinier Indices (PI) [14].

The Body Mass Index (BMI) was determined by the Quetelet formula

***Corresponding Author:** Saule M. Bazarbaeva, Department of General Biology and Genomics, Gumilyov Eurasian National University, Nur-Sultan, Republic of Kazakhstan; E mail: ssdarina12@mail.ru*

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(QI)

QI, kg/m2=BM (kg)/BH (m2) (1)

The Pinier and Sthenic indices and were used to assess the individual constitutional status.

SI=BH,(cm)/(2 × BM, (kg)+CC,(cm)) (2)

SI above 1.25 indicates the predominance of the dolichomorphic type of constitution, SI in the range of 0.85-1.25 indicates the mesomorphic type, and SI below 0.85-the brachymorphic type.

PI=BH, (cm)-(BM,(kg)+CC,(cm)) (3)

PI above 30 is typical for the asthenic body type, PI in the range from 10 to 30-for normosthenic, and PI below 10-for hypersthenic type of constitution.

Constitutional type

The type of constitution was determined by the method proposed by M. Chernorutsky [15,16]. The analysis revealed three types of constitution: asthenic, normosthenic and hypersthenic ones.

Functional indicators

The functional parameters determined in the study were the following: The strength of the hands (HS) (measured with a dynamometer) and hand strength-to-body mass index (HI) (according to the formula: HI=HS (kg)/BM (kg), vital lung capacity (VC) (measured with an air spirometer) and vital capacity-to-body mass index (VI) (according to the formula: VI=VC (ml)/BM (kg). The cardiovascular system capacity at relative rest was evaluated by the Rate Pressure Product (RPP): RPP=(SBP × HR)/100, where SBP is systolic blood pressure, mmHg, and HR is heart rate, beats per minute [14].

Physical health assessment

The level of physical health was determined on the basis of G. Apanasenko's model [7], which determined the values of the reserve capabilities of the body. This express assessment allowed distinguishing the following health levels: low (≤ 3 points), below-average (4-5 points), average (7-11 points), above-average (12-15 points), high (16-18 points).

Hematological indicators

Assessment of the main characteristics of peripheral blood was carried out in the regional blood Center. Counting and differentiation of peripheral blood platelets were carried out using an automatic hematological analyzer "SysmexXS-1000i" (Japan). Blood was taken for examination after an overnight fast. The analysis of peripheral blood parameters included evaluating the total number of white and red blood cells, hemoglobin concentration in the blood. Erythrocyte tests included the mean corpuscular volume of a red blood cell, the mean cell hemoglobin and mean corpuscular hemoglobin concentration in a red blood cell.

Biochemical parameters

Biochemical blood tests were performed with the use if a Beckman Coulter AU 480 biochemical analyzer. The analyzed indicators were the parameters of protein metabolism (total protein, urea and creatinine content), lipid metabolism (total cholesterol and triglycerides), carbohydrate metabolism (glucose content), mineral metabolism (total calcium, iron) and pigment metabolism (bilirubin content).

Statistical methods

The resulting material was processed by methods of variance and difference statistics using the non-parametric Student's and Fisher criteria for independent samples at a significance level of p≤ 0.05.

Results

Participant's characteristics

54% of students lived in the university hostel (n=216), 38% of students lived at home (n=152) and 8% rented an apartment (n=32). 26.5% of the young people studied at the Faculty of Engineering and Digital Technology (n=106), 22.3%-at the Institute of Language and Literature (n=89), 20%-at the Pedagogical Faculty (n=80), 31.2%-at the Mathematics and Natural Sciences Faculty (n=125).

Anthropometrics and body composition

Table 1 shows that, unlike urban students, rural students of both sexes had significantly smaller body height parameters. BMI was greater for the students who came from the countryside; the BMI parameters for both urban and rural girls and boys corresponded to standard values. The Pinier index was greater among urban students, which can be explained by greater body height and lower body mass.

Indicator	Urban students		Rural students	
	Girls (n=100)	Boys (n=100)	Girls (n=100)	Boys (n=100)
Body height, cm	163.1 ± 0.4	172.6 ± 0.3*	159.3 ± 0.3#	171.2 ± 0.4*#
Body mass, kg	55.8 ± 0.6	71.3 ± 0.4*	61.2 ± 0.7#	73.6 ± 0.4*#
CC, cm	84.1 ± 0.6	92.1 ± 0.4*	87.01 ± 0.5#	94.8 ± 0.4*#
Quetelet index, kg /m2	20.9 ± 0.2	23.9 ± 0.1*	24.1 + 0.2#	25.1 + 0.1*#
Sthenic index	0.83 ± 0.006	0.73 ± 0.009*	0.76 ± 0.006#	0.70 ± 0.003*#
Pinier index	23.1 ± 1.08	9.2 + 0.7*	11.3 ± 1.1#	2.8 ± 0.8*#
HS,kg	32.6 ± 0.7	49.7 ± 0.6*	36.6 ± 0.6#	54.06 ± 0.6*#
HI,kg/kg	0.55 ± 0.01	0.65 ± 0.007*	0.57 ± 0.01#	0.70 ± 0.008*#
VC,ml	3036.9 ± 49.7	4219.01 ± 76.3*	3310.4 ± 57.6#	4592.9 ± 63.4*#
VI,ml/kg	55.1 ± 1.09	59.3 ± 1.09*	54.6 ± 1.04#	62.6 ± 0.9*#
Heart rate at rest, beats / min	67.6 ± 0.8	74.3 ± 0.6*	71.3 ± 0.9#	69.1 ± 0.6*#
SBP at rest, mmHg	111.9 ± 1.05	120.3 ± 0.9*	117.5 ± 1.06#	115.9 ± 0.9#
DBP at rest, mmHg	66.6 ± 0.9	72.3 ± 0.9*	69.4 ± 0.9#	67.9 ± 0.9#
RPP, units	75.8 ± 1.2	89.5 ± 1.1*	84.09 ± 1.4#	80.1 ± 1.04*#
Adaptation potential,points	1.8 ± 0.02	2.1 ± 0.02*	2.07 ± 0.02#	2.01 ± 0.01*#
Physical health level points	7.4 ± 0.3	6.1 ± 0.3	7.1 ± 0.3	7.7 ± 0.3*#

Notes: *# Marksdenote significant differences (≤ 0.05) between: # urban and rural students; * boys and girls.

Table 1. Morphofunctional indicator of urban and rural students.

The assessment of the students' hands strength relatively the place of previous residence, showed that rural boys and girls had higher indicators for both the right and left hands. The average parameters for boys and girls corresponded to the average indicators for their age.

The assessment of cardio-vascular system reserves indicated that rural girls had higher RPP indicators, while this parameter in boys was higher among urban residents. A comparative analysis of the students' VC showed that average values of the respiratory system volumetric characteristics in students were generally lower than the age-appropriate values of the norm. At the same time, VC indicators in urban students were significantly lower than those of their rural peers. An important indicator of the respiratory system functioning is the vital capacity-to-body mass index (VI), which reflects the level of functional supply of oxygen to the body. In urban and rural youths, VI was characterized as "below average". Among girls, this indicator was higher in urban students.

Most boys and girls in urban and rural areas were characterized by

satisfactory adaptation-"Health Level 1". The students from cities had a lower adaptive potential. These indicators correspond to such a state of adaptation mechanisms load, in which function capabilities are ensured by means of mobilization of internal functional reserves.

The results of physical development, the functional indicators of the cardio-respiratory system, and the integral values of the physical health level allowed calculating the distribution of students by the level of physical health. More than half of the students had a medium level of physical health (urban-57% of girls and 43% of boys, rural-49% of boys and 52% of girls). High-medium health level prevailed in the group of urban students. Poorer health level was frequent among urban youths (29%). At the same time, high level of physical health was registered only in rural students (2% of girls and 1% of boys).

The analysis of constitutional types demonstrated that the hypersthenic body type was dominant in young men living both in the rural and urban areas, whereas the normosthenic type of constitution was more common among the young women, regardless of their place of previous residence (Table 2). It is noteworthy that almost one third of urban girls had an asthenic body type.

Area	Asthenic	Normosthenic		Hypersthenic	
	Girls	Boys	Girls	Boys	Girls	Boys
Urban	27	-	57	49	16	51
Rural	5	-	53	21	42	79

Table 2. Constitutional type of urban and rural students.

The analysis of the average values of blood indicators in students revealed that the highest hemoglobin level was specific for urban young men; in the students who came from rural areas this indicator was statistically lower. In girls, the hemoglobin level was normal; its values were higher in urban girls than in rural girls (Table 3). The red blood cell count in urban boys was also significantly higher than in the students who came from the village. The white blood cell count in all the groups under study was within normal limits and did not differ from group to group. The erythrocyte sedimentation rate (ESR) values in girls were higher than in boys. At the same time, there were no significant differences in this index between urban and rural girls. The ESR values in the students from the village were lower. The number of leukocytes in the studied groups was within the physiological norm; there were no significant differences in the content of these blood elements for the students from different regions. The tendency to an increase in white blood cell count can also indicate a load of adaptation mechanisms under the influence of various physiological and stress factors. There were no significant differences in the number of lymphocytes, monocytes, eosinophils and basophils between the compared groups. However, there was a significant decrease in thrombocytes content in urban girls compared to rural girls, while in boys, significant differences in this index were not found. The mean corpuscular hemoglobin concentration in the red blood cells of girls did not show any statistical difference. In boys, the mean cell hemoglobin in the red blood cells for rural residents was higher than for urban residents.

Group	Urban students		Rural students	
Indicator	Girls (n=100)	Boys (n=100)	Girls (n=100)	Boys (n=100)
White blood cells,*109/1	5.9 ± 0.1	5.7 ± 0.1	6.08 ± 0.1	6.1 ± 0.1#
Red blood cells,*1012 /1	4.2 ± 0.05	4.8 ± 0.03*#	4.3 ± 0.03#	4.4 ± 0.04*#
Mean corpuscular hemoglobin concentration, g /1	111.7 ± 1.5	135.3 ± 2.09*#	108.05 ± 1.9	127.5 ± 1.6*#
Hematocrit, %	38.02 ± 0.4	44.4 ± 0.5*	37.2 ± 0.5	41.9 ± 0.4*#
Mean corpuscular volume, fl	89.4 ± 1.07	92.01 ± 0.7*	87.3 ± 1.1#	93.9 ± 0.5*#
Mean cell hemoglobin, pg	26.3 ± 0.4	27.9 ± 0.3*	25.3 ± 0.4#	28.5 ± 0.2*
Mean corpuscular hemoglobin concentration, g/1	29.3 ± 0.1	30.3 ± 0.1*	28.8 ± 0.1#	30.3 ± 0.1*
Platelet count,*109/1	281.3 ± 6.7	256.3 ± 6.6*	304.6 ± 6.8#	243.6 ± 4.8*
Absolute neutrophil count	3.3 ± 0.1	3.1 ± 0.1	3.5 ± 0.1	3.5 ± 0.1#
Absolute lymphocyte count	1.89 ± 0.05	1.9 ± 0.05	1.9 ± 0.04	1.8 ± 0.04
Absolute monocyte count	0.50 ± 0.01	0.5 ± 0.01	0.51 ± 0.01	0.57 ± 0.01*
Absolute eosinophil count	0.15 ± 0.01	0.13 ± 0.005	0.11 ± 0.008	0.14 ± 0.07
Absolute basophil count	0.024 ± 0.001	0.028 ± 0.002	0.026 ± 0.001#	0.018 ± 0.001*#
ESR, mm/h	11.6 ± 1.1	6.2 ± 1.01*	12.3 ± 2.08#	6.15 ± 0.6*

Notes: *# Marksdenote significant differences (≤ 0.05) between: # urban and rural students; * boys and girls.

Table 3. Haematological indicators of urban and rural students.

The adaptation process requires large expenditures of the body. Therefore, the body's need for proteins, enzymes, hormones, vitamins, and chemical elements increases. These processes and their patterns were analyzed by means of biochemical blood tests. All analyzed indicators corresponded to normative values (Table 4). In the group of girls, the total protein content was higher among rural students. In the group of young men, this indicator was higher among students from the city. Blood glucose in the students who came from the village was higher compared to urban students. The iron content in the blood of the subjects was statistically higher in urban girls. In the group of young men, this indicator was higher among the students from the village.

Indicator	Urban students		Rural students	
4.4 ± 0.04*#	Girls (n=100)	Boys (n=100)	Girls (n=100)	Boys (n=100)
Total protein, g/L	74.8 ± 0.5	78.6 ± 0.4*	77.01 ± 0.3#	75.8 ± 0.3*#
Urea, mmol /L	3.7 ± 0.007	4.2 ± 0.1*	3.6 ± 0.08	4.4 ± 0.1
Creatinine, μmol /L	72.1 ± 1.2	75 ± 0.9	77.3 ± 1.1#	80.2 ± 1.1*#
Glucose, mmol/L	4.1± 0.06	4.2 ± 0.06	4.5 ± 0.06#	4.4 ± 0.07#
Total calcium, mmol /L	2.42 ± 0.007	2.44 ± 0.01	2.33 ± 0.01#	2.43 ± 0.07
Iron, μmol /L	16.05 ± 0.6	12.4 ± 0.6*	14.4 ± 0.2#	15.1 ± 0.7*#
Total bilirubin, μmol /L	8.8 ± 0.3	14.2 ± 0.6*	10.4 ± 0.4#	10.6 ± 0.4#
Cholesterol, mmol /L	3.7 ± 0.05	3.8 ± 0.1	4.3 ± 0.1#	3.7 ± 0.09*
Triglycerides, mmol /L	0.76 ± 0.03	1.0 ± 0.05*	0.67 ± 0.02#	0.70 ± 0.04#

Notes: *# Marksdenote significant differences (≤ 0.05) between: # urban and rural students;*boys and girls.

Table 4. The results of biochemical blood tests of urban and rural students.

In the group of all students from the village, the concentration of creatinine and urea was higher than that of their urban peers.

The content of total bilirubin in the examined students' blood was within normal limits; however, this indicator was higher in young men. The cholesterol content in the blood of the students was below the age norm. The tests of the boys did not how significant differences for this indicator. In young women, cholesterol was higher in rural students.

An assessment of the level of first-year students' physical health depending on the place of their previous residence revealed that students who came to study from the village had a higher level of morphological and physiological indicators than their urban peers. At the same time, young men, regardless of their place of residence, had greater total sizes and adaptive capabilities of the cardiovascular system compared to their female peers. The hypersthenic type of constitution prevailed in young men and normosthenic in girls.

The study results revealed a load of regulatory systems that was less pronounced in young women than in young men. The rate of adaptation after changing the residence in students had gender differences. The restructuring in the blood system was faster in girls; it was manifested in the absence of significant differences between the majorities of the analyzed indicators. The biochemical parameters show significant differences in the content of protein, creatinine, glucose, iron, total bilirubin, and triglycerides which was possibly associated with diverse nutritional characteristics.

Discussion

The anthropometric indicators of students do not change during the period of study at a higher educational institution, which confirms the stability of these indicators and completion of physical development. The tests of most students revealed harmonious physical development. Many authors consider that the main condition of students' disharmonious development is overweight [17-21]. A number of authors showed that students gain weight mainly in the first year of study [22, 23]. The increase in body weight and adipose tissue in the first year of university studies varies from 1.0 kg to 2.1 kg and from 0.7% to 1.3%, respectively [24-26].

Nutrition is considered to be a key determinant of youth health. Most students' regime and quality of nutrition are abnormal. Students often eat irregularly; their nourishment is not balanced. The study revealed that 25%-47% of student do not have breakfast, 17%-30% have two meals a day, about 10% do not eat lunch or eat it irregularly, about 22% do not have dinner. All this affects the state of health. The number of students suffering from gastritis is increasing from the first to senior courses. The main causes of food hygiene disorders are lack of time and money.

Overweight affects the functioning of the cardiovascular system, the diseases of which are evident already in middle age. Some studies show that an increase in hypertension cases is associated with an increase in body mass index. A number of authors indicate the interaction of anthropometric, hemodynamic and autonomic indices of health status.

In the Republic, 38.8% of the population suffers from chronic diseases; at that, chronic diseases are found in 37.3% of adolescents. With age, these diseases exacerbate. In addition, it was found that in all regions of the Republic, chronic diseases are less common among people living in rural areas.

The country's incidence of allergic, acute respiratory diseases, chronic pneumonia, bronchial asthma, tonsillitis, and iron deficiency anemia among young people continues to grow. Studies conducted in the Kyzylorda region among women aged 18-45 years revealed iron deficiency anemia in 40.2% of them. This value was significantly higher than the values found for European women (14%), lower than the average values for African (48%) and South Asian women (57%).

In the population of any country, there are significant health disparities between regions and adolescent groups, in which gender differences and social status are important determinants.

Conclusion

The findings of this study dictate the need for further study of the influence of various environmental and social factors on the health of young people, as well as medical and pedagogical correction of the educational process and implementation of preventive measures for students.

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