NEW APPROACHES IN THE ASSESSMENT OF PHYSICAL DEVELOPMENT OF STUDENTS

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Introduction

Human physical development is an important factor for public health, physical education, and sports. Together with the functional level of an individual, it defines a person's physical health [1]. In sports anthropomorphic functional characteristics determine specialization and selection for professional sports [13,14]. The principal criteria of physical development of children and teenagers (up to age 17) is the dynamics of height and weight values, protoplasm growth [2], general motor skills and dexterity, stages of puberty, and other factors [3]. The main objective of the research for this age group is to determine how adequate is the physical development of children and adolescents, how the biological age corresponds to chronological years. For young adults and middle age groups the focus shifts to the estimation of the strength of their physical development which is mainly based on the study of physiometric indices [2,6]. The principal characteristics of the physical development of this age group should be inherent traits. The sum of these traits determines the person's physical potential with the most accuracy [2]. In our study the preference was made in favor of physiometric indices: length (L), body mass (M), moment of force (MF), and vital lung capacity (VLC) translated into body mass index (BMI), strength index (SI) and vital index (VI). It has been established that adaptive mechanisms of regulation of physiological functions are significantly higher in people with normal weight than in those who are overweight or obese [15]. Therefore, BMI was selected for the research. In addition, the students

with increased body mass were more likely to develop chronic diseases, diabetes, and cardiovascular diseases than those with normal body weight [11,12]. The implementation of force in measuring MF requires certain conditions from an individual. First, there should not be any contraindications for applying such force. The contraindications are the presence of high blood pressure, hernia, internal organ prolapse, spinal dysfunctions, osteoporosis, danger of bleeding, and other pathological conditions which in themselves serve as good criteria for health evaluation. Secondly, a good performance on the force dynamometer requires the engagement of the total body muscles (back muscles, abdominals, legs and arms neck, face, etc.). That demands the generation of the powerful impulses in the center of the brain responsible for motor function which is achieved by a high concentration of willpower during implementation of the force. Therefore, moment of force implementation depends on a number of physiological, biochemical, and psychological functions of the body [17]. Thus, we can assume that SI is an indicator of physical potential and biological health. If there are any contraindications for using force dynamometer the hand held dynamometer and the strongest hand can be used instead in the assessment of the physical status.

VI characterizes the respiratory system and lung capacity. It defines their functional capabilities. In addition, VI and SI depend not only on the absolute values of VLC and MF, but also on the body mass of a person. Therefore, all these three factors are closely linked to each other. Changes in one prompt a clear response in the others.

Object and Research Methods

The study conducted in 1979 and 2001 through 2011 involved 1492 first year students of Russian National Research Medical University (RNIMU) named after N.I.Pirogov in the age of 17.8 ± 0.6 years. Somatological and anthropometric

methods were applied in the research.10 Subcutaneous fat was measured with Omron BF 302 appliance. Body mass, vital lung capacity and moment of force parameters were calculated into BMI, VI and SI.

BMI = m/L^ 2, where m is the mass of the body in kg; L is the length of the body in m2.

VI = VLC/m, where VLC is vital lung capacity in ml; m is body mass in kg.
SI = (MF × 100%)/m, where MF is moment of force in kg; m is body mass in kg.

The percentage distribution of the VI and SI ranged on a 0-5 point scale. The higher the result the higher was the score on a straight proportional scale (Table 1).

In BMI evaluation the higher measurement does not necessarily indicate the better score as with SI and VI. According to our research, the values of VI and SI which are directly dependant on body mass displayed poor score in 95 % of people suffering from obesity. For example, a participating in research obese student (BMI > 30.8 kg/m2) receives 5 points for his BMI and 2 points for each VI and SI. The added amount equals to 9 points. Divided by 3, the score for the student's physical development equals to 3. Three points is generally a satisfactory score but it clearly does not reflect the true physical status of the person.

In the work16 the values of the mass - height indices were distributed on a sigmoid type of a scale. Based on this approach certain adjustments were made in our assessment. BMI in the range of 25 -75 % received a good or excellent score only in case when SI and VI corresponded to the same value. In the rest of the cases BMI was assessed as satisfactory regardless of the values of VI and SI. A satisfactory score was assigned to the BMI of 5-25%. In the range between 75 to 95%

it was estimated as bad. BMI was defined as very bad within the upper and lower 5%. (Figure 1).Thus, PD = (BMI + VI + SI)/3 = conventional unit.

Statistical processing and analysis of anthropometric data were carried out using a computer software package Microsoft Office Excel 2007. The average value «M» and its error «±m» (M ±m) were used in the table and in the text. The probability level of p ≤0, 05% was established to denote statistical significance.

Purpose of the Study

The study developed and tested the method for integral quantitative assessment of physical development of students based on the values of length, body mass, moment of force, and vital lung capacity further transformed into the inherent characteristics of BMI, SI and VI.

Results of the study

Table 2 presents the results of structural and functional studies performed on the students. According to the collected data the students' height and subcutaneous fat 20-30 years (2001-2011) later were significantly greater than that of the students in 1979. Body mass differences were not statistically significant with the exception of the students in 2001 and 2002. Most of the other anthropometric data from 2001-2011 was notably lower compared to the students in 1979. Quite distinct differences were observed in the data collected within 2001-2010 period. For example, the students participated in studies in 2001 and 2002 had substantially less subcutaneous fat than their peers in subsequent years. The VLC of the students in 2001 and 2011 was higher than that of their peers in 2006 and 2008.

The students in 2008 demonstrated higher values of moment of force than the students in 2001, 2002 and 2006. No distinct differences were observed in the dynamometric measurements of left and right hands through the years of the

survey. Thus, separate anthropometric measurements do not give a complete and objective picture of the dynamics and tendencies of physical development, especially when collected during long-term studies.

Figure 2 presents the inherent values of physical development of students. A distinct gradual decline is notable in BMI, MF, and VLC over the years. In addition, the indicators of reliability of BMI and SI values are inferior to a combined value of the indicators of physical development (fig. 2.1). The combined values of all the components of physical development carry higher reliability than the components taken separately.

The analysis of the data indicates that the physical status of the students of RNIMU named after N.I Pirogov in 1979 was better than in 2001, 2002, 2006, 2008, and 2011. In addition, the PD of students in 2010 was significantly lower compared to their peers not only in 1979 but in 2001, 2002; 2006, and 2008 as well ($p < 0.05$), (fig. 2.1). According to table 3 physical developments of students in 1979, 2001, and 2002 was estimated as satisfactory. However, it was significantly higher in students in 1979 (3.3 ± 0.12 conventional units) compared to their peers in 2001 and 2002 (-2.91 ± 0.03 conventional units), ($R < 0.01$). In 2006, 2007, 2008, 2009 and 2011 the students' PD was measured below average which corresponded to a bad score. The year of 2011 stands out as the year when the physical assessment scores were particularly low. The students with average rating of their PD in 1979 and 2001-2002 were 34% and 41.8% short from the highest score of 5. The students in 2006-2011 were short by 43.7-45.2%. The results of our research confirm the tendency of decline in PD of students.5,8

Discussion

PD is a complex of genetic and acquired morphological and functional anthropometric characteristics changing during the course of a person's life. The specialists of different fields

are in agreement on this part. However, the claim that PD of an individual determines the supply of his physical strength, fitness, endurance, and body capacity is not true. The studies of health and functional status of the students 9 did not find a correlation between PD and breath holding on inspiration, Robinson index, absolute and relative physical performance as determined by test PWC170 (Physical Working Capacity). Analyzed study of PD and physical preparedness of 3905 students of both sexes aged 17-22 showed different dynamics in their developments.7 For example, motor development is often seen in extreme variants (low and high). PD mostly prevails on average level. Consequently, it is argued that PD refers to the human potential, which under the right conditions can be realized in the ability to demonstrate a good physical fitness, strength, agility, and other physical qualities. The proposed method of integral assessment of human PD based on the inherent values of BMI, SI, and VI is a tool for adequately measuring the human physical potential. The value of PD obtained by this method is valid. Morphofuncional studies performed on more than 1492 students specializing in different kinds of physical training and sports, proved the practicality and reliability of the developed method for integral assessment of PD.

Conclusions

1. Separate anthropometric indicators do not give objective characteristic of PD.
2. Quantitative integral assessment of PD based on values of length, body mass, moment of force, and vital lung capacity converted into BMI, SI and VI best reflects the essence of PD (human physical potential).
3. The comparative assessment of PD of college students indicates the decline in PD of young men in 2011-2001 compared to the students in 1979.

Vital index (ml/kg body mass)	Strength indicex (% of body mass)		% distribution and the score
	Force dynamometer	Hand dynamometer	
>87	>226	>87	100-95% - (5)
87-74	226-201	87- 76	94-75% - (4)
73-57	200-150	75 - 60	74-25% -(3)
56-46	149-112	59 - 46	24-6% - (2)
<45	<112	<46	5- 0% - (1)

Table 1. The assessment characteristics of physical development of students (n = 530)
2001-2002 year

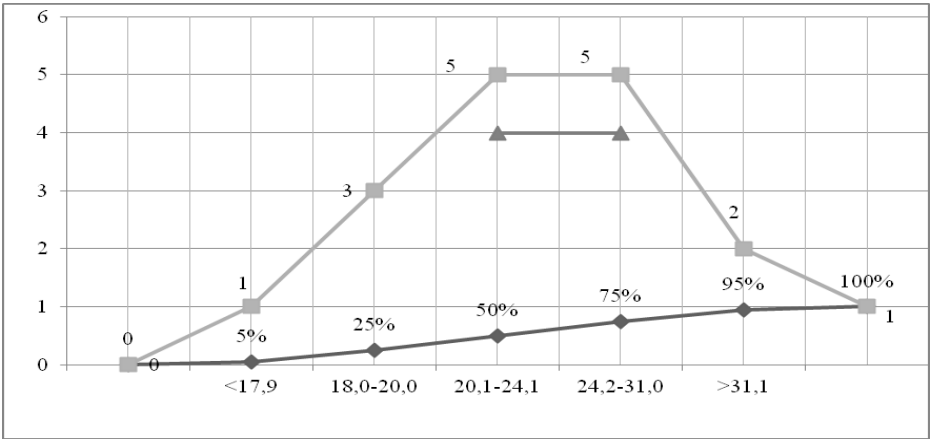

Figure 1. The assessment scale and the percentage distribution of the students' BMI
Horizontal axis (Axis X) - Body mass index ranges (kg/m2)
Vertical axis (Axis Y) - Points
Percent-♦
Score - □ ▲

Anthropometric characteristics	1979, n=153	2001,2002 n=530	2006 n=283	2008 n=284	2011 n=242
1. Body length, (cm).	174,4 ±0,8	178,4± 0,4*	177,1±0,4*	177,3± 0,6*	179,0 ±0,55 *
2. Body mass (kg).	73,8± 1,2	68,1±0,65*	72,1±0,9	70,6±1,0	77,6± 1,3
3. Subcutaneous fat (% of body weight).	14,2± 0,6	16,0±0,7*	18,2±0,37*	17,6±0,34*	18,3± 0,47*
4. Vital lung capacity, (l).	5,0±0,08	4,5±0,1 *	4,2±0-,04**	4,14±0,06**	4,62± 0,06*
5. Moment of force, (kg).	148,0 ±2,8	116,6± 1,4*	113,9±1,5*	122,0± 2,0***	118,5 ±4,1*
6. Right hand strength (kg).	53,5± 1,3	45,6±0,6*	40,3±0,4**	38,5±0,5**	44,3± 0,3*
7. The index of the right hand, (% of body weight).	74,5± 1,1	67,0±0,9*	57,3±0,7**	54,7±0,8**	57,2± 1,0**
8. Left hand strength (kg).	48,7± 1,3	41,9±0,4**	37,8±0,4**	34,6±0,45**	41,3± 0,82** *
9. Index of left hand (% of body weight)	63,4± 1,4	60,0±0,5*	53,6±0,6***	48,4±0,7***	53,1± 0,75** **

*compared to 1979: $p < 0.05$

** compared to 2011, 2001, 2002 : $p< 0.01$

*** compared to 2006, 2001, 2002 : $p<0.001$

Table 2 Model characteristics of physical development of students learning

in to 1979 and 2001- 2011.

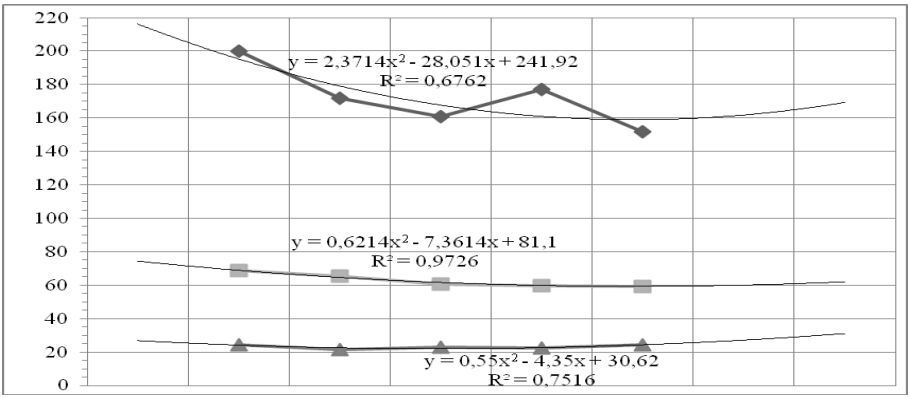

Figure 2. Model characteristics of physical development of students

Horizontal axis (Axis X) - Year 1979 2001 2006 2008 2011

Vertical axis (Axis Y) - Conventional units

Strength index (% of body masse) -

Vital index (ml/kg body masse) -

Body mass index (kg/m2) -

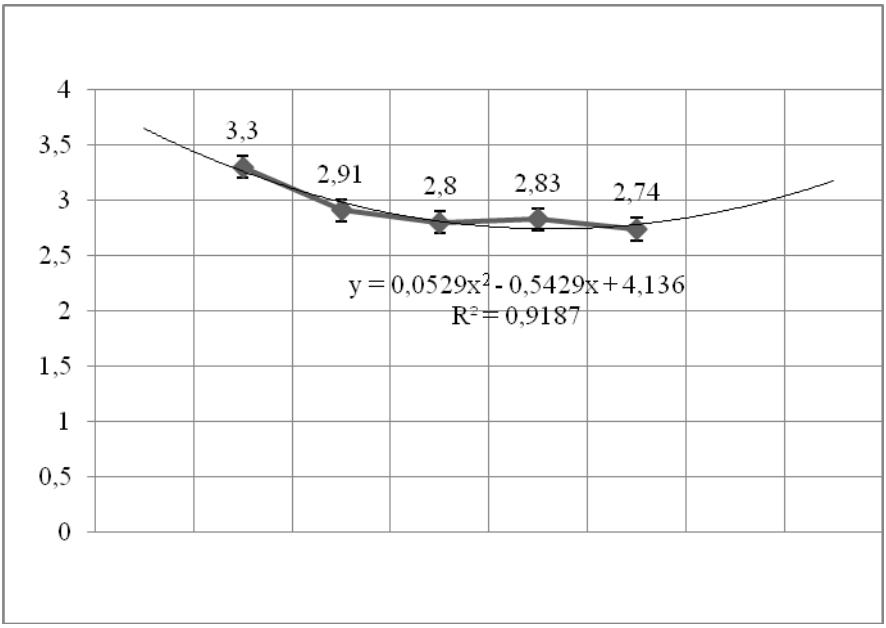

Figure 2.1. Physical development of students
Horizontal axis (Axis X) - Year 19792001 2006 2008 2011
Vertical axis (Axis Y) - Conventional units

Conventional units of PD	PD score
<2,5	1 point, very bad
2,51 - 2,83	2 points, bad
2,84 - 3,50	3 points, satisfactory
3,51 - 3,99	4 points, good
>4,00	5 points, excellent

Table 3. Physical development score of college students

Correlation of PD of male students with BMI (r = 0.61); VI (r = 0.67); SI (r = 0.72); SI of the strongest hand (r = 0.54)

Correlation of PD in female students with BMI (r = 0.62); VI (r = 0.69); SI (r = 0.69); SI of the strongest hand (r = 0.71). $P < 0.01$

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