PHYSIOLOGICAL CRITERIA OF THE EVALUATION OF SOMATIC HEALTH LEVEL

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Introduction. During the last years the active scientific discussion arises around the problem of the criteria of somatic health estimation [1–9, 11, 13]. The indices, which are necessary for determination of the norm limits for the optimum level of functioning of the cardiorespiratory system remain not enough investigated for today. There is a necessity of the detailed study of problem concerning the criteria of estimation of the physical health level and topic of its diagnostics methodology. Interest to the estimation of the level of somatic health is caused also by the necessity of adequate choice and intensity determination of physical exercises, which are used in the system of mass examinations of sportsmen and untrained persons fitness level. Except for that, diagnostics of the somatic health level is one of the most necessary parts in the complex process of health improvement and diseases prophylaxis. The purpose of current investigation is to analyse the present systems of estimation of the somatic health level and substantiate the integral indices of somatic health estimation on the basis of the level of aerobic capacity of organism.

Research methods. Analysis of literary sources, anthropometry, standard methods of the following indices determination: the main cardiorespiratory indices, physical capacity (PWC_{170}), maximal oxygen consumption, physiology reserves of organism [8, 10, 12, 15], some indices of lipid exchange.

Results of research and their discussion. During many historical stages of physiology and medicine development different determinations of "health" have been proposed. Among them is well-known determination of WHO: "Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" [5]. Kaznacheev V.P. complemented this determination: "Health of man is a process of maintainance and development of his psychical and physiology functions, optimum capacity and social activity at maximal life duration". A somatic (physical) health can be defined as the state at which the harmony of physiology processes, high level of self-regulation of functions, sufficient functional reserves and maximal adaptation to the different factors of environment are shown [11]. A lot

of other determinations of "health" can be found in literature sources. However, that variety of determinations is caused by the variability of different authors approaches to description of that term and insufficient objectivity of methods of somatic health evaluation.

For today the widespread, particularly in the medical literature, is interpretation of health as the conformity to some "norms" (standards), ideal variants – the normal temperature of body, normal level of sugar in blood, normal amount of red blood cells and hemoglobin, normal arterial blood pressure, normal EKG, etc. But we should assume that the more methods of measurings and determinations of different physiological indices we use, the more of these statistical norms of health arises. Besides, the mean values of "norm" depends on many factors (age, sex, way of life, geographical group and other) and does not represent ability of the organism to resist the influence of external factors (the different environmental factors, physical loadings, diseases, etc).

Considering this, we should analyze the term of "health" not in statics, but in a dynamics, in close relationship with adaptation potential of organism and level of its functional reserves.

An estimation of health level must be the subject of wide scientific research in physiology and medicine. There are many of different approaches to the estimation of the health level: anthropometric, physiological, biochemical and others

The anthropometric approaches are often used for the estimation of the somatic (physical) health level, particularly those, based on the normalization of body weight and composition, posture estimation, and others. There are no doubts that body weight normalization is important for the maintenance of health [2, 3, 6, 9]. An overweight creates favourable conditions for a decrease in health level and increase the risk of some diseases origin (diabetes, atherosclerosis, high blood pressure, etc.). The overweight was included into the list of main health risk factors by the UNO in 2000. An overweight is always a disbalance between the expenses of energy and caloric value of the meal.

There are a lot of methods for determination of ideal body weight. One of them is the determination of weight-height indices. Very popular for today around the world is the method of calculation of body mass index (BMI), proposed by the Belgian mathematician Lambert Adolphe Jacques Quatelet. The body mass index is calculated as body weight in kilograms divided by height in meters squared. From data of WHO the physiological norms of BMI are within the limits of 20.0-24.9 kg/m^2. The values of index from 25.0 to 29.9 specify the light overweight, from 30.0 to 40.0 – the serious overweight and large risk for the health. In this case overweight can cause also the special hormonal pathology – the syndrome of insensitivity to leptine. It is discovered [14] that there is very effective hormonal control of level of fat metabolism. Adipose tissue, which consists with adipocytes, has the endocrine function. Leptin (greec *leptos* – thin) is manufactured primarily in the adipocytes of white adipose tissue, its level is directly proportional to the total amount of fat in the body. At obesity the leptin level in blood grows to 50–200 ng/ml (normal level – 4–15 ng/ml).

The health risk from overweight arises as a result of additional loadings on the separate systems and some pathological changes (increase risk of the osteoporosis, high blood pressure, increasing blood content of triglycerides and cholesterol, violation of carbohydrate and fat exchange, diabetes type 2 and other).

The physiological approaches to the estimation of health level should be complex with the obligatory examination of the physical working capacity (PWC), aerobic energy production potential, functional state of the cardiorespiratory system (CRS), reserves of the main systems of organism, the immune system condition. The objective estimation of health level must be quantitative.

In previous works Yaremko E.O. [11] has proposed the model of health level estimation, based on anthropometric information, indices of peripheral blood, cardiohemodynamics and spirometric indices, description of the condition of the immune system with determination of immunoproteins IgA and IgG level in blood. A method requires the complex clinical and physiological research, which limits its wide implementation in sport and mass medical examinations.

The simple method of health estimation, based on conception of physical (somatic) health with the use of easily determined indices, was elaborated by Apanasenko G.L. [2, 3]. The quantitative estimation is based on the indices, calculated from heigh, body mass, muscle strength, heart rate, and maximal arterial pressure. This approach is very close to the "normative" one, that slightly reduces its theoretical value.

The physiological approaches to the evaluation of health level should be based on the CRS indices and aerobic capacity (productivity). The basic factors, which determine the aerobic capacity are the oxygen-transport system (depends on heart contractility), velocity of O_2 utilization in muscles, activity of oxidative enzymes. The level of maximal oxygen uptake (VO_2max) depends on the functional state of CRS. Therefore the biological essence of health is characterized by the indices of the aerobic capacity, which is

physiology basis of PWC, endurance, physical health, and is determined by the functional reserves of CRS.

The well-trained persons has of VO_2 at a 12-minute test within the limits of 43,6–51,6 ml/kg/min, untrained – only 25,0–33,0 ml/kg/min. The accordance between the level of VO_2max and risk of ischemic heart desease (IHD), especially the content of cholesterol and high density lipoproteids (HDL) is discovered (table 1).

Table 1 – Health level and blood cholesterol ratio (K.H.Cooper, 1987)

Physical health level	Blood cholesterol/HDL ratio	
	men	women
very bad	6.1	4.0
bad	5.7	3.9
satisfactory	5.1	3.9
good	4.9	3.3
excellent	4.3	3.2

The data in table 1 testifies that the cholesterol ratio must not exceed 4.3-4.9 for men and 3.2-3.3 for women. The lipoproteids are the main factors in atherosclerosis development. The higher level HDL decreases the risk of pathological process and vice versa. The "safe" level of HDL is 45 mg % for men and 55 mg % for women (1.45-2.2 mmoles/l).

Only the persons with the high level of PWC and aerobic capacities have "safe" level of somatic health. The decrease of PWC or VO_2max is accompanied with the reduction of functional reserves to the near pathological level. We mark the close connection of somatic (physical) health level with the level of VO_2max and reserves of organism. The experimental results, which supports this, are given in a table 2.

The experimental data substantiate the optimal (threshold) levels of VO_2max and PWC_{170} for men (accordingly – 40,0 ml/kg/min and 30,0 ml/kg/min) and women (30,6 ml/kg/min and 25,0 ml/kg/min) which provide a "safe" physical health level.

Table 2 – An estimation of health level from the VO_2max and basic indices of the functional state of organism (persons of 20-24 years age)

Level of health	VO_2max (ml/kg/min)	PWC_{170} (kGm/kg/min)	Cardiac output(l/min)	Functional reserves
Men				
low	< 30	12.2-16.0	8-11	< 2
satisfactory	30.5-40.0	16.1-20.3	12-15	3-4
good	40.1-50.0	20.4-21.4	16-20	4-5
excellent	> 50	> 21.4	> 20	> 5
Women				
low	< 25.0	9.8-12.2	7-10	< 2
satisfactory	25.1-30.5	12.9-15.1	11-14	3
good	30.6-46.0	15.2- 19.1	15-18	4-4.5
excellent	> 46.0	> 19.1	> 18	> 4.5

The higher values of aerobic capacity (table 3) have been found for the athletes (runners).

Table 3 – Mean VO_2max and PWC_{170} levels for the untrained persons and athletes (runners, rated sportsmen) of different age

Running distances	14-16 years		18-22 years	
	VO_2max (ml/kg/min)	PWC_{170} (kGm/kg/min)	VO_2max (ml/kg/min)	PWC_{170} (kGm/kg/min)
sprint	68.3 ± 0.4	1100 ± 47	61.8 ± 0.2	1290 ± 71
middle	76.1± 14.2	1510 ± 41	70.4 ± 18.1	1760 ± 14
long	78.4 ± 6.2	1590 ± 27	80.6 ± 9.4	1810 ± 46
untrained	46.1 ± 2.8	900 ± 36	49.4 ± 9.1	1050 ± 40

Consequently, we have found the close relationship between the health level, PWC and aerobic capacity of organism. The high level of functional reserves of CRS has been found for the persons with VO_2max more than 45 ml/kg/min and even higher level – for the athletes-runners.

The factors of IHD risk are formed only in the case of aerobic capacity lowering to the certain threshold. The lowering of the functional state is accompanied with progressive growth of diseases and weakening of reserves to the dangerous level.

The comparative analysis of publications [2, 3, 5-9, 8, 10, 15] testifies some uncoincidence in the estimation of health by different authors. Reasons of this may be the use of different approaches for PWC testing, testing of persons with different qualification, fitness level etc.

Our results testify that health level must be calculated on the basis of functional reserves of CRS, level of PWC and aerobic capacity (VO_2max). The aerobic capacity is related to the anthropometric and physiological indices of organism, with the correlation coefficient in the range of $0,70 < r < 0,84$.

Obviously, the VO_2max appears to be the main criterion of somatic (physical) health. The conception of aerobic capacity application as the indicator of functional reserves and health level is in the good agreement with the biological essence of health.

Consequently, the VO_2max level can be considered the main physiologic criterion of person health, as the quantitative estimation of health level. The VO_2max level is determined by the functional state of the oxygen-transport system, which includes the respiratory system, blood and cardiovascular systems. Any disorders of these systems can negatively affect the VO_2max and decrease the health level. That is why the VO_2max inclusion into the integral system of health evaluation increases probability of objective diagnostics of health level.

Close connection of VO_2max level and factors of IHD risk has been established. The higher level of aerobic capacity – the better are indices of body mass, arterial pressure and cholesterol ratio. Thus, the decline of aerobic capacity to the certain critical level is accompanied by the considerable growth of IHD risk.

Quantitative approach, based on VO_2max determination appears to be very perspective not only for the estimation of the health level, but also for complex control of physical fitness.

Conclusions. The level of somatic (physical) health is determined by the level of aerobic capacity (VO_2max). The VO_2max level is considered to be not only the greatest level of transport and consumption of O_2, but the integral index of health level and functional capacity of cardiorespiratory system. The VO_2max provides physiology basis of physical working capacity and functional reserves of organism.

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