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Mathematical Modeling of Somatic Health Scales

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Abstract

A main purpose of the work is to develop ways for increasing of scale accuracy for estimation of the physical health level, which are used in physical culture basing on of physical fitness example. Errors during quick evaluation of the physical human health are determined. The dependences of the errors in calculations of estimation parameters of the physical health have been obtained. A model of the approximation of the scale of evaluation of the level of physical fitness by analytical are determined. It has been shown that interpolation of the scales of the test battery from which a summary estimation is added, makes possible to decrease in four-six times of upper boundary of its error.

Keywords: *Physical Health, Fitness, Scale, Estimation, Accuracy, Error.*

INTRODUCTION

Development of Physical and Health programs for different groups of peoples is a very important problem for the sports sciences. Consequently, accuracy of methods for estimation of the somatic health level is an actual problem of medicine and fitness specialists. High quality of the mathematical and metrology background should be an obligatory component of a complex system for the accuracy of testing and evaluation [1-3].

The purpose of the study was to develop ways of increasing of the accuracy of the scales of estimation, which are used in the physical culture based on the example of the scale of the level of the physical health. Tasks and study: to determine errors in the quick evaluation of the level of physical human health (1); to obtain a dependences of errors in the calculation of parameters of the quick evaluation of the level of physical health (2); to develop a model of approximation for the scale of the evaluationof the level of physical health by analytic functions (3); to determine errors in the analytic model of the physical level of the human health (4).

METHODS

For determining of evaluation of test results in the middle of interval interpolation methods The expansion of the scale rang of estimation was carried out by the method of extrapolation. The coefficients of equation of the cubic parabola as functions of the scale of estimation it was determined by the method of solution of a system of four linear algebraic equations by Cramer method. The approximation of function by quadratic parabola it is carried out by the method of least squares. Calculations were carried out in the system of computer mathematics MS Excel and Mathematica [4-6].

RESULTS AND DISCUSSION

A health-improvement effect of training by physical exercises [7] is controlled with the aid of determination of physical state [11,15], physical development [10], physical fitness [16], physical training [12], a level of physical health [7], and adaptive potential of organism [8]. One of two methods is used in accordance with technology of the removal of estimation in these methods. The first method provides for obtaining general estimation in the points from mathematical formula, in which substitute the results of testing, anthropometric data, age, and so on [15]. The second method provides for test determination of estimation according to the parameters (by results of testing, by anthropometric data or by relationships between them), and then calculation of summary estimations [9,11].

With the first method, the accuracy of estimation depends on the accuracy of the parameters, i.e. the results of measurements. With the second method it is a source of an inaccuracy in the evaluation can be the process in the transvers of estimation, i.e. strictly the scale of estimation. For example, in accordance with the method [3], the step by which evaluation results are equal to 1, 2 or 3 points (Table 1).

Relative error composes half from the step, i.e, 0.5, 1.0, or 1.5 points. General estimation in the points is defined as a bag of five estimations, each of which is calculated by the results of the specific test and separate table of estimations. An error in the summary estimation of the battery of five tests from 3.0 to4.5 points (Table 2). The effect equal to three inside intervals of estimation (below average, average and above average): from 3.0 to 4.0 (see Table 1). Errors of measurements and calculations of very indices are considerably less than of errors in the estimations, since the value the value of the latter is bounded below by a quantity of intervals. For example, one of the indices (recovery time

of a pulse after twenty squatting in 30 s) is evaluated by the step of 2 or 3 points with a difference of recovery time of pules in 30 or 60 seconds. Since the pulse is measured for 10 seconds, a minimum steps with which it equal to 60/10=to 6 second. Consequently, to derive the approximate estimation is possible with step 6x2/30=0.4 points, i.e., 5 – 10 times it is less than over (see Table 1). Respectively smaller there will beerrorsin the estimations: 0.15 – 0.20 points. Taking this data into consideration it is possible to expect that lower boundaries of arrows in the estimation of the remained four tests will be also substantially less than those, which are placed in the tabular scale.

Table 1. A scale for estimation of a somatic health level

i.Test, units (mark)	sex	Parameter`s level				
		low	below average	average	above average	high
1.Body mass index, kg/m^2 (point)	M* F* M, F	< = 18.9 < = 16.9 -2	19.0÷20.0 17.0÷18.6 -1	20.1÷25.0 18.7÷23.8 0	25.1÷28.0 23.9÷26.0 1	>28.0 >26.0 2
2.Vital index, ml/kg (point)	M F M, F	< = 50 < = 40 -1	51÷55 41÷55 0	56÷60 45÷60 1	61÷65 51÷56 2	>65 >56 3
3.Force index, % (point)	M F M, F	< = 60 < = 40 -1	61÷65 41÷50 0	66÷70 51÷55 1	71÷80 56÷60 2	>80 >60 3
4.Robinson index, dm mer. col/min (point)	M, F	> = 111 -2	110÷95 -1	94÷85 0	84÷70 3	<70 5
5.Pulse restoration (s) (point)	M, F	> = 180 -2	179÷120 -1	119÷90 3	89÷60 5	<60 7
Sum mark (point)	M, F	< = 3	4÷6	7÷11	12÷15	16÷18

*M – Male; F – Female.

A decrease of the steps of the intervals of the scale must be accompanied by determination of the corresponding boundary values of indices and estimations of these narrowed intervals, i.e., by interpolation of the scale [17,18].

Table 2. Errors of scales of estimation

Test (*i*)	Parameter		Points (see Table 1)		Marks
	min	max	min	max	max
1	0.12	0.20	0.50	0.50	0.18
2	0.31	0.56	0.50	0.50	0.11
3	0.09	0.18	0.50	0.50	0.04
4	0.85	1.08	0.50	1.50	0.21
5	3.00		1.00	1.50	0.22
Sum	-		3.00	4.50	0.76

Errors in the quick evaluation of the level of physical human health have been determined. A dependence of the errors in the calculation of parameters estimations of the level of physical health was obtained. Models of the appropriation of the scale in the evaluation of the level of physical health by analytic functions were developed. Errors in the analytical model of the estimation of the level of the physical human health are determined. It was shown that interpolation of the scales of a battery of the tests, from which a summary estimation should be added, makes it possible to decrease in four-six times an upper boundary of its error [19-21].

CONCLUSION

An error in the known system of the express-estimation of physical human health is from 3.0 to 4.5 points which in effect equal to the values of three interval ranges of estimations (below average, average, and above average), i.e., from 3.0 to 4.0 points. Interpolation of the scales of battery, of which consists summary estimations, makes it possible in four-six times to decrease the boundary of this error.

Directions of further: because the approach to the increase in the accuracy of the estimation of the level of physical health proposed gave positive results, the following step of studies will be interpolation and extrapolation of the scales of estimations of the physical state, physical development, physical fitness for work, physical preparation, and adapted potential of organism.

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