Integral assessment of the level of preparedness of kissboxers based on the harrington-mencher function

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Abstract

Objective of the study was to reveal the mechanism for identifying a generalized assessment of the level of preparedness of kickboxers.

Methods and structure of the study. The application of the Harrington-Mencher desirability function to determine the level of preparedness of kickboxers is presented. The work of the desirability function is that it converts dimensional indicators into dimensionless ones, in fact, generalizes diverse indicators, bringing them to a single complex indicator.

Results and conclusions. The technique of an integral assessment of the level of preparedness of a kickboxer using the Harrington-Mencher function is given. A specific example shows the mechanism for converting actual indicators into a 10-point scale, and then into desirability coefficients. Thanks to a special system for translating desirability indicators into the usual rating scale, it is possible to obtain a complex indicator at the output that objectively evaluates their total set. Weight indicators of the significance of the preparedness of kickboxers were determined on the basis of expert assessments, which included reputable kickboxing coaches and referees.

Keywords: *Harrington-Mencher desirability function, integrative indicator, kickboxer's level of preparedness, defining indicators of preparedness.*

Introduction. As you know, the level of sports readiness is an indicator of sports and technical skills of an athlete. It is by comparing the values of the indicators of the properties of the athlete being evaluated with his previous indicators or with analogue samples that it is possible to determine whether there is an improvement in the training dynamics, or, accordingly, whether this athlete can be included in the team for competitions or high-level tournaments. Indicators of sports readiness related to the totality of its properties, according to which a coaching decision is made, are called defining indicators. But a set of less significant indicators sometimes makes such a significant contribution to the overall picture of the preparedness assessment that one has to resort to the definition of a complex (integrated) indicator.

There are many classifications of sports fitness, among which the main ones are those groupings of properties and operating factors that show the functional (physiological - medical, anthropometric, biomechanical, etc.) capabilities of an athlete. But sometimes, having their high level, the athlete does not achieve the desired results, so it is necessary to take into account reliability indicators, as well as psychological, pedagogical and even social indicators. But these and many other indicators, as a rule, are expressed in different measuring scales, have a different order of numerical expression and different units of measurement. Therefore, decision makers have a problem with the generalization of indicators and the objective finding of an integrative overall indicator.

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Methods and structure of the study. There are many mathematical methods for integrating numer-

ous factors and causes that can generalize various indicators and, in this way, all of them can be reduced to a single integrative expression [9, 10].

American scientist E.S. Harrington [7, p. 37–41; 8] managed to translate the parameters, different in their essence and dimension, into a single dimensionless evaluation scale. For this, a separate evaluation indicator d (from the French desirable - "desirable", "preferred") is translated into a dimensionless scale from 0 to 1, moreover, the value di=0 corresponds to an absolutely unacceptable level of this property of the indicator, and the value di=1 - to the most the best value of this property, where i = 1, 2, 3, 4, 5, ..., n; where n is the number of such indicators.

The desirability evaluation indicator is considered as a specific reliability or unreliability of the i-th indicator (that is, its best or worst value in this scale).

The desirability function corresponding to the acceptable/unacceptable level for a one-sided restriction is described by the formula:

$$d = e^{-e^{x^*}}, \quad (1)$$

for a two-sided restriction - by another formula [5, pp. 24-30]:

$$d = e^{-e^{|x|^*}}, \quad (2)$$

where x^* – the encoded value of a specific parameter x, that is, its value in the conditional scale (scale) of the measurement.

When all specific parameters (x) are listed in "their desirability" (d), a generalized assessment parameter is calculated, which E.S. Harrington called the generalized *desirability function D*. It is determined through the geometric mean of specific desirability, that is, according to the formula [8]:

$$D = \sqrt[n]{d_1 \cdot d_1 \cdot d_1 \cdot \ldots \cdot d_i \cdot \ldots d_n}. \quad (3)$$

In our case, the function D acts as an integral indicator, that is, it takes into account all internal parameters and, therefore, generalizes them as a complex value.

But for the practical use of this formula as a single generalized indicator, this function had a drawback, which is that all internal indicators used in it are considered only equilibrium, and in real life, experimenters often have to deal with parameters that have different weights (significance).

A way out of this situation was found by E.M. Mencher [4, p. 7-12], who proposed to correct the formula of E.S. Harrington, taking into account the indicated shortcoming. To do this, he introduced *an indicator of weight*. This desirability function began to be called by a double name: *the Harrington-Mencher formula* [1,6]:

$$D = \sqrt[\sum_{i=1}^{n} V_i]{d_1^{V_1} \cdot d_2^{V_2} \cdot d_3^{V_3} \cdot \ldots \cdot d_i^{V_i} \cdot \ldots \cdot d_n^{V_n}}, \quad (4)$$

where di are dimensionless desirability parameters; Vi is their weight (significance); n is their number; i - 1, 2, 3, ..., n.

When determining the value of the weight (Vi), the most important indicator is assigned a value of 1, a little less important - 0.9, and so on in descending order, with a gradation step no more than 0.1, that is, in descending order: 1.0; 0.9; 0.8; 0.7; 0.6; 0.5; 0.4; 0.3; 0.2; 0.1.

To determine the final integral (generalized) indicator of desirability, a recalculation table is used, usually it looks like this (for five gradations) (Table 1).

Table 1. *Table for converting desirability indicators into the usual rating scale*

Result	Value D
Fine	1,00 – 0,80
Good	0,80 – 0,63
Satisfactorily	0,63 – 0,37
Badly	0,37 – 0,20
Very bad	0,20 – 0,00

Results of the study and their discussion. As indicators of the sports readiness of kickboxers, the defining indicators for different classification categories were selected.

From the section of functional fitness, from its subgroup of physical fitness, the following indicators were selected: speed, strength qualities, as well as the level of development of flexibility, endurance, coordination of complex movements, mobility in the joints, flexibility of the kickboxer. From the subgroup of technical readiness: an indicator of the versatility of motor actions, an indicator of implementation efficiency, an indicator of noise immunity. From the subgroup of psychometric preparedness: threshold of sensitivity in various modalities, features of perception of spatial relationships, the pace of mental processes under the influence of interference, features of attention in combat with a forced pace and with a lack of time. From the section of sports reliability, the following were selected: the effective-

Table 2. *Table of conversion of actual indicators to a 10-point scale, and then to desirability coefficients*

Designation, Vi	The name of the indicator, unit	Quantitative expression of the indicator	The value of the assessment by i-indicator, in a 10-point scale, u_i	Desirability ratio, d_i
V_1	Motor coordination, number / s	7,8/(0,31)	9,34	0,9274
V_2	Muscular endurance, right/(left hand) kg	52,5/(48,6)	7,08	0,6788
V_3	Simple visual-motor reaction (SVMR), ms	263,4	8,34	0,8174
V_4	Choice reaction (CR), ms	363,6	9,20	0,912
V_5	Concentration of attention, c. unit	1,04	8,17	0,7987
V_6	Switching attention, points	31,5	6,56	0,6216
V_7	Side impacts with the left and right foot for 30 s, quantity	78,5	8,95	0,8845
V_8	Frontal kicks with the left and right foot in 30 s, quantity	59,3	7,85	0,7635
V_9	Punches (P)	47,1	8,98	0,8878
V_{10}	Kicks (K)	18,2	6,24	0,5864
V_{11}	Number of attacking strikes	25,0	7,10	0,681
V_{12}	Number of retaliatory strikes	21,2	6,91	0,6601

Table 3. *Values of expert weights of indicators of the level of athletic fitness of a kickboxer*

	V_1	V_2	V_3	V_4	V_5	V_6	V_7	V_8	V_9	V_{10}	V_{11}	V_{12}
V_i	0,7	0,5	0,6	0,7	0,4	0,4	0,8	0,7	1,0	1,0	0,9	0,8

ness of the athlete's actions, the stability of preparedness in extreme conditions. From the section of psychophysiology and psychomotor: the degree of motivation, the will to win.

It should be noted that the selected indicators are not comprehensive, a large number of other indicators remain behind the scenes, but due to their cumbersomeness, we will leave only the 12 most significant indicators (Table 2).

The desirability functions described by Harrington have sigmoidal forms (see formulas 1 and 2). The mechanism for converting dimensional indicators into dimensionless ones, taking into account the linear dependence, is described in many works [2; 3, p. 128; 5]. As the simplest solution, we will take the formula for calculating the desirability coefficients: $di = 0.11 \times ui - 0.10$, where $0.01 < di < 1$. For substitution, values are taken from previously reduced values to a 10-point scale *ui*. For example, for the "Motor coordination" indicator, the value of the desirability coefficient is obtained: $d1 = 0.1 \times 9.34 - 0.10 = 0.9274$ (see Table 2, first line).

Weight indicators of the importance of indicators of sports readiness of kickboxers were determined with the help of experts, which included authoritative coaches and referees in cocktail boxing (10 people). Together, they adopted the following values of weights for 12 indicators of the preparedness of athletes (Table 3).

According to formula (4), the generalized desirability function D was calculated:

$$D = \sqrt[8.5]{0{,}927^{0.7} \cdot 0{,}679^{0.5} \cdot 0{,}817^{0.6} \cdot 0{,}912^{0.7} \cdot 0{,}799^{0.4} \cdot 0{,}622^{0.4} \cdot 0{,}885^{0.8} \cdot 0{,}764^{0.7} \cdot 0{,}888^{1.0} \cdot 0{,}586^{1.0} \cdot 0{,}681^{0.9} \cdot 0{,}660^{0.8}}$$

The value D = 0.760 is interpreted according to Table 1 as "good".

So, the integrative indicator of the kickboxer's sports readiness for our case is interpreted as "above average".

Conclusions. The application of the generalized Harrington-Mencher function as a complex indicator of the preparedness of a kickboxer according to diverse indicators is considered. The technique for identifying a generalized assessment of the level of preparedness of athletes makes it possible to evalu-

ate the internal consistency of the answers of experts, it makes it possible to verify the correctness of their conclusions by calculating the coefficient of concordance and the correspondence of the ranking to the natural laws of nature. If we add to the integrative indicator such indicators as the athlete's productivity, as well as the value of statistical sensitivity to the indicators used, it becomes clear that it can be used as a criterion for optimizing sports preparedness.

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