МОДЕЛИРОВАНИЕ И АНАЛИЗ СЛОЖНЫХ ТЕХНИЧЕСКИХ СИСТЕМ

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METHOD OF ESTIMATION AND SELECTION OF INFORMATIVE INDICATORS, FOR DETERMINING THE LEVEL OF READINESS OF SPORTSMEN

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Existing approaches in assessing the level of athletic readiness of athletes have shown that various sports organizations use different methods and means. They allow to explore different aspects of athletes' preparedness.

Using different groups of heterogeneous data, it is possible to obtain sufficiently accurate estimates of the level of readiness of athletes for the competition. The more information is used, the more the evaluation process is tightened, which significantly hampers practical sports work.

One of the urgent problems is the choice and development of methods for assessing the informative of the indicators used in conditions of uncertainty.

Based on the research, several groups of indicators can be identified, used to assess the degree of preparedness and quality of training athletes. Of these, the most used are groups of indicators to analyze the features of their structure, which affects the choice of adequate methods for assessing information.

In technical-aesthetic sports, the quality of performing skills is assessed by three groups of characteristics, defined on qualitative scales: generalized, group and single characteristics.

Often, according to physiological studies, indicators are calculated that are related to the degree of readiness of athletes, their level of fitness and health status.

Functional methods of research in sports are focused mainly on assessing the functional state and functional reserve of the body. The basis of these methods is the study of the reaction (most often physiological indicators) of the body to any dosed effect (functional tests).

The functional state (FS) is investigated with respect to specific organs, systems and the organism as a whole. FS in sports is assessed by such qualitative categories as optimal performance, fatigue, monotony, physiological stress, psychological stress, psycho emotional stress, extreme state.

The functional reserve (FR) is considered as a component of the wider concept of an adaptation reserve. The functional reserve in sports is considered as a hidden opportunity to realize unusually large work, which is studied at the biochemical, physiological and psychological levels.

An analysis of the indicators used to comprehensively assess the level of athletic readiness shows that even within one data block, information can be represented by different types and scales of characteristics, and most blocks are described at the level of qualitative indistinctly defined scales. Such a situation does not allow us to use the traditional statistical methods of evaluating information in a complex approach.

To analyze and process various types of poorly formalized scales, including quantitative scales, a theory of latent variable measurement was developed, the effectiveness of which was proved in medicine, psychology, economics and pedagogy [1, 2].

In the theory of changing latent (hidden) variables, the mechanism for estimating the informative of the indicator variables used is used, but the use of this theory is limited by the fact that the structure of the initial data must satisfy the mathematical model used, in particular G. Rash's logistic model, and the amount of data collected for analysis must satisfy the corresponding statistical criteria [1, 3].

Less strict restrictions to the data structure are presented by the method of group accounting of arguments (MGAA) [2]. But this method has a less developed evidentiary mechanism for assessing the degree of confidence in the informative value of the analyzed indicators.

Taking into account the merits and demerits of both methods, it is proposed to combine these two approaches, adding to them an expert component for solving the problem of assessing the informative value of the indicators used to assess the level of sports readiness of athletes.

With this approach, a method for evaluating and selecting informative indicators characterizing the level of sports readiness of athletes is proposed, consisting in the following sequence of actions:

1. Qualimetry defines requirements for which an expert group is formed.

2. At the expert level, a list of the groups of indicators used to assess athletic preparedness and forecasting of athletes is determined. For each of the selected groups, a list of characteristics is drawn up that can potentially be used and actually identified in the current constraints.

3. In the theory of measuring latent variables with G.Rash's model, a block of data is formed on the quantitative K_i scales, from the signs determined on the initial generally accepted scales.

For the transition from the quantitative values of the informative characteristics $X_i=(i=1,2,3,\dots,n)$ to the quantitative normalized scales $K_i(i=1,2,3,\dots,n)$ is carried out according to the formula:

$$K_i = \begin{cases} int\frac{(X_i - X_{i,min})}{R_i}, at\ X_i \leq X_{i,max} \\ m-1, at\ X_i = X_{i\,max} \end{cases} \quad (1)$$

where X_i is the current natural value of the i-th indicator; $X_{i,\,min}$ - the smallest value of the i-th indicator; $X_{i,\,max}$ - the largest value of the i-th indicator; *int (m)* is the integer part of m; m - the basis of the qualitative scale (m = *2,3, ...*), selected in accordance with the recommendations [3].

4. Depending on the type of problem being solved, latency variables are chosen to be the level of athletic preparedness, confidence in the forecast associated with sports activities.

As indicator variables, the original characteristics, translated into K_i scales, are used. Latent variables are associated with the indicator variables of G.Rash's model. The graphs of functions are called characteristic curves of indicators, and the variables used in G.Rash's model are defined as logits.

5. If for each indicator variable, with confidence, a decision is made that all the selected source indicators are compatible with each other and define the same latent variable, otherwise the next item is executed.

6. Each of the indicator variables X_i is assigned a calculated significance level. Indicator variables are corrected or excluded from the list of informative features. After the exclusion of indicator variables, a space of informative features is formed that describes the latent variables under study from the point of view of the axiomatic of the theory of measurement of latent variables.

7. The above procedures are repeated until all the indicator variables satisfy the critical value of the level of compliance of the indicator variable of the latent variable being measured.

8. At the final stage of selecting a list of informative features, a control check is performed using the graphs of the correspondence between the level of the integral indicator of the latent variable and the significance of the informative indicators (indicators).

If the average significance of informative characteristics does not differ from the average level of the integral indicator by more than 0.5 logit, then the conclusion is made that the system of informative signs (indicators) corresponds to the measured latent variable and the set of informative indicators used is effective for the purposes measurements of the generalized latent variable, and in addition to assessing the informative, it is expedient to use the obtained models for the synthesis of prognostic and diagnostic decision rules .

9. If the average significance of informative characteristics differs from the average level of the integral reading by more than 0.5 logit, the L_i index decreases proportionally to the difference logit in accordance with the formula

$$L_i = L_{i0} \cdot \alpha, \quad (2)$$

where L_{i0} is the value of the significance level; α-weighting factor, determined by experts based on their level of confidence in G.Rash's model, taking into account the difference.

Under the conditions of paragraph 9, G.Rash's models should be used in the synthesis of prognostic and diagnostic decision rules, with caution, checking their effectiveness on control samples.

10. In the space of initial characteristics X_i, using the MGAA algorithms, the equations of the relationship of these characteristics with the objective functions Z are constructed, which in this paper are defined as: the level of athletic readiness; confidence in the prognosis of the disease ω_l; presence of an early stage of the disease ω_l. The initial features are included in the type

$$Z_{k\ell}=F_{\ell}(X_{jk\ell}, A_{jk\ell}), \quad (3)$$

where $Z_{k\ell}$ is the objective function with respect to the group of attributes k of class ω_l; $X_{jk\ell}$ is a vector of attributes with the number j of group k of class ω_l; $A_{jk\ell}$ is a vector of configurable parameters with the number j of group k of class ω_l.

The $X_{jk\ell}$ attributes included in type 3 expressions are considered informative.

11. At the expert level, the informative value m_i of each of the characteristics X_i is determined taking into account the values of the coefficients $a_i \in A_{jk\ell}$ in linear models and degrees in nonlinear models.

12. The obtained values of L_i and m_i by normalization are reduced to unified measurement scales, for example, using expressions

$$IL_i = \frac{L_{\max i}-L_l}{L_{\max i}-L_{\min i}}; \quad Im_j = \frac{m_{\max\, i}-m_i}{m_{\max\, i}-m_{\min\, i}} \quad (4)$$

If the experts are ready to assess the informative character of the characteristics without using additional mathematical models on the chosen scale, for example, using the Delphi technology, the expert informative character of the I_e signs is determined.

13. Taking into account the adequacy of the selected models to the tasks being solved and the experts' confidence in their decisions, weighting coefficients are assigned for each of the methods for assessing the informative of A_L, A_m, A_e, and for each of the informative features, its integral informative value

$$I_i = \frac{A_L * IL_i + A_m * I_{mi} + A_e * I_e}{3} \quad (5)$$

For different objective functions, the values of informativity for the same characteristics can vary significantly. Indicators I_i reflect the contribution of the informative attribute to the examined assessment of the athlete's condition and are the basis for its inclusion in the appropriate decision-making models.

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