Training Process Modeling of Hammer Throwers Taking into Account Peculiarities of Stress Adaptation

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Abstract: The article considers the solution of the forecast problem to improve the efficiency of the training process of hammer throwers taking into account the peculiarities of their adaptation to the load. This problem was solved by computer modelling. To solve this problem, restrictions were set on the control and managed parameters. The number of parameters that were entered into the model was determined by the methods of expert assessments. These parameters were adjusted in the process of modelling the dynamics of the training system in time on a personal computer. Basing on the results of forecasting it was revealed that taking account the peculiarities of stress adaptation in hammer throwers training led to doubled number of sportsmen's who fulfilled the qualification norm successfully.

1 INTRODUCTION

At present the problem of increased efficiency of the training process in hammer throwers is very urgent (Bolotin et al., 2017). For this purpose, computer modeling is widely used. The development of such a model is intended for solving the problem of training process prognostication in hammer throwers taking into account their stress adaptation (Bolotin et al., 2014; Hopkinset al., 2009). Practice has shown that the organizational and pedagogic management of the training process in hammer throwers becomes a classical task in the management theory (Bartonietz et al., 1997; Bartonietz et al., 1988; Murofushi et al., 2007; Malcata and Hopkins, 2014). If limitations for control and controlled parameters are set such problem has a solution. Maximization of the number of hammer throwers who fulfilled the qualification norm successfully for participation in international competitions was the target function in our problem settings (Winter, 2005).

2 ORGANIZATION AND METHODS

We consider the equation of computer model for prognostication of training process efficiency in the form of a year's full training cycle.

The following flows act in the system: information flow - I, number of training sportsmen's N_n, number of trainers $N_{tr.}$

Let us designate the initial number of training sportsmen as N_{n0} and their number after completion of the year's full training cycle as N_{nT}, where T is the year's full training cycle. N_{nT} is summed up from: $N_{nTs,}$ the number of sportsmen who fulfilled the qualification norm; $N_{nTn,}$ the number of sportsmen which did not fulfill the qualification norm and $N_{nl,}$ the number of sportsmen who left the training camp and who were not selected for the competitions because of different reasons.

The general objective of the organizational and pedagogic ma nagement of the training process is to maximize N_{nTs} , i.e. the number of sportsmen who fulfilled the qualification norm. The method of computer modeling belongs to heuristic methods and a significant number of parameters included in the model are determined by the methods of expert assessment. These parameters may be corrected

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during the modeling process of training system (model on PC) dynamics over time using PC.

Let us designate the number of intervals during which the model will turn to the final condition as M. It is convenient to use the number of training cycles of 2 months each, i.e. 6 cycles, as M. Thus, we obtain the possibility to compare the actual training results with results revealed in the model and to make quick correction (to implement feedback). Then the model increment size is Δt=T/N. At the initial time point: $N_{nTs0}= N_{n0}$ (all sportsmen wishing to fulfill the qualification norm) and $N_{nTn0} = N_{l0}$. So, the number of sportsmen was determined successfully. The values introduced for components of this flow at any time point i are the level of this flow.

The finite-difference equation of the simulation model for the flow of the number of training sportsmen has the form:

$N_{ni+1} = N_{ni}+ N_{ni+}- N_{ni-}$,

$N_{ni+1}\leq N_{n0}$,

here N_{ni+} is the rate (increase rate of sportsmen number). If we consider that reinstatement is impossible after dismissal of sportsmen from the training process, then $N_{ni+}=0$.

If reinstatement is possible after appearance of vacancies then Nni+=1 at the time of appearance of a vacancy in the team.

N_{ni-} – decrease rate of sportsmen number.

This rate is summed up from a complex of factors favoring the effective continuation of the training process:

- psychologic compatibility of sportsman with a trainer,
- selection of the training program and training method in accordance with individual resources of sportsmen,
- successful sportsmen’ adaptation to the training process,
- efficient fulfillment of the training program by a sportsman,
- sportsmen’s motivation to achieving high sports results etc.

The trainer’s role should be considered in the form of coefficient which is composed from the requirements to the trainer.

The linear relationship is usually supposed at the initial stage of modeling basing on the results of the previous training cycle. The pedagogic methods such as subject-subject relations between a sportsman and a trainer, current and midterm test should be used to minimize N_{ni}, i.e. to implement the organizational and pedagogic management.

The information flow is described by the following equation:

$I_{кn+1} = I_{ni}+ I_{ni+}- I_{ni-}$,

where I_{ni+1} is information about sportsmen at time point i+1, I_{ni+} is rate of positive information about sportsmen (fulfillment of control norms, participation in interim competitions, increase of physical fitness parameter values etc.); I_{ni-} is rate of negative information (disciplinary misdeeds, violations of sports regimen, non-fulfillment of the training program etc.).

If I_{ni-} has non-zero value (negative feedback functions) it is necessary to correct the rate N_{ni+} immediately (listen to the trainer’s and sportsman’s report, provide assistance in training of sportsmen etc.).

The model validity is checked by solving the prognostication problem for several previous periods (training cycles) because when modeling the process for previous periods the modeling result is known in advance, therefore, it is possible to select some model coefficients as per the program.

3 RESULTS AND DISCUSSION

Constructing the simulation model is based on the reports on results of the training process for a sufficiently long time period and our additional studies. Table 1 presents a fragment of summarized reporting data on training of hammer throwers in 2013-2016.

Table 1: Summarized reported results of training for 2013-2016 used for selecting initial and final conditions.

Analyzed years	Number of training sportsmen	Number of sportsmen who fulfilled the qualification norm
2013	16	8
2014	12	5
2015	20	5
2016	15	2
Standardized mean	1.00	0.31

Basing on Table 1 we form the initial and final conditions for solving the problem of determining simulation model coefficients (solving the prognostication problem from known past to known present events).

When solving prognostication problems standardized units are commonly used because the trend in change of the test parameters is of the main interest.

When selecting the computer modeling program we used the AnyLogic program (www.anylogic.com). It is recommended for construction of the computer model as the most general one and at the same time it has an understandable interface.

During the preliminary study we revealed factors determining the efficiency of the training process of hammer throwers. For this purpose, we conducted questioning of coaches and sportsmen. Results of this study are presented in Table 2. Of course, the transition from non-parametric criteria to parametric ones (ranking: r_1, …, r_8) requires parameter standardization. Therefore, it is necessary to standardize them by rank size, thereby, to make the variable models “equal in rights”.

Therefore, in accordance with Table 2 we obtain eight independent variables (x_1, …, x_8) where $x_1 = r_1/0,198$ etc. $x_8 = r_8/0.052$.

Practice has shown that the main causes for leaving the training process by sportsmen include impossibility of sportsmen ‘adaptation to physical stress or other force-major circumstances (Bakaev et al., 2015; Bakaev et al., 2016; Bolotin and Bakayev, 2016; Bolotin and Bakayev, 2017; Bakayev and Bolotin, 2017; Bolotin et al., 2015; Osipov et al., 2016; Rojas-Ruiz and Gutiérrez-Dávila, 2009; Kim et al., 2011). In order to remove these causes it is necessary to create appropriate psychologic and pedagogic conditions required for successful adaptation of hammer throwers to the training process. When solving this study task we questioned 72 respondents. Results of this study are presented in Table 3.

The similar method is used to standardize also the conditions favoring effective sportsmen’ stress adaptation after transition to parametric values (y_1, …, y_8) where $y_1 = r_1/0,213$ etc. $y_8 = r_8/0,037$. The decrease and increase rate of the number of sportsmen N_{ni-} and N_{ni+} are linear functions of independent variables (x_1, …, x_8) and (y_1, …, y_8),

Table 2: Factors determining the training process efficiency of hammer throwers (n=72).

Factors	Rank test (%)
Optimum height and weight parameters of hammer throwers	19.2
Use of individual approach to training of hammer throwers	17.3
Orientation of the training of hammer throwers to fulfillment of the qualification norm	15.7
Availability of favorable environment during the training process	14.4
Availability of target nature of the training process of hammer throwers	10.6
Objective registration sportsmen ‘ training process quality	9.3
High level of trainers’ personal responsibility for high-quality training of sportsmen	7.7
Availability of permanent monitoring of physical fitness level of hammer throwers in the year’s training cycle	5.8

Table 3: Rank structure of psychologic and pedagogic conditions required for effective adaptation of hammer throwers to the training process (n=72).

Psychologic and pedagogic conditions	Rank (%)
Inclusion of separate programs for formation of skills of training by sportsmen themselves in their training process	21.3
Formation of aspiration for permanent growth of sport results in sportsmen	19.7
Use of innovative training methods during training of hammer throwers	15.2
Formation of hammer throwers’ striving for fulfillment of the qualification norm	12.8
Development of a complex of measures for controlling the level of physical and psychologic parameters in sportsmen required for achievement of high sports results	12.2
Development of objective assessment criteria of the level of physical and psychological parameters in sportsmen	9.8
Implementation of measures for searching ways to increase sportsmen’ interest and motivation to the training process	5.3
Creating the environment for manifestation of high sports mastery of hammer throwers	3.7

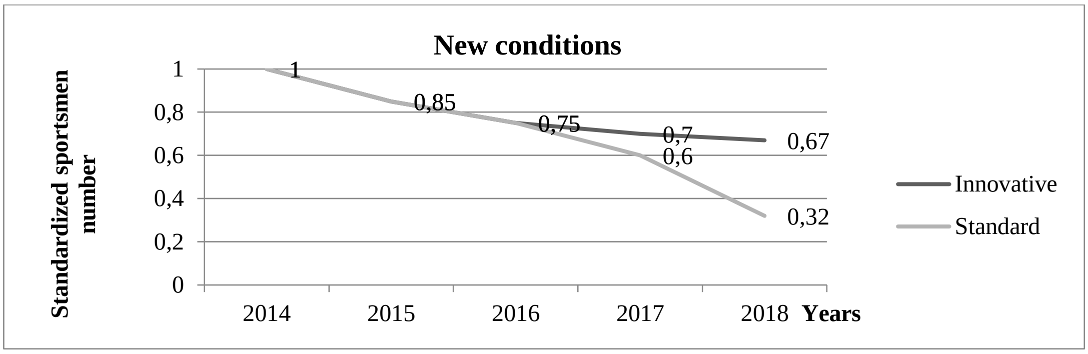

Figure 1: Solving the prognostication problem from known to present events (innovative technologies and new training conditions are included in 2016).

coefficients of which are calculated by the program when solving the problem of computer modeling.

4 CONCLUSIONS

When using developed pedagogic methods for increasing the training process efficiency: implementation of individual-oriented approach to selection of training means and methods, optimum selection of physical stress in accordance with sportsmen' individual resources, continuous methodical support of the training process with trainer's participation, criterion conditions presented in Tables 2 and 3 will be met (Bolotin and Bakayev, 2016; Bolotin and Bakayev, 2017).

Figure 1 presents forecasting results for 2018 with existing organization of the training process and in case of introduction of the innovative training methods suggested by us (meeting conditions of Tables 2 and 3). Figure shows sportsmen number dynamics with the standard training system and the prognostication result in case of introduction of the innovative training process technologies in 2018.

The use of simulation modeling has shown the high efficiency for solving the problem of training process prognostication in hammer throwers taking into account peculiarities of their stress adaptation. It is found that if limitations for controlling and controlled parameters of the training process of hammer throwers are set the problem for prognostication of training efficiency has solution. Maximization of the number of hammer throwers who fulfilled the qualification norm successfully for participation in the international competitions was the target function for solving our problem.

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