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FIVE-BLOCK PEDAGOGICAL MODEL FOR DEVELOPING DYNAMIC BALANCE IN 10-12-YEAR-OLD JUDOKAS AND ITS THEORETICAL AND METHODOLOGICAL FOUNDATIONS

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Abstract. The article presents the theoretical and methodological foundations, structure and functioning mechanism of a five-block pedagogical model aimed at developing dynamic balance in 10-12-year-old judokas. The study used theoretical analysis of scientific and methodological literature and regulatory documents, comparative analysis of balance assessment methods, systemic-structural analysis and pedagogical modeling. The developed model consists of theoretical, methodological, control-analytical, special developmental and outcome blocks. The theoretical and methodological blocks form the permanent foundation of the model, while the remaining three blocks form a recurring cycle linked by feedback based on the “VESKORQ” control tool and the Balance Efficiency Index (MSI). The cycle consists of seven steps: baseline measurement, identification of the weak link, selection of an exercise and game combination, setting the vestibular load, execution, repeated measurement and readjustment. The special developmental block integrates 20 special exercises and 12 movement games into a system of three complexity groups, nine 15-minute combinations and a vestibular load that is increased on the basis of five individual criteria. The model serves as a theoretical and methodological basis for individualized management of the training process, while testing its effectiveness in a controlled pedagogical experiment is a task for further research.

Keywords: judo, dynamic balance, balance ability, pedagogical model, feedback, “VESKORQ” control tool, Balance Efficiency Index, vestibular load.

INTRODUCTION

In judo, balance is of decisive importance in all phases of a technical action: while unbalancing the opponent, entering the technique and completing the throw, the athlete must control their own center of mass, and after rapid turns, rotations and falls they must restore their position in space within a short time. Therefore, balance ability is regarded as one of the factors that determine sports performance [9; pp. 221-232], and in combat sports it is not general but acquires features specific to the particular sport [17; pp. 579-590]. The fact that a judo bout takes place under conditions of high-intensity intermittent actions [7; pp. 147-166] further increases the demand for maintaining balance under fatigue and time pressure.

Resolution No. PQ-286 of the President of the Republic of Uzbekistan of June 20, 2022 “On measures for the further development of judo” [1] set out measures aimed at developing this sport. In implementing these tasks, it is important to develop the sports preparedness of young judokas, including their coordination abilities, on the basis of scientifically grounded methods.

Theoretically, the ability to maintain balance is regarded as a special coordination ability within the system of coordination abilities, while coordination training is considered an

independent component of an athlete's preparation [4; pp. 40-46]. Postural control is ensured by integrating vestibular, visual and proprioceptive afferentation and by reweighting the significance of sensory information when conditions change [12; pp. 1097-1118]. In children these systems do not mature simultaneously: whereas the proprioceptive system reaches the adult level at an early age, the contribution of visual and vestibular afferentation to balance control continues to develop during adolescence [15; pp. 477-482], and locomotor balance control develops step by step [5; pp. 527-532]. Age- and sex-related differences in balance performance in children and adolescents aged 6-18 years have been summarized in a systematic review and meta-analysis [14].

At the same time, the evidence for the idea that strictly delimited sensitive periods exist for developing general motor abilities is being critically appraised [16; pp. 7-14]. Therefore, in this study the age of 10-12 years is regarded not as an absolute sensitive period, but as a period that corresponds to the initial training stage, in which vestibular-coordination mechanisms are actively developing and there is a favorable opportunity for targeted pedagogical influence. This, in turn, requires managing pedagogical influence on the basis of each athlete's individual state rather than age norms.

Empirical studies have shown that judo training develops the sensorimotor adaptabilities involved in balance control [11; pp. 187-194] and that the characteristics of postural regulation in judokas differ according to the level of competition [10; pp. 304-305]. The effect of balance training on balance performance in children and adolescents, and the dependence of this effect on the training period, frequency and volume, have been assessed in a meta-analysis [8; pp. 2067-2089]. The need to assess the effectiveness of neuromuscular training in young athletes with sport-specific tests has also been emphasized [18].

However, the balance tests widely used in practice - BESS [6; pp. 287-295] and the Y Balance Test [13; pp. 1190-1209] - although they assess static and dynamic balance, do not include the rotational vestibular provocation characteristic of judo. In addition, pedagogical models that combine diagnostics, special means, load dynamics and feedback into a single system integrated into the main part of a judo training session have not been sufficiently developed. This contradiction defines the research problem.

Aim of the study - to provide a theoretical and methodological substantiation of the five-block pedagogical model for developing dynamic balance in 10-12-year-old judokas and to reveal its structure and functioning mechanism.

Objectives of the study: to identify the theoretical and methodological foundations of the model; to determine the composition and content of the blocks; to develop the functioning mechanism of the model, including the procedures for feedback and load management.

MATERIALS AND METHODS

The study is theoretical and methodological in nature. Its material consisted of scientific and methodological literature on postural control, coordination abilities, balance training in children and adolescents and the balance demands of judo, regulatory documents in the field [1], the "VESKORQ" control tool developed by the author and its application methodology [2], as well as F.A.Kerimov's collection of movement games with kurash elements [3; pp. 37-82].

Four methods were used in the study. Theoretical analysis and generalization served to identify the structural components of balance ability, the sensory-functional mechanisms that ensure it, the age characteristics of 10-12-year-old athletes and the balance demands of judo technique. Comparative analysis was used to compare the capabilities of widely used balance tests and the author's control tool according to the criteria of the presence of rotational vestibular provocation, movement accuracy and the recording of balance recovery time. Systemic-structural

analysis made it possible to determine the structural elements of the model and the links between them. Pedagogical modeling was used to design the structure of the model, the information flow between the blocks and the feedback mechanism.

Three requirements were set for the model during its design: integrity (covering all components from the aim to the result), controllability (the possibility of changing exercises and load at each stage according to the measurement results) and practical applicability (integration of the balance block into the main part of a judo training session).

RESULTS

General structure of the model. As a result of pedagogical modeling, a model consisting of five interrelated blocks was developed: theoretical (I), methodological (II), control-analytical (III), special developmental (IV) and outcome (V) blocks (Figure 1). The main feature of the model is that it is non-linear. The theoretical and methodological blocks form a permanent foundation that operates throughout the cycle, while blocks III-V form a recurring pedagogical cycle linked by feedback. Therefore, control serves not as the final stage of the methodology but as the mechanism that steers it.

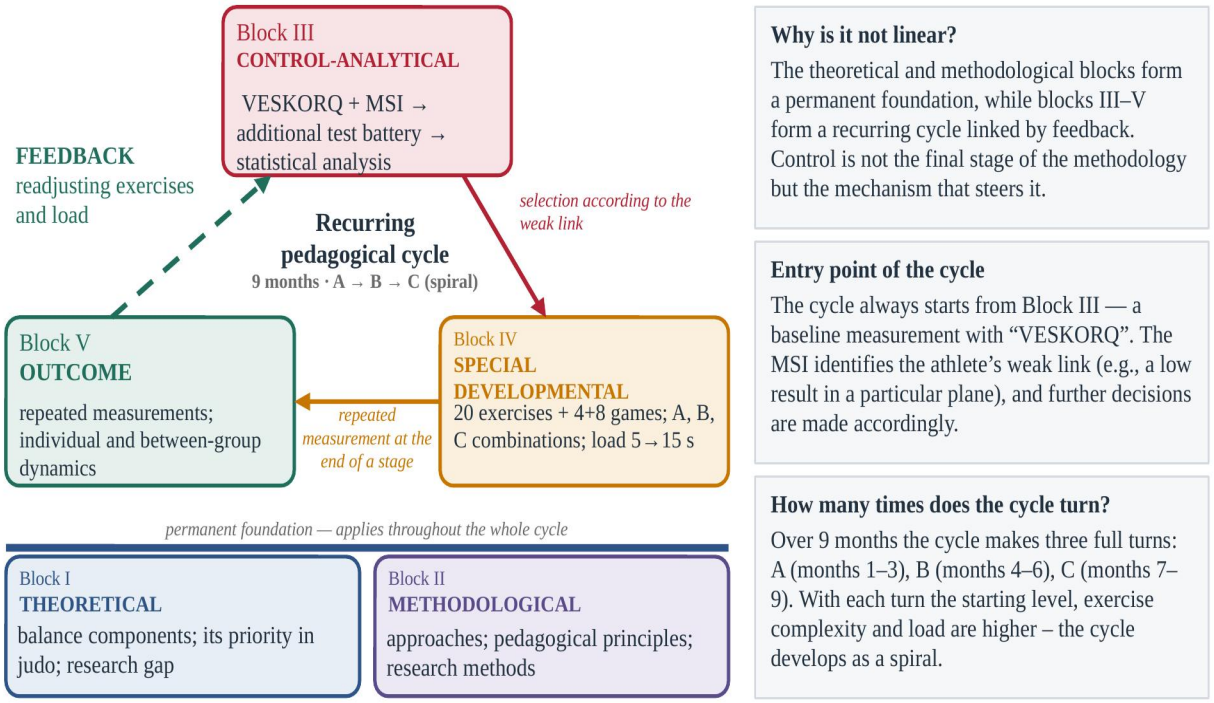


Figure 1. Five-block pedagogical model for developing dynamic balance in 10-12-year-old judokas: permanent foundation (blocks I-II) and recurring cycle (blocks III-V)

The cycle always starts from Block III - the baseline measurement carried out with the VESKORQ control tool. The MSI identifies the athlete's weak link, for example, a low result in a particular plane, and the special means (Block IV) are selected accordingly. At the end of the stage a repeated measurement is carried out (Block V), and its result is returned to Block III to readjust the exercises and load. Over 9 months the cycle makes three full turns: stages A (months 1-3), B (months 4-6) and C (months 7-9). With each turn, the starting level, exercise complexity and load are higher, i.e., the cycle develops as a spiral. The functions and content of the blocks and the output each block passes on to the next one are presented in Table 1.

Table 1

Functions, content and output of the blocks of the model for developing dynamic balance in 10-12-year-old judokas

Block	Function	Main content	Output
I. Theoretical	Defining the scientific basis of the model	Structural components of balance ability; the vestibular, visual and proprioceptive mechanisms that ensure it; balance demands of the kuzushi, tsukuri, kake and ukemi phases; characteristics of the 10-12 age group	The ability to be developed and its components
II. Methodological	Defining approaches and principles	Systemic, activity-based, ontogenetic and person-centered approaches; principles of consistency and gradualness, individualization, load regulation and safety, and age appropriateness	Rules for selecting means and managing load
III. Control-analytical	Objective assessment of the athlete's state and identification of the weak link	"VESKORQ" control tool and MSI; additional test battery (statometry, Schulte tables, O-Goshi and Seoi-Nage); screening questionnaire	The athlete's profile across the planes and weak link
IV. Special developmental	Pedagogical influence targeted at the weak link	20 special exercises; 4 author's and 8 adapted movement games; complexity groups A, B, C; nine 15-minute combinations; vestibular load 5-15 s	Individual program completed during the stage
V. Outcome	Recording changes and making decisions	Repeated measurements at the end of the stage; analysis of individual and group dynamics; assessment of the transfer of results to technical actions	Decision to continue or readjust the program (feedback to Block III)

Control-analytical block. The central tool of the block is the VESKORQ control tool developed by the author [2]. Unlike widely used balance tests, it assesses dynamic balance after rotational vestibular provocation in three planes - the horizontal, vertical and sagittal planes. After a standard 5-second rotational vestibular stimulation, the athlete throws a ball at a target panel 2 m away. Three primary indicators are recorded during the measurement, and on their basis the integral indicator - the Balance Efficiency Index - is calculated (Table 2):

$$\mathbf{MSI = (A + B) / T} \quad (1)$$

where A - the number of rotations during stimulation; B - the result on the target panel, points; T - the time from the end-of-rotation signal until the ball hits the target, s.

Table 2

Indicators of the VESKORQ control tool and the procedure for recording them

Indicator	Content	Unit	Recording procedure
A	Number of rotations during rotational stimulation	times	Counted visually by the researcher and entered in the protocol
B	Result on the target panel: center - 5 points, outer ring - 1 point	points	Read from the control unit display
T	Time from the end-of-rotation signal until the ball hits the target	s	Measured from the device's end-of-rotation signal
MSI	Integral indicator combining the speed of balance recovery and movement accuracy	arbitrary units	Calculated from the protocol using formula (1)

The structure of the MSI determines its pedagogical meaning: the indicator expresses in a single value how quickly balance can be restored (T) and how accurately the movement can be performed (B) after a rotational load (A). Therefore, an increase in MSI indicates improved adaptation to vestibular load, while a decrease indicates insufficient adaptation. Comparing MSI values in the three planes makes it possible to identify the weak link: the plane with the lowest result is set as the priority direction for the next stage.

The additional test battery covers static balance (three statometric tests), attention (Schulte tables) and technical preparedness (speed of performing the O-Goshi and Seoi-Nage techniques). This makes it possible to monitor the transfer of changes in balance to technical actions. To ensure safety, before being included in testing, each athlete is screened with a two-part questionnaire: the first part consists of five questions on health and vestibular status (completed by the athlete or a parent), and the second part consists of seven criteria of pedagogical and technical readiness (assessed by the coach or the researcher). Based on the questionnaire, a decision of "permitted", "temporarily postponed" or "not permitted" is made. The rest interval between attempts is 7-20 seconds, and the next attempt begins after the athlete's readiness has been checked.

Special developmental block. The content of the block consists of 20 special exercises and 12 movement games. Four of the games are competition-format vestibular-activating games developed by the author, while eight were selected from F.A.Kerimov's movement games with kurash elements according to their direct effect on balance and vestibular-coordination qualities and adapted: "Tripped Legs", "Wrestling with a Balancing Pole", "Cockfight", "Palm Push", "Don't Lose Your Balance", "Nimble Rider", "Know How to Jump" and "Contest in the Square" [3; pp. 37-82].

The exercises are divided into three groups by complexity: group A (exercises 1-6) is used in months 1-3 of training, group B (exercises 7-14) in months 4-6, and group C (exercises 15-20) in months 7-9. The exercises and games are combined into nine 15-minute combinations (A1-A3, B1-B3, C1-C3) across the three complexity stages and the three sessions of the weekly microcycle. The balance block is included not in the preparatory part but in the main part of the training session and

is used in three sessions of the weekly microcycle. At each stage, the combination is selected according to the athlete's weak link.

The duration of vestibular load is increased step by step in the order 5-7-10-12-15 seconds. Transition to the next load level is carried out not according to a calendar schedule but on the basis of five individual criteria: absence of vestibulo-vegetative signs, preservation of technique, a decrease in loss-of-balance episodes, stable accuracy of throws at the target, and no decrease in the MSI value. If the criteria are not met, the athlete remains at the current load level. Thus, load dynamics are not the same for the whole group but are set according to each athlete's rate of adaptation.

Outcome block and the functioning mechanism of the model. The outcome block includes repeated measurements at the end of each stage and the analysis of the athlete's dynamics at the individual and group levels. MSI values in the three planes are regarded as the primary criteria, while indicators of static balance, attention and technical preparedness are regarded as additional criteria. The output of the block is a decision to continue or readjust the program, which is passed to Block III through feedback.

The functioning mechanism of the model is represented as a cycle of seven steps within one stage (Figure 2). The steps are grouped into three phases: measurement and identification (steps 1-2), selection and loading (steps 3-5), and re-measurement and adjustment (steps 6-7). The seventh step closes the cycle and starts it again from the first step.

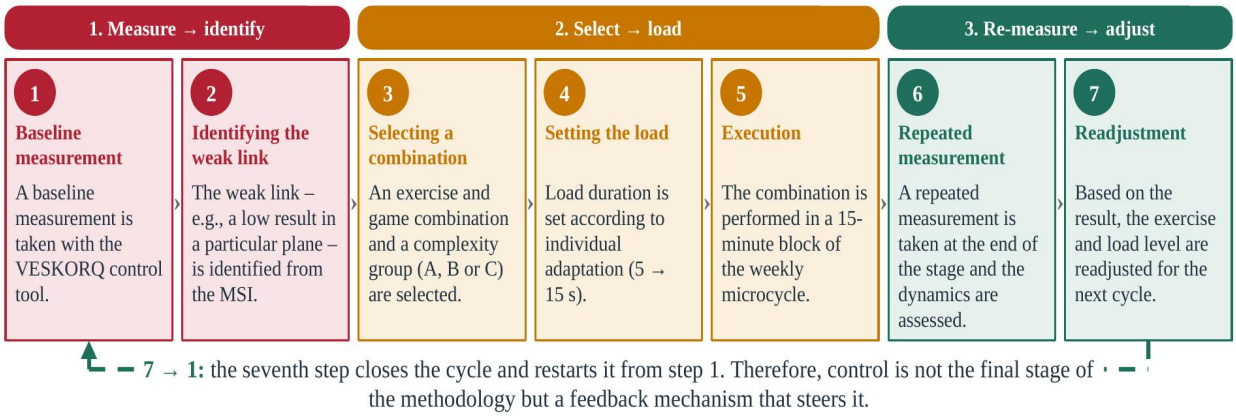


Figure 2. Functioning mechanism of the five-block model: seven steps within one stage

DISCUSSION

The main difference between the developed model and traditional approaches lies in the role of control in the pedagogical process. In practice, control is often regarded as a means of recording results at the end of a training stage. In this model, however, it serves as a management mechanism: the measurement result directly determines the selection of exercises, games and load. This approach is consistent with the view that postural control itself is a closed system based on sensory feedback [12; pp. 1097-1118]: just as sensory information corrects movement in the athlete's body, at the pedagogical level MSI-based feedback corrects the training program. Considering coordination training as an independent component of an athlete's preparation [4; pp. 40-46] also indicates the need to design it as a separate system with its own special means, control and management.

The choice of "VESKORQ" as the central tool of the control-analytical block is justified by the specific demands of judo. Although tests such as BESS [6; pp. 287-295] and the Y Balance Test [13; pp. 1190-1209] are widely used to assess static and dynamic balance, they do not include

rotational vestibular provocation. Yet judo technique itself requires rapid recovery of balance after turns, rotations and falls. The need to assess and develop balance under sport-specific conditions [17; pp. 579-590], as well as the recommendation to assess training effectiveness in young athletes with sport-specific tests [18], form the basis of the concept of the control tool.

The principle of load management in the special developmental block also deserves attention. The effect of balance training in children and adolescents depends on the training period, frequency and volume [8; pp. 2067-2089]. The model takes this relationship into account at two levels: the external volume is kept constant in the weekly microcycle (15 minutes in each of three sessions), while the duration of vestibular load is increased on the basis of five individual criteria. Thus, the "load – effect" relationship is not the same for the whole group but is managed according to each athlete's level of adaptation.

The integration of the balance block into the main part of the judo training session and its reliance on competition-format games are based on data showing that judo training itself develops sensorimotor adaptabilities [11; pp. 187-194] and that postural regulation characteristics are related to the level of sports skill [10; pp. 304-305]. Linking the special means with the kuzushi, tsukuri, kake and ukemi phases creates conditions for the transfer of balance ability to technical actions. However, such transfer is so far a theoretical assumption that needs to be tested in a controlled experiment.

As for the age factor, the uneven maturation of the sensory systems that ensure balance [15; pp. 477-482] and the age- and sex-related differences in balance performance [14] show that athletes of the same age may also have different starting levels. The limited evidence for the idea of strict sensitive periods [16; pp. 7-14], in turn, favors management based on individual measurement results rather than on age. The weak-link-oriented selection and the individual criteria for progressing to the next load level in the model are based precisely on this conclusion.

The study also has limitations. First, the article presents the theoretical and methodological substantiation and structure of the model; its effectiveness should be tested in a controlled pedagogical experiment - using a predefined primary outcome (MSI in three planes), an adequate sample size and assessors blinded to group allocation. Second, the metrological properties of the "VESKORQ" control tool and the MSI (reliability, construct validity, including the relationship with stabilometric indicators) should be substantiated in detail in a separate study. Third, since some of the criteria for progressing to the next load level are based on pedagogical observation, it is advisable to standardize them through rating scales.

CONCLUSIONS

1. Theoretical analysis showed that dynamic balance is a special coordination ability of decisive importance in all phases of judo technique. At the same time, widely used balance tests and developmental means do not sufficiently cover the rotational vestibular demands specific to judo or individual feedback.

2. On the basis of pedagogical modeling, a five-block model was developed. In it, the theoretical and methodological blocks form a permanent foundation, while the control-analytical, special developmental and outcome blocks form a spiral cycle that is linked by feedback and turns three times over 9 months.

3. The "VESKORQ" control tool and the Balance Efficiency Index serve as the feedback tool in the model: measurement in three planes identifies the athlete's weak link and determines the selection of exercises, games and load.

4. The special developmental block integrates 20 special exercises and 12 movement games into a system of complexity groups A, B, C, nine 15-minute combinations and a vestibular load

increased within 5-15 s on the basis of five individual criteria; the block is included in the main part of three sessions of the weekly microcycle.

5. The model serves as a theoretical and methodological basis for individualized management of the training process of 10-12-year-old judokas at the initial training stage. Testing its effectiveness in a controlled pedagogical experiment and substantiating the metrological properties of the control tool are tasks for further research.

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