

# Pattern recognition: modes of teaching boys aged 10 mae-geri (front kick) technique in kyokushin karate

## Authors' Contribution:

- A Study Design
- B Data Collection
- C Statistical Analysis
- D Manuscript Preparation
- E Funds Collection

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## Abstract

### Background and Study Aim:

In the modern educational space, a healthy lifestyle is being shaped through involving school students in extracurricular physical education and sports activities. One of the tools that can be used both as a sport and a health-improving system for all age groups is a martial art – kyokushin karate. The aim of the study was to knowledge about the modes of physical exercises when teaching series of tasks aimed at developing motor skills in boys aged 10.

### Materials and Methods:

The study involved 32 boys aged 10. To solve the tasks set, the following research methods were used: study and analysis of scientific and methodological literature; pedagogical observation, timing of learning tasks; pedagogical experiment, methods of mathematical statistics, methods of mathematical experiment planning. During teaching, the method of algorithmic instructions was used.

### Results:

The results of the study show that in the proposed matrix of factorial design the chosen step of factor variation is sufficient to study the influence of different modes of physical exercises on the effectiveness of teaching. An assumption was made about the possibility of using a discriminant function to assess the effectiveness of different modes of exercises when teaching series of tasks. The verification of canonical functions indicates their statistical significance, and the coordinates of centroids make it possible to choose the best variant to obtain a positive effect of teaching series of exercises.

### Conclusions:

Discriminant analysis made it possible to determine how significantly the modes of training differ by the effectiveness of motor skills development. The discriminant function structure coefficients show that the effectiveness of the training program is determined by selection of series of learning tasks and the mode of their performance. The first discriminant function with an emphasis on the most informative variables can be used to select a generalized mode of performing exercises of the series of tasks when teaching boys aged 10 the *mae-geri* (front kick) technique in kyokushin karate. A universal variant for teaching boys aged 10 series of tasks is the second mode of physical exercises: 3 sets with a rest interval of 60 seconds.

### Keywords:

modeling • modes of performing exercises • physical exercises • programmed teaching • rest intervals

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Authors have declared that no competing interest exists

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**Motor** – *adjective* relating to muscle activity, especially voluntary muscle activity, and the consequent body movements [44].

**Self-defence** – *noun* fighting techniques used for defending oneself against physical attack, especially unarmed combat techniques such as those used in many of the martial arts [44].

**Skill** – *noun* an ability to do perform an action well, acquired by training [44].

**Performance** – *noun* the level at which a player or athlete is carrying out their activity, either in relation to others or in relation to personal goals or standards [44].

**Technique** – *noun* a way of performing an action [44].

## INTRODUCTION

In the modern educational space, a healthy lifestyle is being shaped through involving school students in extracurricular physical education and sports activities [1-3].

One of the tools that can be used both as a sport with various competitive sections and rules of the fight, and a health-improving system for all age groups is a martial art – kyokushin karate. Using the basics of karate in extracurricular activities of secondary educational institutions contributes to the development of special self-defence abilities and skills at school age and increases the younger generation's motor activity [4-6].

Technical training at the initial stage of sports activities is one of the components of the integrated system of a young athlete's development [7-9]. It largely determines the effectiveness of long-term training, as it creates a foundation for comprehensive physical and functional fitness [10-12], mastering technical and tactical actions, promotes health in adolescence [13-15]. The athlete's future success in competitions depends on it [16-18]. At the present stage of science development, modeling is one of the most effective and promising tools for studying the patterns of motor training of children and adolescents [19, 8].

Scientific literature has substantiated the use of multivariate statistics in studying the effectiveness of motor skills and motor abilities development in children and adolescents [20, 21]. Studies found the effectiveness of factorial designs and discriminant analysis in determining the modes of physical exercises [22, 21, 23]. According to García-Moya et al. [24], Wang et al. [25], the use of factorial designs in studies involving children and adolescents improves the quality of evaluation of their development indicators. The validity of using a 2<sup>k</sup> full factorial experiment is confirmed by data of Correa et al. [26, 27].

The relevance of the study stems from the insufficiently substantiated methods of initial teaching of technical actions, which are based on coaches' empirical experience. This makes it necessary to investigate the influence of factors "number of sets" and "rest intervals" on the effectiveness of motor skill development in different modes of mastering series of learning tasks within the programmed teaching of the *mae-geri* (front kick) technique in kyokushin karate to boys aged 10.

The aim of the study was to knowledge about the modes of physical exercises when teaching series of tasks aimed at developing motor skills in boys aged 10.

## MATERIAL AND METHODS

### Participants

The study involved 32 boys aged 10. The children and their parents were informed about all the features of the study and gave their consent to participate in the experiment.

### Study organization

To solve the tasks set, the following research methods were used: study and analysis of scientific and methodological literature; pedagogical observation, timing of learning tasks; pedagogical experiment, methods of mathematical statistics, methods of mathematical experiment planning. A conditional division of the process of teaching the front kick is given in Table 1. During teaching, the method of algorithmic instructions was used.

The program of teaching the *mae-geri* (front kick) technique included series of learning tasks.

The first series of learning tasks – exercises for motor abilities development: from a straddle stand, hands on hips, bend the left (right) leg and lift it forward, foot parallel to the floor; hold a stable position for up to 25 seconds; do the same, but with the eyes closed; hold a stable position for up to 15 seconds; high knees running in place with the knee touching the rope located at waist height, at a fast pace for 10 s.

The second series of learning tasks – starting and ending positions: straddle stand (*yoi dachi*) – in this position the back of the head, shoulder blades, buttocks, heels are placed in one plane, feet are parallel and shoulder-width apart, knees relaxed and slightly bent, hands on hips, body weight evenly distributed between both legs; left (right) leg forward straddle stand (*kumite dachi*) – legs are shoulder-width apart, half-bent, feet are parallel, one leg is forward, the other is behind, the distance between the heel of the left (right) foot and the toe of the right (left) foot is an average step, the lower left leg is perpendicular to the floor, the foot rests completely on the floor, the right foot touches the floor only with the toe; the body is in the position 45°, the left (right) shoulder forward, head slightly tilted forward, chin pressed to the

**Table 1.** Division of the process of teaching the front kick (*mae-geri*).

Teaching stage	Characteristics of teaching stages	Main tasks
First	Acquaintance with a separate type of the kick	Giving a preliminary general idea of the kick as a holistic motor act. Detailed acquaintance with the general description and general principles of the kick technique
Second	Mastering the basic structure of the movement	Dividing the kick into elements
Third	Automatization of the skill	Ability to freely perform the kick in standard conditions
Fourth	Acquisition of the ability to freely and accurately perform the front kick	Acquiring one of the most important qualities of the fighter – skill flexibility, that is the ability to apply the kick in different combat conditions and depending on the individual characteristics of different opponents

collarbone, the body weight is evenly distributed between both legs, the fist of the left hand is at the level of the shoulder joint, the elbow is lowered, the right hand is freely located near the right side, the elbow is lowered, the fist is near the chin.

The third series of learning tasks – actions without which the exercise performance is impossible: from the supine position, the front kick phases are gradually performed: the phase of extending the *hip*, the phase of straightening the leg with the formation of the striking surface, the phase of returning the leg, the phase of placing the leg in the starting position.

The fourth series of learning tasks – teaching the ability to control movements: the exercise for training the ability to correctly push off the striking leg from the support at the initial stage of the kick. From the starting position “Straddle stand” (*yoi dachi*), with the back, buttocks and heels against the wall, quickly lift the right (left) knee forward and upward, pushing off the floor with the foot, heel pressed against the thigh. Perform 10 times; from the starting position “Single leg stand”, with the back against the wall, hold the right (left) leg straight in the frontal position at waist height, fixing the foot in the final phase of the kick with the lower part of the foot, just underneath the toes (ball of the foot) forward (*chusoku*) 10 s; stand with the back against the wall, facing the partner, the right (left) knee is bent, the lower part of the foot rests on the partner’s stomach (*chusoku*); push the partner away straightening the leg, including the work of the hip in the final phase; the partner offers possible resistance; perform 10 times.

The fifth series of learning tasks – separate parts of the target exercise and preliminary exercises: from the starting position “Left (right) leg

stand, right (left) leg bent forward”, with the back against the wall, perform a sharp extension of the leg in the knee joint, maintaining the height and position of the foot; perform 10 times; stand on the left (right) knee – the thigh of the left (right) leg is perpendicular to the floor, the right (left) leg is bent and placed forward on the whole foot so that its shin is parallel to the thigh of the left (right) leg; the body is positioned and held vertically during the exercise; on one count, perform two phases of the movement: bring the knee forward and upward and sharply extend the leg in the knee joint; perform 10 times.

The sixth series of learning tasks – performing the entire exercise: practice the technique of kicks in the air, alternating legs, from the starting position “Straddle stand (*yoi dachi*)” in place; do the same from the starting position “Left (right) leg forward straddle stand (*kumite dachi*)”; do the same from the *kumite dachi* stand moving forward in a straight line; practice the technique of kicks against pads for accuracy from the starting position “Left (right) leg forward straddle stand (*kumite dachi*)” in place; perform the exercises 10 times; breathing in all exercises must match the pace of movements and moments of tension.

The next exercise started after a correct performance of the previous exercise with exact observance of all technical requirements. At the same time, minor mistakes were allowed.

The level of proficiency in the *mae-geri* (front kick) technique (Y) was evaluated by a group of three independent experts on a 10-point scale: 10 – the motor action was performed correctly, all technical requirements were exactly observed; 9 – the motor action was performed correctly, but one minor mistake was made; 8 – the motor action was performed in accordance with the requirements, freely,

but not more than two minor mistakes were made; 7 – the motor action was performed in accordance with the requirements, but not more than three minor mistakes were made; 6 – the motor action performance was basically correct, but with one significant mistake; 5 – the motor action performance was generally correct, but with one significant and not more than one minor mistakes; 4 – the motor action was performed with one significant and not more than two minor mistakes; 3 – when performing the motor action, one gross mistake and more than two other mistakes were made; 2 – when performing the motor action, two gross mistakes were made; 1 – the motor action was performed with more than two gross mistakes.

To achieve the objective set, the study examined the effect of different variants of exercises, namely: number of sets ( $X_1$ ) and rest intervals ( $X_2$ ) on mastering the *mae-geri* (front kick) technique. The boys aged 10 were divided into four groups according to the experiment plan. The differences between the groups in the methods of conducting classes resulted from the factorial experiment conditions given in Table 2. The bottom and top levels of the factors were chosen based on the data provided by Khudolii & Ivashchenko [28], Khudolii et al. [29] and were limited to the lesson framework.

### Statistical analysis

The study used the methods of analyzing the results of mathematical planning of a  $2^k$  FFE [14].

The experimental data were processed by the IBM SPSS 20 software. During discriminant analysis (in order to clarify the impact of different modes of physical exercises on the level of proficiency), the study created a prognostic model for group membership. This model builds a discriminant function (or, if there are more than two groups – a set of discriminant functions) in the form of a linear combination of predictor variables, which ensures the best division of groups. These functions are built according to a set of observations, for which their group membership is known. These functions can continue to be used for new observations with known values of predictor variables and unknown group membership.

For every canonical discriminant function (which allow to determine the ratio of the contribution of variables to the result of the function), the study calculated: eigenvalue, dispersion percentage, canonical correlation, Wilks' *Lambda*, Chi-square.

**Table 2.** The  $2^2$  factorial design.

Variants of exercise performance	Modes of teaching	
	Number of sets, times ( $X_1$ )	Rest interval, s ( $X_2$ )
1	1(-)	60(-)
2	3(+)	60(-)
3	1(-)	120(+)
4	3(+)	120(+)

**Table 3.** Tests of equality of group means.

Series of tasks	Modes of exercises								Wilks' Lambda	F	P
	Variant 1		Variant 2		Variant 3		Variant 4				
	Mean	SD	Mean	SD	Mean	SD	Mean	SD			
1	6.125	1.183	7.875	1.366	6.875	1.727	8.125	1.321	0.732	3.423	<b>0.031</b>
2	5.75	0.975	5.25	0.762	4.825	0.887	5.487	0.753	0.845	1.710	0.188
3	7.625	1.159	8.25	1.073	6.625	0.678	7.75	1.396	0.755	3.025	<b>0.046</b>
4	5.125	0.956	6.25	1.267	4.638	0.791	6.0	0.997	0.681	4.373	<b>0.012</b>
5	6.013	1.192	7.375	1.354	5.875	0.942	6.5	0.984	0.764	2.880	0.054
6	7.375	1.173	8.963	0.626	6.25	1.386	7.5	1.144	0.541	7.932	<b>0.001</b>

The study protocol was approved by the Ethical Committee of the University. In addition, the children and their parents were fully informed about all the features of the study, and a signed informed-consent document was obtained from all the parents.

## RESULTS

The score for performing the second series of tasks varies statistically insignificantly depending on the modes of training ( $p > 0.05$ ). The results of other tasks differ statistically significantly ( $p < 0.05$ ). Thus, motor skills development is statistically significantly influenced by the modes of exercises (Table 3).

The first canonical function explains 54.8% of the results variation, the second function 39.8%, the third function 5.5%, which indicates their high informative value ( $r_1 = 0.765$ ;  $r_2 = 0.712$ ;  $r_3 = 0.352$ ) (see Table 4). The materials of the canonical functions analysis show a statistical

significance of the first and second canonical functions ( $\lambda_1 = 0.179$ ;  $p_1 = 0.001$ ;  $\lambda_2 = 0.433$ ;  $p_2 = 0.016$ ). The first, second, and third functions have a high discriminant ability and value in interpretation of the general population (Table 5).

The score for performing exercises of the third and sixth series of learning tasks makes the greatest contribution to the first canonical function. The score for performing exercises of the first and fifth series of learning tasks contributes most to the second canonical function. This points to a differentiated impact of exercises modes on the effectiveness of teaching boys aged 10 the *mae-geri* (front kick) technique in kyokushin karate (Table 6).

Table 7 shows the structure coefficients of the first canonical discriminant function, which are the coefficients of correlation between the variables and the function. Thus, the first function is most closely connected with the score for performing exercises of the sixth, third and fifth series of learning tasks: hence, a significant

**Table 4.** Eigenvalues of the examined boys aged 10 ( $n = 32$ ).

Function	Eigenvalue	% of variance	Cumulative %	Canonical correlation
1	1.413	54.8	54.8	0.765
2	1.026	39.8	94.5	0.712
3	0.141	5.5	100.0	0.352

**Table 5.** Wilks' Lambda of the examined boys aged 10 ( $n = 32$ ).

Test of function(s)	Wilks' Lambda	Chi-square	Df	Sig.
1 through 3	0.179	44.695	18	0.000
2 through 3	0.433	21.790	10	0.016
3	0.876	3.433	4	0.488

**Table 6.** Standardized canonical discriminant function coefficients of the examined boys aged 10 ( $n = 32$ ).

Series of learning tasks	Function		
	1	2	3
1	-0.776	<b>1.102</b>	0.214
2	0.285	-0.807	0.587
3	<b>0.465</b>	-0.515	0.092
4	0.248	0.239	0.621
5	0.242	<b>0.495</b>	-0.161
6	<b>0.845</b>	0.012	-0.546

**Table 7.** Structure matrix of the examined boys aged 10 (n = 32).

Series of learning tasks	Function		
	1	2	3
6	0.730	0.308	-0.056
3	0.454	0.112	0.371
5	0.359	0.348	-0.121
2	0.212	-0.236	0.665
4	0.430	0.379	0.649
1	0.105	0.545	0.575

**Table 8.** Classification results (78.1% of original grouped cases correctly classified).

Observations results	Variant	Predicted group membership				Total	
		1	2	3	4		
Original	Count	1.000	6	2	0	0	8
		2.000	0	7	0	1	8
		3.000	0	0	7	1	8
		4.000	0	1	2	5	8
	%	1.000	75.0	25.0	0.0	0.0	100.0
		2.000	0.0	87.5	0.0	12.5	100.0
		3.000	0.0	0.0	87.5	12.5	100.0
		4.000	0.0	12.5	25.0	62.5	100.0

**Table 9.** Functions at group centroids. Unstandardized canonical discriminant functions evaluated at group means

Variants of exercise performance	Modes of teaching		Functions at group centroids		
	Number of sets, times, (X <sub>1</sub> )	Rest interval, s (X <sub>2</sub> )	1	2	3
1	1	60	0.491	-1.585	0.028
2	3	60	1.390	0.843	-0.283
3	1	120	-1.649	0.156	-0.309
4	3	120	-0.231	0.586	0.564

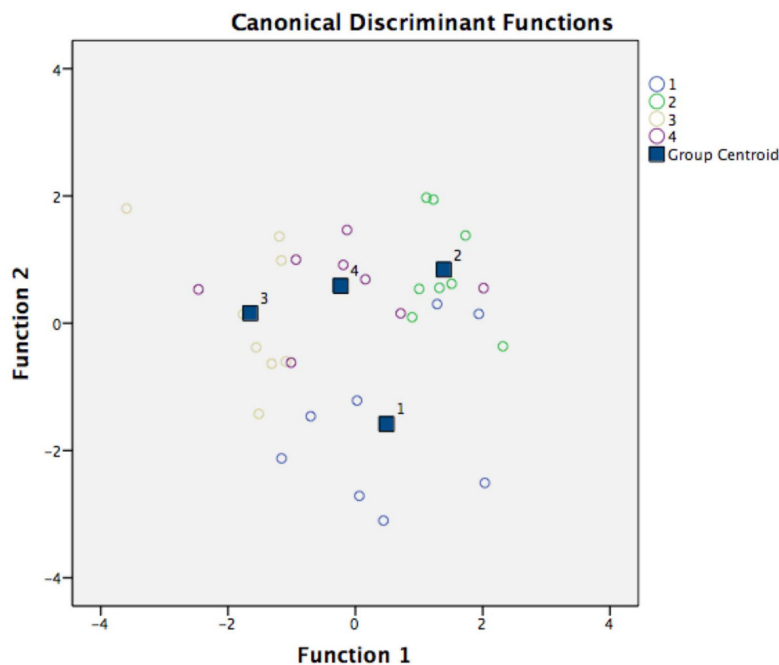
difference between exercises modes 1-4 is observed in the quality of actions without which the exercise performance is impossible, preliminary exercises and the entire exercise.

The results of classification of groups shows that 78.1% of the original grouped observations were classified correctly (Table 8). The coordinates of centroids for three groups (Table 9) and the graphic visualisation (Figure 1) shows the density of objects in each class and a clear boundary between the classes. The second mode of physical exercises is the most universal in the process of teaching series of tasks.

## DISCUSSION

The study assumed that a full factorial experiment and discriminant analysis would make it possible to determine the peculiarities of motor skills development in boys aged 10. The results of the study show that in the proposed matrix of factorial design the chosen step of factor variation is sufficient to study the influence of different modes of physical exercises on the effectiveness of teaching (Table 2).

An assumption was made about the possibility of using a discriminant function to assess the effectiveness of different modes of physical



**Figure 1.** Graphic representation of classification results (modes of physical exercises 1-4).

exercises when teaching series of tasks. The verification of canonical functions indicates their statistical significance, and the coordinates of centroids make it possible to choose the best variant to obtain a positive effect of teaching series of exercises (Table 9). Therefore, a canonical discriminant function can be used to classify the modes of physical exercises when developing motor skills. A universal variant for teaching boys aged 10 series of tasks is the second mode of physical exercises: 3 sets with a rest interval of 60 seconds.

The obtained results confirm that a positive effect of teaching depends on the *consistent solution of learning tasks* and *rational application of methods* [8, 22, 23]. The findings confirmed the study of Lopatiev et al. [19], Ivashchenko et al. [20] on the effectiveness of using the modeling method in pedagogical studies to examine the patterns of functional and motor training in physical education.

The obtained results expand and supplement the findings of Ivashchenko et al [20], Iermakov et al. [21] about the effectiveness of using  $2^k$  factorial designs in studying the process of teaching and motor abilities development in children and adolescents. The study results confirm the data

of García-Moya et al. [24], Wang et al. [25] on using factorial designs in studies involving children and adolescents.

The obtained data supplement the information of Ivashchenko et al. [20], Iermakov et al. [21] that the teaching process management is more effective if the modes of teaching are determined based on regression models; supplement the information on the use of a discriminant function in classifying schoolchildren by motor development [30], attitude to physical education and out-of-school physical activity [31].

As a result of the study, a program of teaching the *mae-geri* (front kick) technique was developed. Based on the results of assessing the technique of physical exercise performance, the study obtained the values of discriminant functions, which make it possible to determine a generalized mode of teaching series of tasks aimed at developing motor skills in boys aged 10. Based on this information, the coach can make or adjust the work plan of the sports section or a student's individual plan.

In this work, when we talk about the integrated system of a young athlete's development (also about health aspects), we abstract from the mental effects of training. However, the methodology presented in



this paper may be applicable to the study of various aspects of the integrated system of a young athlete's development. The still innovative exploration should cover various issues related to immunizing juvenile athletes, not only martial arts practitioners, to personality deforming factors (e.g. the way of expressing triumph after victory [32-34]), but also stimulating the development of the personality [35, 36]. Among the broad problems of health prevention based to a large extent on the practice of martial arts, the dominant issues are the issues of preventing bodily injuries and death as a result of falls [37], also during judo training and tournaments [38, 39] and disability persons [40]. Limitations of judo in the prevention of falls among farmers were well justified by Blach et al. [41]. The limitations of martial arts practice also apply to the mental aspects. Fun forms of martial arts are not only more effective means of teaching safe falls than practicing judo and other combat sports, but when used by a competent expert, they effectively reduce the aggressiveness of adolescents and adults [42, 43].

## CONCLUSIONS

Discriminant analysis made it possible to determine how significantly the modes of training differ by the effectiveness of motor skills development; what motor tasks most significantly influence the differentiation of classes; to which class the object belongs based on the values of discriminant variables. The discriminant function structure coefficients show that the effectiveness of the training program is determined by selection of series of learning tasks and the mode of their performance.

The first discriminant function with an emphasis on the most informative variables can be used to select a generalized mode of performing exercises of the series of tasks when teaching boys aged 10 the *mae-geri* (front kick) technique in kyokushin karate. A universal variant for teaching boys aged 10 series of tasks is the second mode of physical exercises: 3 sets with a rest interval of 60 seconds.

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