IMPACTS AND PREDICTION VALIDITY OF MORPHOLOGICAL AND MOTOR SKILLS ON MAWASHI GERI

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Original scientific paper

Abstract

A system of 24 dependent variables, and 1 criterion variable, were analysed on the sample of 82 karate-practising boys aged 10-14. There were 12 morphological variables, 12 basic motor skills variables, and the remaining one was the single criterion variable: the roundhouse kick (mawashi geri), as a specific situational motion structure. The purpose of this study was, on one hand, to determine the specific impact of each predictor variable on a single criterion variable (the roundhouse kick) with the forward stepwise regression model, and, on the other, to create a battery of instruments for the evaluation and monitoring of all the relevant parameters based on this prediction model, with the aim of planning, programming and monitoring of the effects of an operationalised training process. The results of the regression analysis demonstrated that only an integrated system of morphological variables had a significant impact (p=.02) on the roundhouse kick. The stepwise regression method has identified Shoulder breadth as the variable with the greatest individual impact (p=.00). As for the motor skills variables, it has been determined that Half-squat with weight (p=.04) had the greatest predictor value on the roundhouse kick, while Triple-jump (p=.00), Half-squat with weight (p=.02), and Long-jump from a standing start (p=.04), were shown to have the greatest predictor value by the stepwise regression analysis. Based on these results, we propose the following battery of tests to be used for the diagnostics, evaluation, monitoring and assessment of the roundhouse kick performance: shoulder breadth, triple-jump, long-jump from a standing start, and half-squat with weight.

Key words: *boys, motor behaviour, anthropometry, mawashi geri, predictor value.*

Introduction

Current trends in karate demand contemporary, up-to-date approaches to training technologies with young karate trainees, especially concerning the structure of anthropological characteristics, their correlations and specific impacts on athletic performance. Furthermore, it is necessary to determine the diagnostic and predictor validity of instruments used for modelling, diagnostics, planning, programming and monitoring of the effects of an operationalised training process (Kuleš, 1985; Mudrić, 1994; Doder, 1998; Doder, 2000; Doder, 2002).

In order to acquire the desired effects in a training and competition process of young karate trainees, it is essential to begin an early selection and apply appropriate training technologies that are based on a pre-constructed model, i.e. a desirable state (eg., model of complexity, sport specificity equation, hierarchical structure of anthropological characteristics), as well as on the validity of the constructed instruments for evaluation and monitoring of the relevant motion structures and anthropological characteristics (Jovanović, 1988; Milošević, Zulić, & Božić, 1988; Jovanović, 1991).

The predictor/prognostic validity of instruments (i.e., assessments of motion structures and anthropological characteristics) in a sports discipline is established with the purpose of using the acquired results to anticipate or predict athletic performance. This method requires drawing of a representative subject sample, an assessment of their relevant anthropological characteristics and abilities, and subsequent investigation of the causal relationships with sport performance (or situational motion structures) leading to a final calculation of their predictor validity. These relations may be univariate or multivariate, in which correlation between the criterion variable and a whole system of the tested predictor variables is determined, most often by way of multiple regression and/or stepwise analysis (Malacko & Popović, 2001; Malacko & Doder, 2008). More recent studies confirm the aforesaid observations regarding the duration and complexity of the leg vs. arm techniques in karate (Robazza, Bortoli, & Hanin, 2004; Doder, D. & Doder, R. 2006). When we talk about the leg techniques, one must have in mind that they are performed from a longer distance, hence covering a longer path with lower precision.

For these very reasons, they are easier to 'recognize' or detect because of the related compensatory movements both prior to and after a kick. They are also riskier balancewise, and more difficult to control in the ultimate phase of the movement. It is important to stress that out-of-control kicks are sanctioned by the rules, thereby inhibiting the competitor's intentions for a rapid, explosive, powerful kick, whilst giving the defender additional time for a reaction. Mawashi geri is also called the 'roundhouse kick', the name indicative of its circular form. Very attractive and efficient, it is frequently used in a free combat, especially performed at around the height of the opponent's head.

This kick is often done in combination with other upper- or lower-limb techniques, requiring excellent technical skill, flexibility and superb balance. Moreover, it has been previously reported that leg techniques contribute with about 10% of the total points scored, with mawashi geri contributing the most with 6.63% of all points scored (Mudrić, Jovanović & Gužvica, 1988). The main goals of this study were, on one hand, to determine the specific impact of each predictor variable on the single criterion variable (roundhouse kick), and, on the other, to create a battery of instruments for the evaluation, programming and monitoring of all the relevant parameters based on this prediction model.

Methods

Entity sample

A total of 82 boys, aged 10-14, from 18 different karate clubs from the Serbian Province of Vojvodina, participated in this study. Parental consent was obtained for each participant. All the assessments took place in the Sports Performance Centre of the Faculty of Sport and Physical Education, University of Novi Sad, Novi Sad, Serbia. Testing conditions were strictly controlled, with the room temperature set at 18-22°C. All measurements were taken approximately at the same time of the morning, and the instruments calibrated prior to each session.

Variables sample

The following predictor variables for the assessment of morphological characteristics were applied: *longitudinal dimensions* - 1. body height (HEIGHT), 2. leg length (LEG), 3. arm length (ARM); *transverse dimensions*: 4. shoulder breadth (SHOULD), 5. pelvic breadth (PELVIS), 6. wrist diameter (WRIST); *body volumes:* 7. mid-chest circumference (CHEST), 8. forearm girth (FORARM), 9. body mass (MASS); *subcutaneous skinfolds*: 10. triceps skinfold (TRICEP), 11. abdominal skinfold (ABS), and 12. subscapular skinfold (SUBSCA).

The following predictor variables for the assessment of basic motor skills were used: *motion structure mechanisms* - 1. agility in the air (AGIL), 2. single-hand plate tapping (HANTAP), 3. foot tapping (FOOTAP); *tonus regulation and synergistic action mechanisms*: 4. stand and reach on the bench (BEND), 5. single-leg balance on the balance beam (BAL), 6. step-over the yardstick (STEP); *mechanisms of regulation of excitation duration*: 7. 30-sec sit-ups (SITUP), 8. push-ups on parallel bars (PUSHUP), 9. half-squat with weight (HALFSQ); *mechanisms of regulation of excitation intensity*: 10. long-jump from a standing start (JUMP), 11. triple-jump from a standing start (3JUMP), and 12. 20-m run from a flying start (RUN).

The Roundhouse kick (mawashi geri) was used as the single criterion variable (situational motion structure). The roundhouse kick performance was tested in the following way: each participant was supposed to stand in a standard karate combat stance, about 1 m away from the contact electronic touch-plate which was fixed to the wall, at ~80 cm above the ground. At the sound signal, he would perform the roundhouse kick to the best of his ability, making contact with the touch-plate and thus initiating an electronic signal that was recorded by a computer processor. Each subject had three attempts, with only the best one recorded (in 1/100 sec) for subsequent analysis. This assessment has been used in previous studies (Milošević & Zulić, 1988; J; Arlov, 1993; Mudrić, 1994), and was shown to have good metric characteristics. Additionally, it has been extensively applied at the Exercise Laboratory of the University of Belgrade's Faculty of Sport and Physical Education, as well as the Belgrade Police Academy, for testing specific speed/explosiveness.

Data processing methods

Descriptive statistics included calculations of central and dispersion parameters: arithmetic mean (M), standard deviation (SD), standard error of mean (SE), minimum (Min) and maximum scores (Max). Distribution normality was tested with skewness (Sk) and curtosis (Cu). A regression analysis was applied for the determination of the impacts of all variables on the Roundhouse kick (mawashi geri) as the single criterion variable. The following univariate statistic parameters were also used: β – individual impact of each standardized predictor variable on the criterion variable; t-test – testing of the significance of each predictor variable's individual impact on the criterion variable; p – the set level of statistical significance of each predictor variable's impact on the criterion variable p=.05-00. Multivariate analyses yielded the following parameters: R_o^2–multiple correlation squared, or the predictor variables' system total variance; R_o–multiple correlations of

the whole system of predictor variables with the criterion variable; F–testing of significance by means of F-ratios; p–the set level of statistical significance of the impact of the whole system of predictor variables on the criterion variable p=.05-.00. The forward stepwise method was applied as a part of the regression analysis. It is characterized by a step-by-step addition of predictor variables in a certain order, determined by the size and significance (p) of their univariate and multivariate impact on the criterion variable. The main purpose of this method is to single out those regression procedures that provide us with the most information about a criterion variable, and also to evaluate and interpret the contributions of the individual or pooled predictor variables to the criterion variable's total variance. In this way, the predictor variables' prognostic validity or predicting value is established, considering their optimal number, multivariate and univariate multiple correlation coefficient (R_o), multiple correlation squared (R_o^2) as well as the individual multiple correlation squared (R_o^2)(p).

Results

It is clear from Table 1 (below) that the majority of the morphological variables do not vary significantly from normal distribution, excluding subscapular (Sk=2.35) and abdominal skinfold (Sk=1.67) and pelvic breadth (Sk=1.23). The positive asymmetric measurements indicate that young karate trainees have wider pelvis and somewhat increased content of subcutaneous fat tissue. Like the morphological variables, the majority of the applied basic motor variables do not deviate significantly from normal distribution (Table 2). This demonstrates that the selected assessments were indeed discriminative enough, except for single-leg balance on the balance beam (Sk=2.25), push-ups on the parallel bars (Sk=1.64) and stand and reach on the bench (Sk=-1.17), due to high occurrence of low scores on these tests. Finally, the results for roundhouse kick (mawashi geri) as a situational motion structure (technical element) do not significantly vary from the normal distribution (Sk=-.19).

Table 1. Central and dispersion parameters of morphological measurements

Variables	M	SD	SE	Min	Max	Sk	Cu
HEIGHT	149.88	13.16	1.45	120.90	182.40	**.21***	-.43
LEG	86.05	7.72	.85	71.70	104.30	**.16***	-.67
ARM	63.19	6.26	.69	49.60	79.10	**.28***	-.33
SHOULD	31.98	3.17	.35	25.10	41.50	**.21***	.08
PELVIS	23.23	2.77	.30	15.90	36.40	1.23	5.39
WRIST	4.80	.46	.05	3.90	5.90	**.11***	-.52
CHEST	70.35	7.96	.87	56.50	91.50	**.38***	-.43
FORARM	21.05	2.26	.25	17.10	29.20	**.66***	1.10
MASS	39.68	11.05	1.22	20.00	72.00	**.53***	-.07
TRICEP	10.64	4.35	.48	1.60	23.60	**.89***	.57
ABS	10.83	8.53	.94	2.40	40.00	1.67	2.38
SUBSCA	9.50	5.41	.59	4.00	34.80	2.35	6.58

M - arithmetic mean, SD - standard deviation, SE - standard error of arithmetic mean, Min/Max - minimal/maximal score, Sk - skewness, Cu – curtosis.
HEIGHT - body height, LEG - leg length, ARM - arm length, SHOULD - shoulder breadth, PELVIS - pelvic breadth, WRIST - wrist diameter, CHEST - mid-chest circumference, FORARM - forearm girth, MASS – body mass, TRICEP – triceps skinfold, ABS – abdominal skinfold, SUBSCA – subscapular skinfold.

Table 2. Central and dispersion parameters of basic motor skills

Variables	M	SD	SE	Min	Max	Sk	Cu
AGIL	15.30	1.79	.19	11.80	20.00	**.55***	.49
HANTAP	41.37	6.70	.74	24.00	55.00	**.09***	-.16
FOOTAP	53.87	5.61	.61	32.00	66.00	**-.55***	1.80
BEND	42.95	6.61	.73	17.00	53.00	-1.17	2.57
BAL	14.31	9.57	1.05	1.70	59.20	2.25	7.69
STEP	5.99	1.19	.13	2.30	8.60	**-.58***	.78
SITUP	23.12	3.31	.36	15.00	34.00	**-.08***	.90
PUSHUP	1.62	2.14	.23	.00	8.00	1.64	2.07
HALFSQ	4.69	2.05	2.26	4.00	11.40	**.73***	1.08
JUMP	161.13	25.61	2.82	105.00	240.00	**.11***	-.01
3JUMP	502.20	71.15	7.85	313.00	700.00	**.32***	.27
RUN	3.83	.35	.03	3.10	4.80	**.18***	-.15

M - arithmetic mean, SD - standard deviation, SE - standard error of arithmetic mean, Min/Max - minimal/maximal score, Sk - skewness, Cu – curtosis.
AGIL - agility in the air, HANTAP – single-hand tapping, FOOTAP - foot tapping, BEND - hyper-extension on the bench, BAL – single-leg standing on the balance beam, STEP – step foreward with baton, SITUP – 30-sec sit-ups, PUSHUP – push-ups on parallel bars, HALFSQ - half-squat with weight, JUMP – long-jump from a standing start, 3JUMP - triple-jump from a standing start, RUN - 20-m run from a flying start.

Table 3. Impact of the morphological variables system on the criterion variable (Roundhouse kick).

Variables	B	t	p
HEIGHT	-.72	-1.49	.14
LEG	.27	.85	.39
ARM	-.29	-1.12	.26
SHOULD	-.33	-1.53	.12
PELVIS	.13	.70	.48
WRIST	.09	.36	.71
CHEST	-.00	-.00	.99
FORARM	.03	.11	.90
MASS	.45	.97	.36
TRICEP	.02	.20	.83
ABS	-.00	-.03	.97
SUBSCA	-.10	-.49	.62

Ro^2=.27 **Ro=**.52 **F=**2.17 **p =.02***

R_o - multiple correlation, **Ro^2** - predictor value of the whole system, **Ro^2 (p) -** individual predictor value, **F -** F-ratio, **B** – individual impact on the criterion variable, **t** – test of statistical significance of impact, **p** – level of significance of impact.

Table 3 shows the impact of the morphological predictor variables' system on the criterion variable (Roundhouse kick). The calculated multiple correlation of .52 (R_o=.52) demonstrated a significant impact this system had on the Roundhouse kick at .02 (p=.02). Considering the squared value of multiple correlation of .27 (R_o^2 =.27), we may conclude that 27% of the criterion variable's total variance can be accounted for by the applied system of morphological variables.

Table 4. Predictor value of morphological variables

Variables	Ro	Ro^2	Ro^2 (p)	F	p
SHOULD	.45	.20	.20	20.52	**.00***
WRIST	.46	.21	.01	1.52	.22
MASS	.49	.24	.02	2.37	.12

Ro^2 = .24 **Ro** = .49 **F** = 8.31 **p** = **.00***

R_o - multiple correlation**, Ro^2** - predictor value of the whole System, **Ro^2 (p) -** individual predictor value, **F -** F-ratio, **p -** statistical importance of the system influence.

The subsequent stepwise analysis (Table 4) yielded a correlation of .49 (R_o=.49), whereas a reduced, three-variable system, had a significant impact on the criterion variable at .00 (p=.00). This accounted for some 24% of the total variance, as shown by the multiple correlation squared of .24 (R_o^2=.24), with Shoulder breadth explaining 20% of the total variance at the level of significance of .00 (p=.00). Table 5 data reveal a significant impact of .60 (R_o=.60) of the entire system of basic motor skills variables on the criterion variable at .00 (p=.00). Additionally, the value of multiple correlation squared of .36 (R_o^2=.36) indicates that some 36% of the total variance can be accounted for by the motor skills system of variables. Of all the motor skills variables, only Half-squat with weight had a significant impact on the criterion variable at .04 (p=.04).

Table 5: Impact of the motor skills variables system on the criterion variable (Roundhouse kick)

Variables	B	t	p
AGIL	-.00	-.02	.97
HANTAP	.06	.54	.58
FOOTAP	-.08	-.64	.52
BEND	-.01	-.09	.92
BAL	-.00	-.04	.96
STEP	-.04	-.36	.71
SITUP	-.11	-.88	.37
PUSHUP	.01	.15	.88
HALFSQ	.25	2.02	**.04***
JUMP	-.26	-1.59	.11
3JUMP	-.31	-1.89	.06
RUN	-.04	-.29	.76

Ro^2=.36 **Ro**=.60 **F**=3.28 **p**=**.00***

R_o - multiple correlation, **Ro^2** - predictor value of the whole system, **Ro^2 (p) -** individual predictor value, **F -** F-ratio, **B** – individual impact on the criterion variable, **t** – test of statistical significance of impact, **p** – level of significance of impact.

Table 6. Predictor value of basic motor variables

Variables	Ro	Ro^2	Ro^2 (p)	F	p
3JUMP	.51	.26	.26	28.88	**.00***
HALFSQ	.55	.31	.04	5.19	**.02***
JUMP	.58	.34	.03	4.24	**.04***
SITUP	.59	.35	.01	1.32	.25

Ro^2=.35 **Ro**=.59 **F**=10.70 **p**=**.00***

R_o - multiple correlation**, Ro^2** - predictor value of the whole System, **Ro^2 (p) -** individual predictor value, **F -** F-ratio, **p -** statistical importance of the system influence.

A reduced, four-variable system of basic motor skills also had a significant impact on the criterion variable at .00 (p=.00), with multiple correlation of .59 (R_o=.59), and multiple correlation squared .35 (R_o^2=.35), hence explaining 35% of the total variance. Triple-jump from a standing start was found to have had the greatest predictor value of .26 (R_o^2=.26) on the criterion variable, which was significant at .00 (p=.00), accounting for 26% of the total variance. It was followed by Half-squat with load, with the multiple correlation squared of .04 (R_o^2=.04), significant at .02 (p=.02), explaining 4% of the total variance, and Long-jump with the predictor value of .03 (R_o^2=.03), accounting for 3% of total variance, significant at .04 (p=.04) (Table 6).

Discussion and conclusions

The regression analysis results showed that no individual morphological variable had a statistically significant impact on the sole criterion variable, mawashi geri or the Roundhouse kick. There was a significant impact, however, of the systems (all-variable and three-variable) of morphological variables, where Shoulder breadth had the greatest predictor value, as determined by the stepwise analysis method.

The roundhouse kick is largely influenced by the upper-body strength, 'responsible' for lifting a leg for the kick, and also quicker rotation of the standing leg. Accordingly, individuals with wider shoulders appear to perform the roundhouse kick more quickly and more forcefully. The regression analysis of basic motor skills data uncovered a significant impact of Half-squat with weight on the Roundhouse kick. From the standard fighting karate stance, the kicking leg is lifted and comes into the initial position, from which it acts like a spring waiting to be released. In the next phase, the hip is rotated quickly and forcefully, followed by an explosive motion forward of the knee and foot for the actual kick. The standing leg, its foot rotated by ~90%, is bent in the knee, representing a substantial source of energy - mostly through its isometric strength - for the roundhouse kick. The forward stepwise analysis of the motor skills results pointed to significant impacts of Triple-jump from a standing start, Half-squat with weight, and Long-jump from a standing start on the roundhouse kick. These findings provide further evidence of the critical role of explosive strength of the lower extremities for the successful performance of mawashi geri, as has been demonstrated earlier. In conclusion, based on our findings, we propose the following test-battery for evaluating, training, monitoring and predicting morphological characteristics and motor skills development: triple-jump from a standing start, half-squat with weight, long-jump from a standing start, and shoulder breadth.

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UTJECAJ I PREDIKTORSKA VALJANOST MORFOLOŠKIH I MOTORIČKIH VARIJABLI NA MAWASHI GERI

Sažetak

Na uzorku od 82 karatista, uzrasta od 10 do 14 godina, bio je primjenjen sustav od 25 varijabli, od toga 12 morfoloških, 12 bazično-motoričkih (kao sustavi prediktorskih varijabli) i jedna varijabla situacijske kretne strukture (kao kriterijska varijabla), s ciljem da se kod dječaka u karateu regresijsko-redukcijskim postupkom utvrdi utjecaj morfoloških i bazično-motoričkih varijabli na kriterij (kružni udarac nogom prema naprijed – mawashi geri). Također, da se na temelju utvrđene prognostičke valjanosti konstruira baterija mjernih instrumeneta za procjenu i praćenje relevantnih parametara, zbog svrsishodnog planiranja, programiranja i kontrole efekata operacionalnog trenažnog procesa. Rezultati regresijske analize su pokazali da samo prediktorski morfološki skup varijabli ima statistički značajan utjecaj (p=.02) na izvođenje kružnog udaraca nogom prema naprijed, što znači da samo njihova integralna struktura proizvodi efekat koji značajno utječe na rezultate ispitanika u kriteriju. Redukcijskom stepwise regresijskom analizom utvrđen je najveći pojedinačni utjecaj na kriterij varijable širina ramena (p=.00). Analizom bazično motoričkih varijabli utvrđeno je da statistički značajan utjecaj na izvođenje kružnog udaraca nogom prema naprijed ima samo izdržaj u polučučnju s opterećenjem (p=.04). Primjenom stepwise metode u okviru regresijske analize utvrđeno je da najveću pojedinačnu prediktorsku vrijednost imaju troskok (p=.00), izdržaj u polučučnju s opterećenjem (p=.02) i skok udalj s mjesta (p=.04). Utvrđivanjem prediktorske valjanosti pomoću regresijske analize i primjenom stepwise tehnike, može se konstruirati baterija mernih instrumenata za dijagnosticiranje, procjenu, praćenje i vrednovanje izvođenja kružnog udarca nogom. Ta baterija uključuje: širinu ramena, troskok, skok udalj s mjesta i izdržaj u polučučnju s opterećenjem.

Ključne riječi: *dečaci, motorika, morfološki, mawashi geri, prediktorska valjanost*

Received: July 27, 2009.
Accepted: October 11, 2009.
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