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# PREDICTOR VALIDITY OF MORPHOLOGICAL AND BASIC MOTOR VARIABLES FOR ASSESSMENT AND MONITORING OF THE KARATE PUNCH WITH THE LEAD ARM (OI-TSUKI)

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**ABSTRACT:** The purpose of this study was to determine the influence of morphological and basic motor variables on the karate forward punch (oi tsuki) as the only criterion variable, and secondly, to design a test battery for the assessment and monitoring of boys in karate, based on the predictive validity of the tested variables. A system of 25 variables in total – 12 morphological, 12 basic motor (the system of predictor variables) and 1 variable of situational moving structure (criterion variable), i.e. the karate punch with the lead arm (oi-tsuki) – was applied on a sample of 82 karate trainees aged between 10 and 14. The results of regression analysis showed that a system of morphological and basic motor variables had a significant impact on punching with the lead arm ($p<0.01$). The stepwise method identified the largest individual value in the case of morphological variables of arm length, upper arm skinfold and body mass at the level of significance $p<0.01$, whereas basic motor variables (long jump from a standing start and half squat with weight) also have a level of significance $p<0.01$. This shows that respondents with longer arms, less subcutaneous fat tissue on the upper arm, higher body mass and greater static and explosive strength of the lower extremities achieve better results. Determining predictor validity by regression analysis and the stepwise method is employed in order to diagnose, assess, monitor and evaluate the direct punch with the lead arm, so the next battery of measurement instruments can be constructed: arm length, upper arm skinfold, body mass, half squat with weight, long jump from a standing position.

**KEY WORDS:** boys, morphological characteristics, motor skills, oi-tsuki, predictor validity

## INTRODUCTION

Greater development of karate as a sport demands modern approaches, concepts, forms, activities and procedures in training technologies with young karate trainees, especially concerning the structure of anthropological characteristics, their correlations, and specific impacts on athletic performance. Moreover, 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 [15].

In order to acquire the desired effects in a training and competition process of young karate trainees, it is essential to apply appropriate training technologies that are based on a pre-constructed model, i.e. a desirable state (e.g., model of complexity, sport specificity equations, 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 determined by the bases of their measurement features [5,6,18].

Predictor validity of instruments is established with the purpose of using the acquired results in applied variables of moving and/or anthropological characteristics (as the system of predictor variables) to anticipate or predict athletic performance in a criterion variable on the basis of determined univariate and multivariate relations by way of regression and/or stepwise analysis [14].

Since the application of diagnostics of morphological characteristics and basic motor skills in the training process of karate trainees is related to an interdisciplinary approach, where the complexity of moving structures and anthropological interdisciplinary features of character is high, it is necessary to include as many basic, specific and situational measurement instruments as possible. While constructing the instruments, one must have in mind the information value of each measurement instrument, which means that the applied instruments must have satisfactory metric characteristics, such as diagnosis and/or predictor validity, objectivity, reliability and discrimination [4].

The aim of the research was to determine the impact of a predictor system of morphological and basic motor variables on the criterion variable in the case of karate-practising boys by applying regression analysis and a stepwise procedure, with the hypothesis that the battery of measurement instruments for estimation and monitoring of relevant parameters can be constructed in order to achieve reliable planning, programming and control of the effects of an operationalised training process.

## MATERIALS AND METHODS

*Participants.* A total of 82 boys, aged 10-14, from 18 different karate clubs from the Serbian Province of Vojvodina, participated in this study.

*Instruments*

The following predictor variables for the assessment of morphological characteristics were applied: *longitudinal dimensions* – 1. body height (BODHEI), 2. leg length (LEGLEN), 3. arm length (ARMLEN), *transverse dimensions* – 4. shoulder breadth (SHOBRE), 5. pelvic breadth (PELBRE), 6. wrist diameter (WRIDIA), *body volumes* – 7. mid-chest circumference (CIRCUM), 8. forearm girth (FORGIR), 9. body mass (BODMAS), *subcutaneous skinfolds* – 10. triceps skinfold (TRICSK), 11. abdominal skinfold (ABDSKI) and 12. subscapular skinfold (SUBSKI). Metric characteristics of morphological variables have been checked by a large number of researchers [12,24].

The following predictor variables for the assessment of basic motor skills were used: *motion structure mechanisms* – 1. agility in the air (AGIAIR), 2. single-hand plate tapping (HANDTA), 3. foot tapping (FOOTTA), *tonus regulation and synergistic action mechanisms* – 4. stand and reach on the bench (SBENCH), 5. single-leg balance on the balance beam (BALBEA ), 6. step over the yardstick (STYARD), *mechanisms of regulation of excitation duration* – 7. 30-s sit-ups (S-U30S), 8. push-ups on parallel bars (P-UPAB), 9. half-squat with weight (H-SQWW), *mechanisms of regulation of excitation intensity* – 10. long jump from a standing start (L-JFSS), 11. triple jump from a standing start (T-JFSS), and 12. 20-m run from a flying start (20MRFS). Metric characteristics of basic motor variables have been checked by a large number of researchers [9,12,24].

The punch with the lead arm (oi-tsuki) was used as the single criterion variable (situational motion structure). The punch with the lead arm was tested in the following way: each participant was supposed to stand in a standard karate combat stance, about 1 m from the contact electronic touch-plate which was fixed to the wall, at about 80 cm above the ground. At the sound signal, he would perform oi-tsuki 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 made three attempts, with only the best one recorded (in 1/100 s) for subsequent analysis. Metric characteristics of the best punch have been checked by a large number of researchers [16,17,20,28].

*Procedure*

All measurements were made at the sports hall of the Sport Centre of the Faculty of Physical Education, University of Novi Sad, Novi Sad, Serbia. The gym was spacious and bright, with a temperature of 18-22°C. All the tests were done in the morning. The instruments were standard and calibrated immediately prior to the testing. Participants wore a karate kimono. They had been informed of the procedures and potential risks, and gave their informed consent personally or had their parents do so if under 18.

*Statistical analysis*

Descriptive statistics included calculations of central and dispersion parameters: arithmetic mean (M), standard deviation (S), standard error of mean (Se), minimum (min) and maximum scores (max). Distribution normality was tested with skewness (Sk) and kurtosis (Ku).

A regression analysis was applied for the determination of the impacts of all variables on the punch with the lead arm (oi-tsuki).

**TABLE 1.** STATISTICAL PARAMETERS OF MORPHOLOGICAL VARIABLES

| Variables | M | Min | Max | S | Se | Sk | Ku |
|---|---|---|---|---|---|---|---|
| BODHEI (cm) | 149.88 | 120.90 | 182.40 | 13.16 | 1.45 | 0.21* | -0.43 |
| LEGLEN (cm) | 86.05 | 71.70 | 104.30 | 7.72 | 0.85 | 0.16* | -0.67 |
| ARMLEN (cm) | 63.19 | 49.60 | 79.10 | 6.26 | 0.69 | 0.28* | -0.33 |
| SHOBRE (cm) | 31.98 | 25.10 | 41.50 | 3.17 | 0.35 | 0.21* | 0.08 |
| PELBRE (cm) | 23.23 | 15.90 | 36.40 | 2.77 | 0.30 | 1.23 | 5.39 |
| WRIDIA (cm) | 4.80 | 3.90 | 5.90 | 0.46 | 0.05 | 0.11* | -0.52 |
| CIRCUM (cm) | 70.35 | 56.50 | 91.50 | 7.96 | 0.87 | 0.38* | -0.43 |
| FORGIR (cm) | 21.05 | 17.10 | 29.20 | 2.26 | 0.25 | 0.66* | 1.10 |
| BODMAS (kg) | 39.68 | 20.00 | 72.00 | 11.05 | 1.22 | 0.53* | -0.07 |
| TRICSK (mm) | 10.64 | 1.60 | 23.60 | 4.35 | 0.48 | 0.89* | 0.57 |
| ABDSKI (mm) | 10.83 | 2.40 | 40.00 | 8.53 | 0.94 | 1.67 | 2.38 |
| SUBSKI (mm) | 9.50 | 4.00 | 34.80 | 5.41 | 0.59 | 2.35 | 6.58 |

Note: M – arithmetic mean, min, max – minimal and maximum score, S – standard deviation, Se – standard error of arithmetic mean, Sk – skewness, Ku – kurtosis
Variables: body height (BODHEI), leg length (LEGLEN), arm length (ARMLEN), shoulder breadth (SHOBRE), pelvis breadth (PELBRE), wrist diameter (WRIDIA), mid-chest circumference (CIRCUM), forearm girth (FORGIR), body mass (BODMAS), triceps skinfold (TRICSK), abdominal skinfold (ABDSKI) and subscapular skinfold (SUBSKI).

**TABLE 2.** STATISTICAL PARAMETERS OF BASIC MOTOR SKILLS

| Variables | M | Min | Max | S | Se | SK | Ku |
|---|---|---|---|---|---|---|---|
| AGIAIR (s) | 15.30 | 11.80 | 20.00 | 1.79 | 0.19 | 0.55* | 0.49 |
| HANDTA (fr) | 41.37 | 24.00 | 55.00 | 6.70 | 0.74 | 0.09* | -0.16 |
| FOOTTA (fr) | 53.87 | 32.00 | 66.00 | 5.61 | 0.61 | -0.55* | 1.80 |
| SBENCH (cm) | 42.95 | 17.00 | 53.00 | 6.61 | 0.73 | -1.17 | 2.57 |
| BALBEA (s) | 14.31 | 1.70 | 59.20 | 9.57 | 1.05 | 2.25 | 7.69 |
| STYARD (s) | 5.99 | 2.30 | 8.60 | 1.19 | 0.13 | -0.58* | 0.78 |
| S-U30S (fr) | 23.12 | 15.00 | 34.00 | 3.31 | 0.36 | -0.08* | 0.90 |
| P-UPAB (fr) | 1.62 | 0.00 | 8.00 | 2.14 | 0.23 | 1.64 | 2.07 |
| H-SQWW (s) | 4.69 | 4.00 | 11.40 | 2.05 | 2.26 | 0.73* | 1.08 |
| L-JFSS (cm) | 161.13 | 105.00 | 240.00 | 25.61 | 2.82 | 0.11* | -0.01 |
| T-JFSS (cm) | 502.20 | 313.00 | 700.00 | 71.15 | 7.85 | 0.32* | 0.27 |
| 20MRFS (s) | 3.83 | 3.10 | 4.80 | 0.35 | 0.03 | 0.18* | -0.15 |

Note: M – arithmetic mean, min, max – minimal and maximum score, S – standard deviation, Se – standard error of arithmetic mean, Sk – skewness, Ku – kurtosis Variables: agility in the air (AGIAIR), 20-s single-hand tapping (HANDTA), 20-s foot tapping (FOOTTA), stand and reach on the bench (SBENCH), single-leg standing on the balance beam (BALBEA), step forward with a yardstick (STYARD), 30-s sit-ups (S-U30S), push-ups on parallel bars (P-UPAB), half squat with weight (H-SQWW), long jump from a standing start (L-JFSS), triple jump from a standing start (T-JFSS) and 20-m run from a flying start (20MRFS)

The following univariate statistical parameters were also used: β – individual impact of each standardized predictor variable on the criterion variable; t – testing of the significance of each predictor variable's individual impact on the criterion variable; and p – the set level of statistical significance of each predictor variable's impact on the criterion variable p=0.05 - 0.01. 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; and p – the set of statistical significance of the impact of the whole system of predictor variables on the criterion variable p=0.05 - 0.01.

The stepwise method was applied as 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 predictive value is established, considering their optimal number, multivariate and univariate multiple correlation coefficient (Ro), multiple correlation squared ($Ro^2$) as well as the individual multiple correlation squared, $Ro^2$(p).

## RESULTS

It is clear from Table 1 (below) that the majority of the morphological variables do not differ significantly from a 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 a 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 a 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 in these tests.

Table 3 shows that the calculated value of multiple correlation is 0.60 (Ro=0.60), and that the applied system of morphological variables has a significant impact on the punch with the lead arm (oi-tsuki) at p<0.01. Considering the squared value of multiple correlation of 0.36 ($Ro^2$=0.36), we may conclude that 27% of the criterion variable's total variance can be accounted for by the applied

**TABLE 3.** IMPACT OF THE MORPHOLOGICAL VARIABLE SYSTEM ON THE CRITERION VARIABLE OI-TSUKI

| Variables | β | t | p |
|---|---|---|---|
| BODHEI | 0.13 | 0.30 | 0.76 |
| LEGLEN | 0.16 | 0.53 | 0.59 |
| ARMLEN | -0.67 | -2.71 | <0.01* |
| SHOBRE | -0.06 | -0.30 | 0.76 |
| PELBRE | -0.05 | -0.31 | 0.75 |
| WRIDIA | 0.12 | 0.48 | 0.62 |
| CIRCUM | -0.71 | -2.74 | <0.01* |
| FORGIR | -0.23 | -0.83 | 0.40 |
| BODMAS | 0.87 | 1.88 | 0.06 |
| TRICSK | 0.22 | 1.76 | 0.08 |
| ABDSKI | 0.27 | 1.21 | 0.22 |
| SUBSKI | -0.28 | -1.52 | 0.13 |
| $Ro^2$=0.36 Ro=0.60 F=3.29 p<0.01* | | | |

Note: β – individual impact of each standardized predictor variable on the criterion variable, t – 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

**TABLE 4.** PREDICTOR VALIDITY OF MORPHOLOGICAL VARIABLES

| Variables | Ro | $Ro^2$ | $Ro^2$(p) | F | p |
|---|---|---|---|---|---|
| ARMLEN | 0.39 | 0.15 | 0.15 | 14.80 | <0.01* |
| TRICSK | 0.48 | 0.23 | 0.07 | 8.24 | <0.01* |
| BODMAS | 0.56 | 0.32 | 0.06 | 7.92 | <0.01* |
| CIRCUM | 0.50 | 0.25 | 0.01 | 1.91 | 0.17 |
| SUBSKI | 0.58 | 0.33 | 0.01 | 1.82 | 0.18 |
| $Ro^2$=0.33 Ro=0.58 F=.7.81 p<0.01* | | | | | |

Note: $R_o$ – multiple correlation; $Ro^2$ – predictor value of the whole system; $Ro^2$ (p) – individual predictor value; F – F-ratio; p – statistical significance of the influence of the whole reduced system, Variables: arm length (ARMLEN), abdominal skinfold (TRICSK), body mass (BODMAS), mid-chest circumference (CIRCUM), subscapular skinfold (SUBSKI).

**TABLE 5.**IMPACT OF THE SYSTEM OF PREDICTOR BASIC MOTOR VARIABLES ON THE CRITERION VARIABLE OI-TSUKI

| Variables | β | t | p |
|---|---|---|---|
| AGIAIR | -0.09 | -0.79 | 0.42 |
| HANDTA | 0.12 | 0.99 | 0.32 |
| FOOTTA | -0.17 | -1.31 | 0.19 |
| SBENCH | 0.14 | 1.13 | 0.25 |
| BALBEA | 0.10 | 0.95 | 0.34 |
| STYARD | 0.06 | 0.54 | 0.58 |
| S-U30S | -0.00 | -0.07 | 0.94 |
| P-UPAB | -0.05 | -0.41 | 0.67 |
| H-SQWW | 0.35 | 2.79 | <0.01* |
| L-JFSS | -0.37 | -2.27 | 0.02* |
| T-JFSS | -0.26 | -1.58 | 0.11 |
| 20MRFS | 0.05 | 0.37 | 0.70 |
| $Ro^2$=0.38 Ro=0.61 F=3.56 p<0.01* | | | |

Note: β – individual impact of each standardized predictor variable on the criterion variable, t – 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

**TABLE 6.** PREDICTOR VALIDITY OF BASIC MOTOR VARIABLES

| Variables | Ro | $Ro^2$ | $Ro^2$(p) | F | p |
|---|---|---|---|---|---|
| L-JFSS | 0.44 | 0.19 | 0.19 | 19.79 | <0.01* |
| H-SQWW | 0.56 | 0.31 | 0.12 | 13.98 | <0.01* |
| T-JFSS | 0.58 | 0.33 | 0.01 | 2.06 | 0.15 |
| Ro2=.33 Ro=.58 F=13.18 p<0.01* | | | | | |

Note: Ro – multiple correlation; $Ro^2$ – predictor value of the whole system; $Ro^2$ (p) – individual predictor value; F – F-ratio; p – statistical significance of the influence of the whole reduced system
Variables: long jump from a standing start (L-JFSS), half squat with weight (H-SQWW), triple jump from a standing start (T-JFSS)

system of morphological variables. On the basis of calculated individual values of statistical parameters with the regression analysis, we may state that arm length (ARMLEN) and mid-chest circumference (CIRCUM) have the greatest impact on the criterion variable at p<0.01.

The subsequent stepwise analysis (Table 5) yielded a multiple correlation of 0.58 (Ro=0.58), whereas a reduced, three-variable system had a significant impact on the criterion variable at p<0.01. Since multiple correlation squared accounts for 0.33 ($Ro^2$=0.33), it means that 33% of the total variance can participate in prediction of the success of a reduced system of morphological variables on the criterion variable. Of all the variables, arm length has the largest predictor value (15%), followed by triceps skinfold (7%), and body mass (6% of the explained variance), and all are at the significance level of p<0.01.

Table 5 data reveal that the system of predictor basic motor skills variables on the criterion variable oi-tsuki has a significant impact of p<0.01 and multiple correlation of 0.61 (Ro=0.61). Additionally, the value of multiple correlation squared of 0.38 ($Ro^2$=0.38) indicates that some 38% of the total variance can be accounted for by the basic motor skills system of variables on oi-tsuki. On the basis of analysis of individual basic motor variables, one may conclude that half squat with weight at the significance level of p<0.01 has the most significant influence on the criterion variable oi-tsuki as well as long jump from a standing start of 0.02 (p=0.02).

A reduced stepwise three-variable system of basic motor skills (Table 6) also had a significant impact on the criterion variable oi-tsuki at p<0.01. Multiple correlation is 0.58 (Ro=0.58), and multiple correlation squared is 0.33 ($Ro^2$=0.33), which means that 33% of total variance can participate in prediction of success of the applied system of basic motor variables on the criterion variable. Long jump from a standing position was found to have the greatest predictor value of 19%, which is followed by half squat with weight accounting for 12%; both have a statistical significance of p<0.01.

## DISCUSSION

Within contemporary theory and practice of karate in order to solve the most comprehensive tasks of successful management of the sports training process we use different measurements of motion structures and anthropological characteristics and abilities, which is one of the most complex problems due to the overlapping of interconnected basic, specific and situational characteristics that often cannot be measured without harming the unity of the human body. This complexity becomes more dominant along with the diversity of human motion behaviour and load in different situations in competitions.

It is believed that there are five hand-arm techniques in karate combat: giaku tsuki diodan, giaku tsuki cudan, kizami tsuki, oi tsuki and uraken uchi. Oi tsuki has become one of the most performed, most effective techniques in a modified technical-tactical form. Hand punches are more natural than leg kicks; they are quicker, more easily controlled, and harder to block or avoid, which can easily explain why they are more often used in karate combat than leg kicks [1,10].

There has been little research on the speed of performing oi-tsuki from zenkutsu-dachi. It has been measured to be anywhere from 0.57 to 0.98 s [8,17,19,22]. The average speed in our study for oi-tsuki was 0.82 s.

Plagenhoef investigated a boxer's punch and a karate chop and presented tracings in two planes. He concluded that the energy which can be transferred from a human body to an object depends on the striking mass, the velocity of the striking mass, and the rigidity of the human body [21].

The punch studied herein is the oi-tsuki (lunge punch) in zenkutsu-dachi (front stance). A common description found for this skill is as follows. In the zenkutsu-dachi position the knee and hip of the front leg are flexed. The rear leg is extended at the knee with the hip joint in outward rotation. The rear foot is dorsiflexed at the ankle and directed forward and outward. The outward rotation of the ankle is between 20 and 45 degrees. Weight distribution on the front and rear feet is 60 and 40%. The length of the stance is twice the width of the karateka's shoulders. The fist with which the punch is delivered is placed at the waist, forearm supinated. During the forward motion in zenkutsu-dachi the rear leg slides forward and at the same time the fist is accelerated as the forearm extends at the elbow and the arm flexes at the shoulder. The fist starts at the waist with the closed palm upward and as the fist is moved forward, the forearm pronates until the closed palm is downward when the arm is fully extended [13,26,27].

Authors of karate books disagree about certain aspects of an oi-tsuki in zenkutsu-dachi. They disagree about the turn-out angle of the rear foot, the weight distribution on the front and rear feet, and the length and width of the stance. Nakayama said the front foot should bear 60% of the body's weight and the rear foot 40% [20]. Song claimed that 70% of the body's weight is supported by the front foot and 30% by the rear. The turn-out angle of the rear foot should be between 20 and 30 degrees [23]. Ventrusca suggested a turn-out angle of 45 degrees of the rear foot [25].

The regression analysis results showed that the whole system of applied morphological variables has a statistically significant impact of $p<0.01$ on the punch with the lead arm (oi-tsuki), whereas among individual variables there are arm length and mid-chest circumference. Stepwise analysis showed that the variables arm length, triceps skinfold and body mass have the greatest predictor validity. Specifically, this means that the best time scores for making a direct punch with the lead arm and with the fore part of a fist and full step were shared by trainees with longer arms, less subcutaneous fat tissue on the upper arm and higher body mass, which represents more developed muscularity that enables strong and fast motion as well as faster and more explosive punching [7,11].

As far as basic motor skills are concerned, regression and stepwise analysis showed that the whole system of applied basic motor variables ($p<0.01$) has a statistically significant impact on making a direct punch with the lead arm; among individual variables, half squat with weight and long jump from a standing start are the most significant. Regarding the acquired data, it can be said that the trainees with larger basic static and explosive strength of the lower extremities had better results in making a direct punch with the lead arm and with the fore part of a fist and full step. Static strength intended for making pressure over the pelvis, knees and feet on the ground speeds up the making of this punch because the ground reacts with the same force in an upward direction, causing energy potential that gathers through the knees in the lower part of the abdomen along with explosive forward motion. When performing oi-tsuki, it is essential to move forward fast, which demands greater static and explosive strength of the lower extremities that is the main source of energy [3,16,18] and is responsible for fast motion and punching [2].

Having predictor validity determined by regression analysis and the stepwise method, the next battery of instruments can be constructed in order to diagnose, assess, monitor and evaluate the punch with the lead arm (oi-tsuki); these are arm length, mid-chest circumference, triceps skinfold, body mass, half squat with weight and long jump from a standing start.

## CONCLUSIONS

The results showed that the system of predictor morphological and basic motor variables has a statistically significant impact on making a direct punch with the lead arm (oi-tsuki) at $p<0.01$. The stepwise method showed that the morphological variables arm length, triceps skinfold and body mass at $p<0.01$ have the greatest predictor values; among basic motor variables there are long jump from a standing start and half squat with weight also at $p<0.01$. This shows that better results in making a direct punch with the lead arm are achieved by trainees having longer arms, less subcutaneous fat tissue on the upper arm, higher body mass, and greater static and explosive strength of the lower extremities.

The process of determining predictor validity by regression analysis and the stepwise method is possible in order to diagnose, assess, monitor and evaluate the punch with the lead arm (oi-tsuki) so the following battery of instruments can be constructed: arm length, triceps skinfold, body mass, half squat with weight and long jump from a standing position.

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