

IMPACT OF MORPHOLOGICAL CHARACTERISTICS AND MOTOR SKILLS WHEN PERFORMING GYAKU TSUKI

IMPACTO DAS CARACTERÍSTICAS MORFOLÓGICAS E DAS HABILIDADES MOTORAS AO REALIZAR GYAKU TSUKI

IMPACTO DE LAS CARACTERÍSTICAS MORFOLÓGICAS Y DE LAS DESTREZAS MOTORAS AL REALIZAR GYAKU TSUKI

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ABSTRACT

Objective: The aim of this study was to determine the influence of morphology on karate characteristics and basic motor skills for the criterion variable counter-punch (gyako zuki) in boys, after a two-year training program. **Methods:** A system of 25 variables (12 morphological, 12 motor, and one situational (gyako zuki)) was applied in a sample of 82 karatists, aged 10 to 14 years. Data were processed using regression analysis. **Results:** Body weight had a statistically significant influence on the criterion variable in the initial measurement, as well as on the triceps and back skinfolds in the final measurement. In the motor space, semi-squat endurance had a significant impact on both initial and final measurements. In the reduced system, triple jump, half-squat endurance, and long jump impacted the initial measurement, while the 30-second torso lift, hyperextension on the bench, and semi-squat endurance impacted the final measurement. **Conclusion:** From the data obtained, it can be concluded that the counter-punch (gyako zuki) performance results were better in participants with higher body weight, longer arms, less subcutaneous upper arm and back fat, greater static and explosive power in the lower limbs, and greater hamstring and spine flexibility. **Evidence Level II; Therapeutic Studies – Investigating the results.**

Keywords: Karate; Boys; Anthropometry; Motor skills; Gyaku Tsuki.

RESUMO

Objetivo: O objetivo deste estudo foi determinar a influência das características morfológicas e habilidades motoras básicas na variável critério contra-golpe com a mão (gyako zuki) em meninos lutadores de karatê depois de um programa de treinamento de dois anos. **Métodos:** Em uma amostra de 82 lutadores de karatê com idades entre 10 a 14 anos, foi aplicado um sistema de 25 variáveis (12 morfológicas, 12 motoras e uma situacional [gyako zuki]). Os dados foram processados por meio de análise de regressão. **Resultados:** O peso corporal teve influência estatisticamente significativa sobre a variável critério na medição inicial, assim como nas dobras cutâneas triptais e dorsais na medição final. No espaço motor, a resistência no meio agachamento teve impacto significativo nas medidas iniciais e finais. No sistema reduzido, salto triplo, resistência no meio agachamento e salto em distância tiveram impacto na medição inicial, enquanto elevação de tronco em 30 segundos, hiperextensão em mesa e resistência no meio agachamento tiveram impacto sobre a medição final. **Conclusões:** A partir dos dados obtidos, pode-se concluir que os resultados de desempenho do contra-golpe com a mão (gyako zuki) foram melhores nos indivíduos com maior peso corporal, com braços mais longos, menos gordura subcutânea no braço e nas costas, maior poder estático e explosivo nos membros inferiores e maior flexibilidade nos músculos isquiotibiais e na coluna vertebral. **Nível de Evidência II; Estudos Terapêuticos - Investigação de Resultados.**

Descritores: Karatê; Meninos; Antropometria; Destreza motora; Gyaku Tsuki.

RESUMEN

Objetivo: El objetivo de este estudio fue determinar la influencia de las características morfológicas y de las habilidades motoras básicas en la variable criterio contraataque con la mano (gyako tsuki) en niños practicantes de kárate durante un programa de entrenamiento de dos años. **Métodos:** Se aplicaron un total de 25 variables (12 morfológicas, 12 motoras y una situacional [gyako zuki]) a una muestra de 82 practicantes de kárate con edades entre 10 y 14 años. Los datos se procesaron mediante análisis de regresión. **Resultados:** El peso corporal tuvo una influencia estadísticamente significativa en la variable criterio durante la medición inicial, así como en los pliegues cutáneos del tríceps y del dorso en la medición final. En el espacio motor, la resistencia en la media sentadilla tuvo un impacto significativo en las mediciones iniciales y finales. En el sistema reducido, el triple salto, la resistencia en la media sentadilla y el salto de longitud tuvieron impacto en la medición inicial, mientras que la elevación del tronco en 30 segundos, la hiperextensión en mesa y la resistencia en la media sentadilla tuvieron impacto en la medición final. **Conclusiones:** A partir de los datos obtenidos, se puede concluir que los resultados de desempeño de la contraataque con la mano (gyako zuki) fueron mejores en los individuos con mayor peso corporal, brazos más largos, menos grasa subcutánea en el brazo y la espalda, más potencia estática y explosiva en los miembros inferiores y mayor flexibilidad en los isquiotibiales y la columna vertebral. **Nivel de Evidencia II; Estudios terapéuticos - Investigación de resultados.**

Descritores: Karate; Chicos; Antropometría; Destreza motora; Gyaku Tsuki.



INTRODUCTION

Previous numerous practical experiences and scientific researches¹⁻⁵ showed, that a well-programmed training process can effectively contribute to the successful transformation of the anthropological characteristics of children and youth. For these reasons, it is very important to know not only the development of morphological characteristics and motor abilities, but it is necessary to pay attention to those specific and situational abilities, crucial to achieving sports success, which need to be continuously measured, developed, controlled, adjusted and directed in order to achieve the most optimal effects in a shorter time intervals.

Nevertheless, today in karate, it has not been determined yet what are the factual training contents, methods, and loads needed to achieve the optimal effects of desired transformations under the given specific (situational) circumstances in working with young people. However, collecting of data on the development of basic anthropological characteristics and specific-situational move structures of athletes, followed by their statistical processing and monitoring, as well as determining the predictive validity of measuring instruments, is a good basis for their modeling and diagnosis, implementation of programmed training contents and as well performing the control and analysis of achieved training effects.⁶⁻⁹

Analyzed the final matches with the 3rd Senior European and 2nd World Cup. A total of 110 competitors in 55 fights in the men's competition were analyzed. Gyaku zuki's punch was the most represented with a total of 66.91%, in winning points in championships of the Europe and the World.¹⁰

The aim of this research was to determine the influence of predictor morphological and motor variables on the criterion variable gyaku tsuki in the initial and final measurement of young karates after a two-year training process.

METHOD

Respondents' sample

The sample consisted of 82 boys recruited from 18 karate clubs from the territory of the Province of Vojvodina (Novi Sad, Bečej, Subotica, Sremski Karlovci, Indija, Srbobran and Šid), aged 10-12 y, who regularly practiced karate and attended physical education at school, and who were both physically and mentally healthy. Parental consent forms were obtained for all participants. The subjects' parents were introduced to all the testing procedures, and subsequently, their informed consent forms were obtained. The study was performed in accordance with the Helsinki Declaration, and the experimental protocol was approved by the Ethics Committee of the Regional Institute of Sport and Sports Medicine (REC-96/2018.) prior to the beginning of the study. Prior to the initial testing, all subjects were examined by a licensed physician. Only healthy children could participate in the study.

Testing procedure

The following predictor variables for the assessment of morphological characteristics were applied¹¹: BOH – body height, LEL – leg length, ARL – arm length, SHS - shoulder span, PES - pelvic span, WRD - wrist diameter, MCG – mid-chest girth, LAG - lower-arm girth, BOM – body mass, UST – upper-arm skinfold thickness, AST – abdominal skinfold, SST – subscapular skinfold thickness. All measurements were taken as per IBP standards.

The following variables for the assessment of basic motor skills were used:¹² AIA – agility in the air, HAT – hand tapping, FOT – foot tapping, HOB – hyper extensions on the bench, BOF – balancing on one foot on a balance beam, SHF – shoulder flexibility with a yardstick, 30S – 30-sec sit-ups, PPB – push-ups on parallel bars, HSL – half-squat with load,

LSP – long-jump from a standing position, TSP – tripple-jump from a standing position, 20M – 20-m dash with a flying start. Metric characteristics of the basic motor variables have been previously validated.

The following variables for the assessment of specific motor variables were used: PGZ – reverse punch – gyaku tsuki.

Metric characteristics of the specific motor variables have been previously validated.¹³ (Figure 1)

The respondent took a fighting stance (fudo dachi) 1 meter from the contact focus, which was connected to a computer timer and an electronic signaling device for giving an audible signal and it was 80 cm high from the substrate. The hands were in the position of the middle combat guard, and the toes of the front foot at a distance of one meter from the contact focuser. On a beep signal, the subject performed a counter-blow with the opposite hand (gyako zuki-chudan), by sliding forward. The best time of three performed attempts with an accuracy of 1/100 second was calculated.

Statistical Analysis

For calculating the influence of the system of morphological and basic motor variables, (as a system of predictor variables) regression analysis was applied to the criterion variable gyaku tsuki within which the so-called "Stepwise" method, which is based on the gradual inclusion of variables ("step-by-step") by measuring their multivariate and univariate predictor influence on the criterion variable, as well as testing their statistical significance (P).

Experimental treatment

The experimental treatment was run in various karate clubs over a two-year period, in two one-year microcycles. The boys underwent a typical training regimen consisting of 2 x 60 minutes sessions weekly, for 40 weeks in total over the two years. Additionally, they participated in regular physical education classes at school 2 x 45 min/week. The program was based on the balance between motor skills and abilities and other aspects of overall children's development.

RESULTS

(Table 1) shows the influence of the predictor system of morphological variables on the criterion variable gyaku tsuki in the initial and final measurements. Based on the obtained value of multiple correlation of $R_o = .52$ in the initial measurement and $R_o = .56$ in the final measurement, the applied multivariate system of morphological variables in the initial measurement has a statistically significant effect on the gyaku tsuki criterion variable at the level of statistical significance $p = .02$, and final measurement $p = .00$. Since the square of the multiple correlations in the initial measurement is $R_o^2 = .27$, and in the final measurement $R_o^2 = .31$, this means that with 27% in the initial measurement and 31% in the final measurement of the total common variance, the success of

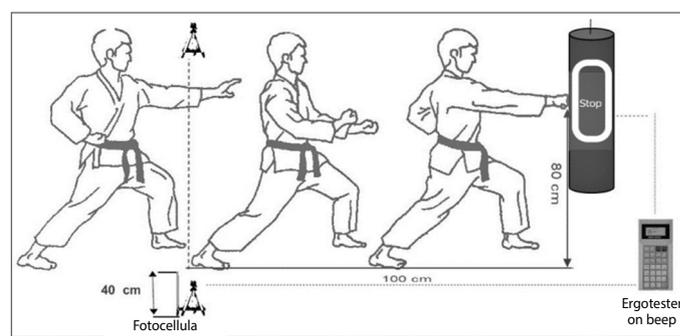


Figure 1. Execution procedure gyaku tsuki.

Table 1. Influence of the system of morphological variables in the initial and final measurement on the gyaku tsuki criterion variable.

a. impact		Initial measurement				Final measurement			
Morphological variables		β	E β	t	p	β	E β	t	p
BOH – body height (mm)	BOH	-0.05	0.48	-0.11	0.90	-0.01	0.42	-0.03	0.97
LEL – leg length (mm)	LEL	-0.08	0.32	-0.27	-0.78	-0.08	0.26	-0.32	0.74
ARL – arm length (mm)	ARL	-0.35	0.26	-1.34	0.18	-0.03	0.29	-0.12	0.90
SHS - shoulder span (mm)	SHS	-0.33	0.21	-1.51	0.13	-0.22	0.21	-1.01	0.31
PES - pelvic span (mm)	PES	-0.05	0.18	-0.31	0.75	-0.04	0.13	-0.34	0.72
WRD - wrist diameter (mm)	WRD	-0.06	0.26	-0.25	0.80	-0.15	0.20	-0.77	0.44
MCG – mid-chest girth (mm)	MCG	-0.02	0.27	-0.09	0.92	0.28	0.20	1.37	0.17
LAG - lower-arm girth (mm)	LAG	-0.47	0.30	-1.56	0.12	-0.13	0.24	-0.53	0.59
BOM – body mass (kg)	BOM	1.06	0.49	2.14	0.03*	0.31	0.40	-0.78	0.43
UST – upper-arm skinfold thickness (mm)	UST	0.20	0.13	1.48	0.14	0.60	0.13	4.44	0.00*
AST – abdominal skinfold thickness (mm)	AST	0.13	0.24	0.55	0.57	-0.07	0.16	-0.44	0.65
SST – subscapular skinfold thickness (mm)	SST	-0.30	0.20	-1.52	0.13	-0.25	0.17	-1.42	0.15

Ro² = 0,27 Ro = 0,52 F = 2,13 p = 0,02* Ro² = 0,31 Ro = 0,56 F = 2,65 p = 0,00*

b. predictor value - Initial measurement		Ro	Ro ²	Ro ² (p)	F	p
Varijables						
Arm length (mm)	ARL	0.36	0.13	0.13	12.45	0.00*
Upper-arm skinfold thickness (mm)	UST	0.42	0.18	0.04	4.56	0.03*

Ro² = 0,25 Ro = 0,50 F = 4,37 p = 0,00*

c- predictor value - final measurement		Ro	Ro ²	Ro ² (p)	F	p
Varijables						
Upper-arm skinfold thickness (mm)	UST	0.46	0.22	0.22	22.38	0.00*
Subscapular skinfold thickness (mm)	SST	0.51	0.26	0.04	4.52	0.03*

Ro² = 0,30 Ro = 0,54 F = 8,18 p = 0,00

the applied morphological variables in performing the criterion variable gyaku tsuki can be anticipated. (Table 1)

Based on the obtained univariate values of statistical parameters within the regression analysis, the only influence on the criterion variable in the initial measurement has the variable body weight at the level of statistical significance of $p = .03$, and in the final measurement the skin fold of the upper arm ($p = .00$). In the initial measurement, better results (faster stroke time) when performing the stroke with the opposite hand by sliding forward, had the subjects with higher body mass, which was responsible for strong and fast movement, had a hand, which helped to perform gyaku tsuki with higher speed force, primarily due to increased muscle mass. In the final measurement, the better time (lower values) for performing the gyaku tsuki stroke was achieved by the subjects with reduced values of subcutaneous fat tissue on the upper arm.

By the Stepwise method it has been determined that the obtained value of the multiple correlation was $Ro = .50$ in the initial measurement and $Ro = .54$ in the final measurement, as well as that the reduced system of two morphological variables (arm length and skin fold of the upper arm in the initial measurement and skin fold of the upper arm and skin fold of the back in the final measurement) based on their statistical significance of the influence on the criterion variable gyaku tsuki is $p = .00$. Since the square of the multiple correlation in the initial measurement is $Ro^2 = .25$, and in the final measurement $Ro^2 = .30$, this means that with 25% or 30% of the total common variance, the success of the reduced system of morphological variables on the criterion variable can be predicted.

The variables of arm length, which accounts for 13% of the explained variability at the level of significance $p = .00$, and the skin fold of the upper arm which accounts for 4% at the level of statistical significance $p = .03$ have the highest predictor value in the initial measurement. This specifically shows that the length of the arm is important for a quick performance of a direct punch with the opposite hand by sliding forward, because a longer arm reduces the distance to the target, and a larger amount of subcutaneous adipose tissue is a ballast in performing this technique. In the final measurement, the variables skin fold of the

upper arm have the highest predictor value at the level of $p = .00$, which accounts for 22%, followed by the skin fold of the back ($p = .03$), which accounts for 4% of the common variability. According to the obtained results, it can be stated that the direct punch with the opposite hand by sliding forward (gyaku tsuki) was performed faster by the subjects with a smaller amount of subcutaneous adipose tissue on the upper extremities and back.

(Table 2) shows the influence of the predictor system of motor variables on the criterion variable gyaku tsuki in the initial and final measurement. It can be stated that the system of predictor motor variables in the initial and final measurement has a statistically significant influence on the criterion variable gyaku tsuki at the level of $p = .00$, so that the multiple correlation coefficient in the initial and final measurement counts $Ro^2 = .61$, and the multiple correlation square in the initial measurement $Ro = .38$, and the final measurement $Ro^2 = .37$, which explains the partial variability of about 38% in the initial measurement, and about 37% in the final measurement.

Based on the obtained univariate values of statistical parameters within the frame of regression analysis, the only individual impact on the criterion variable in the initial measurement has the variable endurance in half-squat with load at the level of statistical significance of $p = .00$, and in the final measurement of the variable trunk lifting for 30 seconds ($p = .01$) and endurance in half-squat with load ($p = .03$).

By the Stepwise method, it was determined that the value of multiple correlations of $Ro^2 = .59$ in the initial measurement and $Ro^2 = .60$ in the final measurement was obtained, as well as that the reduced system of three motor variables based on their statistical significance of influence on the gyaku tsuki criterion variable is $p = .00$. Since the square of the multiple correlations in the initial measurement is $Ro^2 = .37$, and in the final measurement $Ro^2 = .36$, this means that with 37% or 36% of the total common variance, the success of the reduced system of motor variables on the criterion variable can be predicted.

The variable standing triple-jump has the highest predictor value in the initial measurement and accounts for 16% of the explained variability

Table 2. Influence of the system of motor variables in the initial and final measurement on the criterion variable gyaku tsuki.

a. impact		Initial measurement				Final measurement			
Basic motor variables		β	$E\beta$	t	p	β	$E\beta$	t	p
AIA – agility in the air (s)	AIA	-0,14	0,12	-1,18	0,24		0,12	-0,26	-0,78
HAT – hand tapping (fr)	HAT	0,14	0,12	1,12	0,26	-0,06	0,11	-0,58	0,56
FOT – foot tapping (fr)	FOT	-0,06	0,12	-0,50	0,61	-0,01	0,11	-0,15	0,87
HOB – hyperextensions on the bench (cm)	HOB	0,04	0,12	0,34	0,73	-0,09	0,11	-0,82	0,41
BOF – balancing on one foot on a balance beam (s)	BOF	0,17	0,11	1,55	0,12	0,05	0,10	0,50	0,61
SHF – shoulder flexibility with a yardstick (cm)	SHF	0,21	0,11	1,85	0,06	0,21	0,11	1,96	0,05
30S – 30-sec situps (fr)	30S	-0,16	0,12	-1,30	0,19	-0,31	0,12	-2,49	0,01*
PPB – pushups on parallel bars (fr)	PPB	-0,17	0,12	-1,36	0,17	0,07	0,12	0,56	0,57
HSL – half-squat with load (s)	TSP	0,42	0,12	3,39	0,00*	-0,24	0,11	-2,12	0,03*
LSP – long-jump from a standing position (cm)	LSP	-0,27	0,16	-1,67	0,09	-0,10	0,23	-0,46	0,64
TSP – tripple-jump from a standing position (cm)	TSP	-0,28	0,16	-1,75	0,08	0,00	0,16	0,04	0,96
20M – 20-m dash with a flying start (s)	20M	0,01	0,14	0,08	0,93	0,10	0,13	0,81	0,41

Ro² = 0,38 Ro = 0,61 F = 3,53 p = 0,00* Ro² = 0,37 Ro = 0,61 F = 3,51 p = 0,00

b. predictor value - initial measurement		Ro	Ro ²	Ro ² (p)	F	p
Variables						
Tripple-jump from a standing position (cm)	TSP	0,41	0,16	0,16	16,21	0,00*
30-sec situps (fr)	30S	0,50	0,25	0,08	8,82	0,00*
Long-jump from a standing position (cm)	LSP	0,53	0,28	0,03	3,73	0,05*

Ro² = 0,37 Ro = 0,59 F = 4,85 p = 0,00*

c predictor value – final measurement		Ro	Ro ²	Ro ² (p)	F	p
Variables						
30-sec situps (fr)	30S	0,48	0,23	0,23	25,22	0,00*
Hyperextensions on the bench (cm)	HOB	0,53	0,29	0,05	5,63	0,02*
Tripple-jump from a standing position (cm)	TSP	0,56	0,32	0,03	3,95	0,05*

Ro² = 0,36 Ro = 0,60 F = 8,90 p = 0,00*

at the level of significance $p = .00$, then endurance in half-squat with a load of 8% and standing long jump which accounts for 3% at the level of statistical significance $p = .05$. This specifically shows that in the initial measurement, the explosive and static power of the lower extremities played a priority role when performing a direct punch with the forearm sliding forward. In the final measurement, the variables of trunk lifting for 30 seconds at the level of $p = .00$, which accounts for 23%, followed by a deep bend forward on the bench with 5% ($p = .02$) and endurance in half-squat with a load with 3 % of common variability have the highest predictor value. According to the obtained results, it can be stated that the repetitive strength of the abdominal muscles played a primary role in performing gyaku tsuki, and the flexibility of the pelvic girdle and the static strength of the lower extremities had a significantly smaller contribution.

DISCUSSION

In compliance with the obtained results in morphological space in the initial measurement subjects with higher body weight had better results (better stroke time) in performing gyaku tsuki¹⁴ and by the stepwise method, it was found that the subjects with longer arms and less subcutaneous adipose tissue on the upper arm performed faster.¹⁵ Body mass was responsible for the strong and fast movement, which helped the gyaku tsuki to be performed at a higher speed force¹⁶ primarily due to the increased muscle mass.

The Stepwise method determined that the subjects in the initial measurement had a better time (lower values) of performing the gyaku tsuki punch than the subjects with longer arms which reduce the distance to the target, in addition to lower values of subcutaneous adipose tissue on the upper arm. In the final measurement, the subjects with lower values of subcutaneous adipose tissue on the upper arm and back had better results.¹⁷⁻¹⁹ This shows that the gyaku tsuki punch was performed faster by subjects with less subcutaneous adipose tissue on the upper extremities and back.

The results in the motor space in the initial measurement show that the speed of direct impact of gyaku tsuki was mostly influenced by static

force, and the stepwise method determined that they performed faster with increased static and explosive power.^{20,21} Static force is responsible for the initial creation of the motive force (pressure and imprints from the substrate) and explosive force²² for rapid and explosive movement. In the final measurement, the results showed that subjects with pronounced repetitive abdominal muscle strength and static leg strength had better gyaku tsuki performance times, while by the stepwise method it was found that they had performed faster with pronounced abdominal muscle repetitive strength, static leg strength and flexibility of hind thigh and spine. This indicates that the subjects in the final measurement had established control over the center of gravity of the body.

The review of literature showed that little research has been done which deals with the gjaky-tsuki performed in a fudo-dachi. In the forward punch (gjaky-tsuki) the fist reached speeds between 5.7 and 9.8 meters per second.²³⁻²⁵ 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.²⁶

Rosi and Tipargeri²⁷ recommend the use of the KPA scale as an assessment tool to determine the motivation and risk of pathological behavior of karate athletes.

The advantage of this research is that young karatists have been monitored for two years, and we suggest that similar or the same research in senior competition should be conducted.

CONCLUSION

We can conclude that better results in performing the counter-stroke (gyaku-zuki) had participants with higher body weight, longer arms, with less subcutaneous fat on the upper arms and back, as well as greater static and explosive power of the lower extremities.

The process of determining the validity of the predictor by regression analysis and a step-by-step method is possible in order to diagnose, evaluate, monitor, and estimate the arm punch (gyaku-zuki) and the following instrument batteries can be constructed: body weight, arm length, skin fold of upper arm and abdomen, body weight, half-squat with load and long jump, and standing triple jump.

The results obtained by this research can have their scientific, theoretical and practical application. When examining the influence of the dominant arm technique (gyako tsuki) on the anthropological status of young karats, it is of great importance that the explosive and static strength of the legs had the greatest predictor value,

which tells us that it should be developed in early childhood. From this we can conclude that a well-conceived karate program can give satisfactory effects and impacts in the most important anthropological segments, and the message as well that at this age we must work even harder on the integrity of anthropological characteristics and abilities. Limitations of this two-year-long research are that the testing of anthropological traits should be performed every three months.

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