[Baltic Journal of Health and Physical Activity](https://www.balticsportscience.com/journal)

Volume 2 | Issue 1 Article 4

2010

Relations between Bioelectrical Muscles Activity and Isokinetic Strength Parameters in 17–19-Year-Old Judoists

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Recommended Citation

Dornowski M. Relations between Bioelectrical Muscles Activity and Isokinetic Strength Parameters in 17–19-Year-Old Judoists. Balt J Health Phys Acti. 2010;2(1):42-47. doi: 10.2478/v10131-010-0004-y

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Abstract

Background: Muscle strength as an element of preparation and sport competition is one of the most important aspects in technical and tactical efficiency. The aim of this study was to define the level of relation between bioelectrical muscle activity and isokinetic strength parameters in 17–19-year-old judoists. Material/Methods: 30 judo athletes (17–19-year-old) took part in the research. The research was conducted in Gdańsk Academy of Physical Education and Sport Laboratory during 2006–2008. In the research authors used: to evaluate the isokinetic strength level, ”Concept 2 Dyno” device was used in the research, along with surface summary electrical bio-potentials reading on EMG AMT–8 CDN BORTEC BIOMEDICAL with ACQ software. Results: In the upper right limb there are more statistical significant correlations between isokinetic strength parameters and electrical muscle activities. In the lower limbs measurement of the left leg shows more significant correlations. Conclusions: Comparing the upper and lower limbs, it was noticed that the isokinetic strength parameters of the upper limbs are more correlated with the measured muscle electrical activities. Regarding the left and the right side comparison, the right side (the upper and the lower limb) isokinetic strength parameters are more correlated with the measured muscle activities.

Keywords

judo, muscle strength, electromyography

BALTIC JOURNAL OF HEALTH AND PHYSICAL ACTIVITY
©Academy of Physical Education and Sport in Gdansk, Volume 2, No 1, 2010, 42-47

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DOI: 10.2478/v10131-010-0004-y

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Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

Key words: *judo, muscle strength, electromyography.*

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Material/Methods: *30 judo athletes (17–19-year-old) took part in the research. The research was conducted in Gdańsk Academy of Physical Education and Sport Laboratory during 2006–2008. In the research authors used: to evaluate the isokinetic strength level, "Concept 2 Dyno" device was used in the research, along with surface summary electrical bio-potentials reading on EMG AMT–8 CDN BORTEC BIOMEDICAL with ACQ software.*

Results: *In the upper right limb there are more statistical significant correlations between isokinetic strength parameters and electrical muscle activities.*
In the lower limbs measurement of the left leg shows more significant correlations.

Conclusions: *Comparing the upper and lower limbs, it was noticed that the isokinetic strength parameters of the upper limbs are more correlated with the measured muscle electrical activities.*
Regarding the left and the right side comparison, the right side (the upper and the lower limb) isokinetic strength parameters are more correlated with the measured muscle activities.

Word count: 1644
Tables: 7
Figures: -
References: 28

Received: January 2010
Accepted: March 2010
Published: September 2010

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Introduction

Muscle strength, as an element of preparation and sport competition, is one of the most important aspects in technical and tactical efficiency. As such it plays a crucial role at particular stages of a sports career. In the contemporary approach to sport very diverse demands insofar as this ability are observed [1,2]. The analysis of shaping and demonstrating strength abilities is a necessary condition for modern control and optimising the sport training process [3,4].

Isokinetic strength develops in conditions automatically adjusted to an external load. Very essential in this kind of strength is an instant level of load during the movement task realization [5].

Extensive research regarding different kinds of human strength abilities has been carried out by for example: different muscles – Skład, Sulisz [6]; Erdmann [7], Mickiewicz-Zawadzka [8], Adam, Olszewski [9]; Hakkinen, Myllyla [10]; Little [11], Biegunow, Sełujanow [12]; Yen [13], Jagiełło, Tkaczuk [14]; isokinetic strength – Cho et al. [15]; Imaizumi, Arao [16]; Tsuyama et al. [17]; dynamic strength – Pustelnik [18].

EMG research, as a complementation of the mechanical muscle strength measurements, was used, for example, in sport games [19] or judo [20,21].

There are numerous findings regarding relations between static strength parameters and bioelectrical muscle activity [22,23,24]. They present high dependences between static strength indicators and EMG signals of recruited muscles. There are still no strong proofs of the existence relations between isokinetic strength parameters and bioelectrical muscle activity.

The aim of this study was to define the level of relation between bioelectrical muscle activity and isokinetic strength parameters in 17–19-year-old judoists.

Material and methods

30 judo athletes (17–19-year-old) participated in the research. The research was conducted in Gdańsk Academy of Physical Education and Sport Laboratory during 2006–2008.

In the study the author used:

1. “Concept 2 Dyno” device was used to evaluate the isokinetic strength level. The subjects had to perform: deflexion motion of the right and left upper and lower limbs separately and together. The deflexion movement was done from full flexion in the elbow and knee joints to the deflexion position in these joints. The trunk of the subjects was fixed in the perpendicular position with a face directed to a floor, thanks to stable thorax support on the training device seat. During the measurement 5 parameters were gathered: power, work, velocity, load, strength.
2. Surface summary electrical bio-potentials reading was obtained from EMG AMT – 8 CDN BORTEC BIOMEDICAL with ACQ software. Bio-potentials were gathered using surface electrodes (SORIMEX EK-S50WPSG). In the upper limbs emg signals were gathered from *biceps brachii caput longum* (right and left) and *triceps brachii caput lateralis* (right and left); from lower limbs: *quadratus femoris caput longum* (right and left) and *biceps femoris caput longum* (right and left)
3. Statistical analysis was perofrmed using software package STATISTICA 5.0. The author used: arithmetical mean, median, standard deviation and Spearman correlation coefficient.

Results

I. TASK WITH THE RIGHT UPPER LIMB

The strength, power and velocity parameter of isokinetic strength correlates with all (100%) measured muscle activity; work and load parameters correlate with biceps brachii electrical activity

(50%). A high correlation appeared between biceps brachii electrical activity and power, strength and velocity parameter level (Tab. 1).

Tab. 1. Relations between bioelectrical muscle activity and the right upper limb isokinetic strength parameters

Recruited muscle	Strength (kg)	Power (watt)	Work (j)	Velocity (m/s)	Load (c.u.)
biceps brachii caput longum (right)	-0.66**	-0.75**	-0.31*	-0.60**	0.46*
triceps brachii caput lateralis (right)	-0.33*	-0.38*	-0.03	-0.33*	0.12

** $0.3 \le rxy < 0.5$ average correlation factor*
*** $0.5 \le rxy < 0.7$ high correlation factor [25]*

II. TASK WITH THE LEFT UPPER LIMB

The velocity parameter of isokinetic strength correlates with all measured muscle activity (100%), the work parameter correlates with triceps brachii electrical activity (50%). Strength, power and load do not correlate with any of measured muscle activity. Although the correlations presented in Table 2 are statistically significant, their level is average (Tab. 2).

Tab. 2. Relation between bioelectrical muscle activity and the left upper limb isokinetic strength parameters

Recruited muscle	Strength (kg)	Power (watt)	Work (j)	Velocity (m/s)	Load (c.u.)
biceps brachii caput longum (left)	0.27	-0.15	-0.26	0.36*	-0.13
triceps brachii caput lateralis (left)	0.17	-0.14	-0.32*	0.36*	-0.21

** $0.3 \le rxy < 0.5$ average correlation factor*
*** $0.5 \le rxy < 0.7$ high correlation factor [25]*

III. TASK WITH THE RIGHT AND LEFT UPPER LIMB (TOGETHER)

Only the strength, power and velocity parameter of isokinetic strength correlates with one (25%) out of 4 measured muscle activities (left triceps brachii). Work and load parameters do not correlate with any of the measured muscle activity. The level of correlations between left triceps brachii electrical activity and the power and velocity parameter levels can be considered as important (Tab. 3).

Tab. 3. Relation between bioelectrical muscle activity and upper limbs isokinetic strength parameters

Recruited muscle	Strength (kg)	Power (watt)	Work (j)	Velocity (m/s)	Load (c.u.)
biceps brachii caput longum (right)	-0.12	-0.23	-0.26	-0.26	-0.17
triceps brachiii caput lateralis (right)	-0.42*	-0.50**	-0.30	-0.50**	-0.10
biceps brachii caput longum (left)	0.01	0.05	-0.12	0.14	-0.01
triceps brachii caput lateralis (left)	0.13	0.18	-0.05	0.26	-0.04

** $0.3 \le rxy < 0.5$ average correlation factor*
*** $0.5 \le rxy < 0.7$ high correlation factor [25]*

IV. TASK WITH THE RIGHT LOWER LIMB

Only the work parameter of the isokinetic strength correlates with the measured muscle activity (100%). All correlations coefficient levels are average (Tab. 4).

Tab. 4. Relation between bioelectrical muscle activity and the right lower limb isokinetic strength parameters

Recruited muscle	Strength (kg)	Power (watt)	Work (j)	Velocity (m/s)	Load (c.u.)
quadratus femoris caput longum (right)	0.16	0.11	0.38*	0.10	0.09
biceps femoris caput longum (right)	-0.01	-0.19	0.33*	0.00	0.11

* $0.3 \le rxy < 0.5$ average correlation factor
** $0.5 \le rxy < 0.7$ high correlation factor [25]

V. TASK WITH THE LEFT LOWER LIMB

Power, velocity and load parameters of the isokinetic strength correlate with all measured muscle activities (100%). The strength parameter correlates with one measured muscle activity (50%). The work parameter does not correlate with any of the measured muscle activity. Only one correlation can be taken into consideration – *quadratus femoris caput longum* (left) electrical activity with the load parameter level (Tab. 5).

Tab. 5. Relation between bioelectrical muscle activity and the left lower limb isokinetic strength parameters

Recruited muscle	Strength (kg)	Power (watt)	Work (j)	Velocity (m/s)	Load (c.u.)
quadratus femoris caput longum (left)	-0.30	-0.37*	0.17	-0.32*	-0.50**
biceps femoris caput longum (left)	-0.32*	-0.37*	-0.13	-0.34*	-0.42*

* $0.3 \le rxy < 0.5$ average correlation factor
** $0.5 \le rxy < 0.7$ high correlation factor [25]

VI. TASK WITH THE RIGHT AND LEFT LOWER LIMB (TOGETHER)

Strength and work parameters of isokinetic strength correlate with one out of four measured muscles (25%). The velocity parameter correlates with 3 out of four measured muscle activities (75%). Only one correlation can be taken into consideration – biceps femoris caput longum (left) electrical activity with the velocity parameter level (Tab. 6).

Tab. 6. Relation between bioelectrical muscle activity and lower limbs isokinetic strength parameters

Recruited muscle	Strength (kg)	Power (watt)	Work (j)	Velocity (m/s)	Load (c.u.)
quadratus femoris caput longum (right)	0.03	0.22	0.47*	-0.12	0.16
biceps femoris caput longum (right)	-0.21	-0.17	0.00	-0.38*	-0.12
quadratus femoris caput longum (left)	-0.23	-0.08	0.22	-0.32*	-0.01
biceps femoris caput longum (left)	-0.32*	-0.28	0.05	-0.61**	0.10

* $0.3 \le rxy < 0.5$ average correlation factor
** $0.5 \le rxy < 0.7$ high correlation factor [25]

VII. TASK WITH THE RIGHT AND LEFT UPPER AND LOWER LIMB (TOGETHER)

Statistical significant correlations appeared in the power parameter of isokinetic strength with four measured muscle activities (50%), the work parameter with 4 measured muscle activities (50%) and the velocity parameter with 2 measured muscle activities (25%). There have been noticed 3 correlations which are above 0.50 and can be taken into further consideration: *triceps brachii caput lateralis* (right) electrical activity with the power parameter level; *quadratus femoris caput longum* (left) electrical activity with the power and the work parameters level (Tab. 7).

Tab. 7. Relation of bioelectrical muscle activity and lower and upper limbs isokinetic strength parameters

Recruited muscle	Strength (kg)	Power (watt)	Work (j)	Velocity (m/s)	Load (c.u.)
biceps brachii caput longum (right)	0.15	0.27	0.27	-0.17	0.21
triceps brachii caput lateralis (right)	-0.27	-0.70**	0.45*	0.02	-0.17
biceps brachii caput longum (left)	-0.08	-0.41*	0.47*	0.11	-0.17
triceps brachii caput lateralis (left)	-0.24	-0.22	-0.17	-0.34*	-0.06
quadratus femoris caput longum (right)	-0.28	-0.20	0.06	-0.49*	0.14
biceps femoris caput longum (right)	-0.20	-0.19	0.45*	-0.22	0.05
quadratus femoris caput longum (left)	-0.11	-0.57**	0.60**	0.25	-0.30
biceps femoris caput longum (left)	-0.05	-0.37*	0.13	0.14	-0.27

** $0.3 \leq rxy < 0.5$ average correlation factor*
*** $0.5 \leq rxy < 0.7$ high correlation factor [25]*

Discussion

According to the achieved research results, statistically significant correlations appeared between the isokinetic strength parameters and emg signals of recruited muscles had appeared. So far such relations between static strength parameters values and emg signals have been obvious [22,23,24]. There are also findings that describe relations between dynamic strength parameters and emg signals [25,26,27]. This work gives even more information regarding relations between non-static strength parameters and emg signals of recruited muscles on specific research material.

Conclusions

- In the upper right limb more statistical significant correlations between isokinetic strength parameters and electrical muscle activities are observed.
- In lower limbs measurement of the left leg shows more significant correlations.
- Comparing the upper and lower limbs it was noticed that the upper limbs isokinetic strength parameters are more correlated with the measured muscle electrical activities.
- Regarding the left and right side comparison, the right side (upper and lower limb) isokinetic strength parameters are more correlated with measured muscles activities.
- All observations are based on two levels of the correlation factor. Taking into consideration only high correlations, all the conclusions mentioned above are also the same.

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