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## **Influence of a programmed judo training on changes of anthropological features in children attending sports schools / Wpływ zaprogramowanego treningu judo na zmiany cech antropologicznych u dzieci uczęszczających do szkół sportowych**

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This paper completes the follow-up of changes in motor and physiological abilities and anthropometric features during a three-year training cycle. The aim of the paper was to identify the effects of three-year judo training on changes of some anthropological features in judokas-boys. These changes were the result of a three-year long planned and programmed transformation process in the life span from 11 to 14 years of boys' age, that is during the period of their schooling from the fifth, to sixth, to seventh form of elementary school. The sample consisted of 17 boys who underwent the final testing after three years at the age of 14 (+/- six months). Those 17 judokas were tested both initially and at the end of the continuous three-year training program. The sample of variables was comprised of sixteen (16) tests for the assessment of anthropometric features and of motor and physiological abilities. The results obtained showed significant changes in judokas after a three-year organized training process. All motor and physiological abilities, as well as anthropometric features showed a statistically significant progress after the three-year training process. Upon analyzing the whole three-year training process it can be concluded that participation in judo program in adolescents significantly influences the positive development of all analyzed abilities and features.

### **INTRODUCTION**

Judo in translation from Japanese means „Gentle way“. This name is defined with the structures of Judo which are performed without a real threat for a sportsmen's health. But if one considers everything judokas must pass for accomplishing good sport result, a more appropriate name would be „Thorny way“. For achieving these good results judokas must start with systematic and programmed training at early age.

Age for start with judo training is between 8 and 10 years, specialization should start with 15 and maximal results should be expected between 22 and 16 years [Degoutte *et al.* 2003].

One can notice that, for accomplishing good results, judokas must spend 14 to 16 years of hard training. This implies that at early age training process was made by its strict rules and principles. Most of previous research was made on population of judokas between 18 and 27 years old. Linear research of development of anthropological status of judokas at early age was rarely conducted.

Following the changes in motor and physiological abilities and anthropometric features during a three-year judo training cycle started as the part of science-research project “Observations of changes in anthropological status of children in wrestling sports”. As a result of this project it was noticed faster and better development of children incorporated in judo sport [Newton *et al.* 1997; Dopico 2002; Navarro 1998].

This paper presents final results in following motor and functional abilities and anthropometric characteristics during the three-year training period.

The aim of the paper was to identify the effects of three-year judo training on changes of some anthropometric features in judokas-boys. These changes were the result of a three-year long planned and programmed transformation process in the life span from 11 to 14 years of boys' age, that is during the period of their schooling from the fifth, to sixth, to seventh form of elementary school

## METHODS

The sample consisted of 17 boys who underwent the final testing after three years at the age of 14 (+/- six months). Those 17 judokas were tested both initially and at the end of the continuous three-year training program. The control group was consisted of boys who have not participated in any organized training process except during the physical education class in elementary school.

The battery of 16 test items was used for the assessment of: anthropometric characteristics, motor abilities and functional abilities. The control group was tested only by the 11-test battery commonly used in elementary school PE teaching in the educational system of Croatia [Franchini *et al.* 1999]: anthropometric characteristics (ATV – body height, ATT – body mass, AOP – forearm circumference, ANN – upper arm skin fold); motor abilities: coordination (KUS – side steps, MPN – obstacle course backwards), flexibility (MPR – straddle seated forward bent), speed of movement (MTR – hand tapping), explosive power (MSD – standing broad jump), strength endurance of a dynamic type (MPT60 – sit-ups in 60 seconds) and functional abilities (F6 – 6 minute running). Experimental group obtained testing with additional five specific tests: coordination (ONT – ground agility), relative repetitive strength (SKL60 – push-ups in 60 seconds, ČUČ – squats), specific endurance (BAC2SKL – throw+2 push-ups in 90 seconds), strength endurance of a static type (MIV – bent arm hang).

Both groups were tested at the beginning of the fifth and at the end of seventh grade. The three year training program was designed and based on the children is judo sport schools program in Croatia. This program is suitable for preparation of young judoists for their first competitions. The main goal of this training design is that young judokas during the three years learn and perfect basic technical elements of judo (throws and ground holds). Work on coordination (basic and specific) dominate in this period of training followed by relative strength that implies the use of own body weight in basic forms of movement. The development of other abilities depends on sensible phases and specific characteristics of tested judokas. Flexibility, precision and balance drills were used without any limits and anaerobic functional abilities or the strength (except one mentioned above) were not present in a training program of children is judo sport schools.

The data were processed by the statistical software package Statistics for Windows, which is by means of *t*-tests for independent and dependent samples of subjects at the significance level of 0.05.

## RESULTS

**Tab. 1.** Basic descriptive parameters of initial state of boys judokas / Podstawowe parametry opisowe początkujących dżudoków

| VAR   | Valid N | Mean     | Minimum  | Maximum  | Std.Dev. | Skewness | Kurtosis |
|-------|---------|----------|----------|----------|----------|----------|----------|
| ATV   | 17      | 155,471  | 146,8000 | 169,200  | 5,8610   | 0,74789  | 0,44263  |
| ATT   | 17      | 48,453   | 34,2000  | 69,000   | 10,3726  | 0,72681  | -0,66531 |
| AOP   | 17      | 22,159   | 18,5000  | 28,500   | 2,5899   | 0,79363  | 0,66267  |
| ANN   | 17      | 12,824   | 5,0000   | 21,000   | 4,9904   | 0,34427  | -1,06243 |
| MPN   | 17      | 15,564   | 7,9000   | 21,090   | 3,3465   | -0,17204 | 0,41973  |
| MPR   | 17      | 55,941   | 35,0000  | 66,000   | 7,8060   | -1,19775 | 1,89963  |
| MSD   | 17      | 167,118  | 132,0000 | 206,000  | 16,9296  | 0,45359  | 1,21374  |
| MTR   | 17      | 26,941   | 22,0000  | 32,000   | 2,8607   | 0,42996  | -0,40220 |
| MIV   | 17      | 20,831   | 1,0000   | 39,540   | 11,2503  | -0,25596 | -0,67477 |
| MPT60 | 17      | 37,882   | 26,0000  | 48,000   | 5,9883   | -0,23468 | -0,63345 |
| ONT   | 17      | 22,618   | 16,0333  | 27,300   | 3,7497   | -0,63872 | -0,98793 |
| KUS   | 17      | 11,101   | 9,8667   | 13,067   | 0,8510   | 0,83937  | 0,31616  |
| BAC90 | 17      | 12,000   | 10,0000  | 16,000   | 2,1213   | 0,89043  | -0,52698 |
| SKL60 | 17      | 16,941   | 6,0000   | 47,000   | 10,9114  | 1,56504  | 2,65593  |
| CUC60 | 17      | 42,529   | 28,0000  | 52,000   | 7,0721   | -0,76869 | 0,02633  |
| F6    | 17      | 1072,353 | 790,0000 | 1300,000 | 126,5049 | -0,15839 | 0,34035  |

VAR-variables, Valid N-number of entities, Mean-arithmetic mean, Std.Dev.-standard deviation

Table 1 presents standard descriptive parameters of boys judokas who underwent the three year training program at the beginning of this program.

**Tab. 2.** Basic descriptive parameters of boys judokas in final testing / **Tabela 2.** Podstawowe parametry opisowe chłopców dżudoków w testach końcowych

| VAR   | Valid N | Mean     | Minimum  | Maximum  | Std.Dev. | Skewness  | Kurtosis |
|-------|---------|----------|----------|----------|----------|-----------|----------|
| ATV   | 17      | 171,329  | 160,800  | 181,000  | 6,4381   | 0,010009  | -1,22618 |
| ATT   | 17      | 61,982   | 42,000   | 87,000   | 12,1151  | 0,534898  | -0,28276 |
| AOP   | 17      | 25,129   | 20,500   | 30,200   | 2,7633   | 0,131184  | -1,03673 |
| ANN   | 17      | 10,412   | 6,000    | 24,000   | 4,2288   | 2,147267  | 6,42853  |
| MPN   | 17      | 11,783   | 7,070    | 18,500   | 3,2180   | 0,753171  | 0,00041  |
| MPR   | 17      | 63,722   | 53,000   | 74,000   | 4,9073   | -0,225236 | 0,91927  |
| MSD   | 17      | 196,706  | 157,000  | 240,000  | 27,3787  | 0,105489  | -1,08377 |
| MTR   | 17      | 30,294   | 27,000   | 37,000   | 3,2358   | 0,791828  | -0,61986 |
| MIV   | 17      | 43,576   | 12,000   | 81,000   | 18,9643  | 0,029346  | -0,44536 |
| MPT60 | 17      | 47,294   | 30,000   | 57,000   | 7,8562   | -0,783983 | -0,16985 |
| ONT   | 17      | 17,871   | 12,000   | 27,533   | 5,3527   | 0,417098  | -1,40954 |
| KUS   | 17      | 10,019   | 7,867    | 12,033   | 1,0710   | -0,151488 | 0,03796  |
| BAC90 | 17      | 14,059   | 10,000   | 20,000   | 2,8825   | 0,554643  | -0,70995 |
| SKL60 | 17      | 32,353   | 10,000   | 61,000   | 14,9078  | 0,242362  | -0,51633 |
| CUC60 | 17      | 52,294   | 41,000   | 61,000   | 5,1692   | -0,280343 | 0,34675  |
| F6F   | 17      | 1328,529 | 1029,000 | 1520,000 | 133,7615 | -0,514569 | -0,20244 |

VAR-variables, Valid N-number of entities, Mean-arithmetic mean, Std.Dev.-standard deviation

Table 1 presents standard descriptive parameters of boys judokas who underwent the three year training program at the end of this program.

**Tab. 3.** Mean values of participants on tests and their differences after one year training / Średnie wartości uczestników na testach i ich różnica po rocznym szkoleniu

| VAR    | Mean    | Std.Dv. | N  | t      | df | p               |
|--------|---------|---------|----|--------|----|-----------------|
| 1      | 2       | 3       | 4  | 5      | 6  | 7               |
| ATV    | 154,429 | 5,6991  |    |        |    |                 |
| ATVF   | 161,071 | 6,0738  | 17 | -4,282 | 16 | <b>0,000572</b> |
| ATT    | 46,259  | 9,7741  |    |        |    |                 |
| ATTF   | 51,806  | 10,5597 | 17 | -2,334 | 16 | <b>0,032954</b> |
| AOP    | 22,053  | 2,3770  |    |        |    |                 |
| AOPF   | 23,094  | 2,0744  | 17 | -1,681 | 16 | 0,112103        |
| ANN    | 13,824  | 6,3170  |    |        |    |                 |
| ANNF   | 12,176  | 5,8227  | 17 | 1,376  | 16 | 0,187866        |
| MPN    | 15,232  | 3,3094  |    |        |    |                 |
| MPNF   | 13,518  | 2,7523  | 17 | 1,987  | 16 | 0,064294        |
| MPR    | 54,882  | 8,3057  |    |        |    |                 |
| MPRF   | 59,235  | 8,6134  | 17 | -1,799 | 16 | 0,090852        |
| MSD    | 167,647 | 15,6123 |    |        |    |                 |
| MSDF   | 181,294 | 21,6182 | 17 | -2,729 | 16 | <b>0,014873</b> |
| MTR    | 27,196  | 2,9085  |    |        |    |                 |
| MTRF   | 28,529  | 2,8748  | 17 | -1,495 | 16 | 0,154457        |
| MIV    | 17,994  | 11,1211 |    |        |    |                 |
| MIVF   | 34,765  | 19,7350 | 17 | -3,898 | 16 | <b>0,001279</b> |
| MPT60  | 38,118  | 5,2307  |    |        |    |                 |
| MPT60F | 49,000  | 7,6893  | 17 | -5,359 | 16 | <b>0,000064</b> |
| ONT    | 22,630  | 4,1500  |    |        |    |                 |
| ONTF   | 21,577  | 3,9684  | 17 | 1,651  | 16 | 0,118281        |
| KUS    | 10,982  | 0,7317  |    |        |    |                 |
| KUSF   | 10,196  | 0,9397  | 17 | 3,280  | 16 | <b>0,004714</b> |
| BAC90  | 12,235  | 2,2229  |    |        |    |                 |

| 1             | 2        | 3        | 4  | 5      | 6  | 7               |
|---------------|----------|----------|----|--------|----|-----------------|
| <b>BAC90F</b> | 12,941   | 2,0454   | 17 | -1,167 | 16 | 0,260341        |
| <b>SKL60</b>  | 11,706   | 5,8712   |    |        |    |                 |
| <b>SKL60F</b> | 27,529   | 10,5955  | 17 | -6,277 | 16 | <b>0,000011</b> |
| <b>CUC60</b>  | 42,000   | 6,7268   |    |        |    |                 |
| <b>CUC60F</b> | 49,294   | 7,5974   | 17 | -2,823 | 16 | <b>0,012239</b> |
| <b>F6</b>     | 1118,235 | 84,9254  |    |        |    |                 |
| <b>F6F</b>    | 1213,706 | 119,6232 | 17 | -3,186 | 16 | <b>0,005742</b> |

VAR-initial result in variable, VARF-transitive result in variable, Mean-arithmetic mean, Std.Dv.-standard deviation, N-number of entities, t-t value, df- degrees of liberty, p-level of significance (0,05)

Table 3 shows the initial differences that occurred after one year training process. 12-year old judokas achieve statistically better results in 6 of 11 tests for assessment of motor abilities and in one test for assessment of functional abilities.

**Tab. 4.** Mean values of participants on tests and their differences after three year training / Średnie wartości uczestników na testach i ich różnica po 3-letnim szkoleniu

| VAR           | Mean     | Std.Dv.  | N  | t        | df | p               |
|---------------|----------|----------|----|----------|----|-----------------|
| <b>ATV</b>    | 155,4706 | 5,860969 |    |          |    |                 |
| <b>ATVF</b>   | 171,3294 | 6,438145 | 17 | -13,9268 | 16 | <b>0,000000</b> |
| <b>ATT</b>    | 48,45294 | 10,37257 |    |          |    |                 |
| <b>ATTF</b>   | 61,98235 | 12,11514 | 17 | -9,60927 | 16 | <b>0,000000</b> |
| <b>AOP</b>    | 22,15882 | 2,589898 |    |          |    |                 |
| <b>AOPF</b>   | 25,12941 | 2,763323 | 17 | -7,96066 | 16 | <b>0,000001</b> |
| <b>ANN</b>    | 12,82353 | 4,990432 |    |          |    |                 |
| <b>ANNF</b>   | 10,41176 | 4,228753 | 17 | 2,296009 | 16 | <b>0,035523</b> |
| <b>MPN</b>    | 15,56412 | 3,346457 |    |          |    |                 |
| <b>MPNF</b>   | 11,78255 | 3,218004 | 17 | 6,101491 | 16 | <b>0,000015</b> |
| <b>MPR</b>    | 55,94118 | 7,806012 |    |          |    |                 |
| <b>MPRF</b>   | 63,72157 | 4,907264 | 17 | -4,14604 | 16 | <b>0,000760</b> |
| <b>MSD</b>    | 167,1176 | 16,92957 |    |          |    |                 |
| <b>MSDF</b>   | 196,7059 | 27,37874 | 17 | -6,80242 | 16 | <b>0,000004</b> |
| <b>MTR</b>    | 26,94118 | 2,860738 |    |          |    |                 |
| <b>MTRF</b>   | 30,29412 | 3,235829 | 17 | -4,74383 | 16 | <b>0,000220</b> |
| <b>MIV</b>    | 20,83059 | 11,25031 |    |          |    |                 |
| <b>MIVF</b>   | 43,57647 | 18,96429 | 17 | -5,50064 | 16 | <b>0,000048</b> |
| <b>MPT60</b>  | 37,88235 | 5,988347 |    |          |    |                 |
| <b>MPT60F</b> | 47,29412 | 7,856245 | 17 | -5,40706 | 16 | <b>0,000058</b> |
| <b>ONT</b>    | 22,61765 | 3,749722 |    |          |    |                 |
| <b>ONTF</b>   | 17,87078 | 5,352681 | 17 | 4,398378 | 16 | <b>0,000449</b> |
| <b>KUS</b>    | 11,10098 | 0,850986 |    |          |    |                 |
| <b>KUSF</b>   | 10,01853 | 1,070994 | 17 | 4,406249 | 16 | <b>0,000441</b> |
| <b>BAC90</b>  | 12,00000 | 2,121320 |    |          |    |                 |
| <b>BAC90F</b> | 14,05882 | 2,882503 | 17 | -4,34959 | 16 | <b>0,000497</b> |
| <b>SKL60</b>  | 16,94118 | 10,91141 |    |          |    |                 |
| <b>SKL60F</b> | 32,35294 | 14,90780 | 17 | -5,05720 | 16 | <b>0,000117</b> |
| <b>CUC60</b>  | 42,52941 | 7,072108 |    |          |    |                 |
| <b>CUC60F</b> | 52,29412 | 5,169196 | 17 | -5,84529 | 16 | <b>0,000025</b> |
| <b>F6</b>     | 1072,353 | 126,5049 |    |          |    |                 |
| <b>F6F</b>    | 1328,529 | 133,7615 | 17 | -7,09311 | 16 | <b>0,000003</b> |

VAR-initial result in variable, VARF-final result in variable, Mean-arithmetic mean, Std.Dv.-standard deviation, N-number of entities, t-t value, df- degrees of liberty, p-level of significance (0,05)

The results in table 4 show statistically significant differences between two dependent groups of participants. Results in final measurement show statistically significant changes of anthropological status of the judokas who underwent the three year training process.

**Tab.5.** The results of *t*-tests for independent samples of subjects (non-athletes and judokas) at initial testing / Rezultaty testów *t* dla niezależnych próbek podmiotów (nie atletów i dżudoków) na testach początkowych

| VAR   | Mean J   | Mean N   | t        | df | Valid NJ | Valid NN | p               |
|-------|----------|----------|----------|----|----------|----------|-----------------|
| ATV   | 155,471  | 151,1014 | 2,118088 | 85 | 17       | 70       | <b>0,037088</b> |
| ATT   | 48,453   | 43,4777  | 1,696719 | 85 | 17       | 70       | 0,093409        |
| AOP   | 22,159   | 21,3886  | 1,221804 | 85 | 17       | 70       | 0,225160        |
| ANN   | 12,824   | 14,1714  | -0,60126 | 85 | 17       | 70       | 0,549262        |
| MPN   | 15,564   | 16,9529  | -0,90096 | 85 | 17       | 70       | 0,370155        |
| MPR   | 55,941   | 48,7500  | 2,900821 | 85 | 17       | 70       | <b>0,004737</b> |
| MSD   | 167,118  | 163,2667 | 0,680137 | 85 | 17       | 70       | 0,498266        |
| MTR   | 26,941   | 25,8262  | 1,183032 | 85 | 17       | 70       | 0,240095        |
| MIV   | 20,831   | 24,1000  | -0,67083 | 85 | 17       | 70       | 0,504143        |
| MPT60 | 37,882   | 30,3143  | 3,758949 | 85 | 17       | 70       | <b>0,000312</b> |
| F6    | 1072,353 | 992,6829 | 2,047296 | 85 | 17       | 70       | <b>0,043717</b> |

VAR-variables, Mean J-arithmetic mean of judokas, Mean N- arithmetic mean of non-athletes, t-t value, df-degrees of liberty, Valid NJ-number of judokas, Valid NN-number of non-athletes, p-level of significance (0,05)

Table 5 shows the differences between judokas and non athletes at the age of eleven, just before the three year training process started. Statistically significant changes occurred in variables: ATT – body height, MPR – straddle seated forward bent, MPT60 – sit ups in 60 seconds and F6 – 6 minute running.

**Tab. 6.** The results of *t*-tests for independent samples of subjects (non-athletes and judokas) at final testing / Rezultaty testów *t* dla niezależnych próbek podmiotów (nieatletów i dżudoków) na testach końcowych

| VAR   | Mean J   | Mean N   | t        | df | Valid NJ | Valid NN | p               |
|-------|----------|----------|----------|----|----------|----------|-----------------|
| ATV   | 171,329  | 160,714  | 5,04622  | 85 | 17       | 70       | <b>0,000002</b> |
| ATT   | 61,982   | 48,658   | 4,49477  | 85 | 17       | 70       | <b>0,000021</b> |
| AOP   | 25,129   | 22,068   | 5,31013  | 85 | 17       | 70       | <b>0,000001</b> |
| ANN   | 10,412   | 14,176   | -1,91549 | 85 | 17       | 70       | 0,058641        |
| MPN   | 11,783   | 15,368   | -2,40825 | 85 | 17       | 70       | <b>0,018092</b> |
| MPR   | 63,722   | 46,950   | 7,45442  | 85 | 17       | 70       | <b>0,000000</b> |
| MSD   | 196,706  | 177,878  | 3,42674  | 85 | 17       | 70       | <b>0,000927</b> |
| MTR   | 30,294   | 27,791   | 2,44783  | 85 | 17       | 70       | <b>0,016335</b> |
| MIV   | 43,576   | 34,194   | 1,53269  | 85 | 17       | 70       | 0,128900        |
| MPT60 | 47,294   | 36,054   | 6,11326  | 85 | 17       | 70       | <b>0,000000</b> |
| F6F   | 1328,529 | 1110,581 | 4,76736  | 85 | 17       | 70       | <b>0,000007</b> |

VAR-variables, Mean J-arithmetic mean of judokas, Mean N- arithmetic mean of non-athletes, t-t value, df-degrees of liberty, Valid NJ-number of judokas, Valid NN-number of non-athletes, p-level of significance (0,05)

After the three year training process judokas were statistically significantly better than their non-athletic colleagues in nine out of eleven variables. There were no statistically significant changes only in variables ANN – upper arm skin fold and MIV – bent arm hang.

## DISCUSSION

After analyzing given results one can conclude that judokas, after three year training period, have changed their anthropological status statistically significant. All tested abilities imply significant progress during observed period.

One can notice changes that took place in body height, body weight and forearm circumference, probably by influence of growth and development of children, but also reduction of upper arm skin fold. Increase of circumference of forearm in relation with reduction of upper arm skin fold implies growth in lean body tissue or muscle mass as the result of training process. One can confirm already known facts:

„Most dominant anthropometric characteristics for success in judo bout are volume and muscle mass“ [Leveritt *et al.* 1999].

Control group in the same period did not accomplish reduction in upper arm skin fold while the height, weight and forearm circumference enlarged. By given parameters one can presume that because of specific judo training in which judokas pay particular attention to reducing body fat in order to accomplish ideal proportion of muscular mass and subcutaneous fatty tissue.

„Sportsmen who are incorporated in sports such as wrestling or gymnastic have great percentage of lean body mass, which means that they by lower body mass have smaller percentage of body fat“ [Kraemer *et al.* 2006].

Although it wasn't mentioned in reference similar characteristics has judo which is structurally similar to wrestling.

In all variables for assessment of motor abilities one can notice statistically significant progress at the level of importance  $p=0.01$ . If the motor space is compared between experimental and control group one can notice that boys judokas accomplish statistically significant better results in two out of six variables at initial testing (table 5) and after three year training process at the final testing in five out of six variables for assessment motor abilities (table 6).

During the same project differences between 11 and 12 year old boys judokas were tested. Data in table 3. are the result of one year training process. After this period it can be noticed that judokas achieved progress in 7 out of 11 motor variables. After one year of training there is no statistically significant changes in coordination (MPN), flexibility (MPR), speed of movement (MTR) and specific endurance (BAC+2 SKL). If the data after one and three year training period are compared one can notice that the first year of judo training had the biggest influence on different aspects of strength: explosive power (MSD) and relative strength (MIV, SKL, MPT and CUC), and after the rest two year training boys judokas improved in all other variables. By following the mentioned data one can notice the dynamics of development of motor abilities during the three year of specific judo training at younger age. The plan and program for judo sport schools at this age (11–14) prescribes overcoming basic and specific ways of movement on the mat, learning hand, leg and hip throws and ground holds.

„Coordination is developed in two ways: by learning new, different structures of movement or performance of known movement structures in different conditions“ [Iglesias, Dopico 2004].

In spite of many new techniques, boys judokas learned in the first year of specific training, expected progress of coordination was not noticed. Significant progress in coordination occurred after three year training process. Statistically significant changes in the space of relative strength are conditioned by the structure of judo which demands engagement of entire body.

The strength has the biggest influence on result in judo bout [Leveritt *et al.* 1999].

Even the judokas at this age do not perform specific strength training because of it's contraindications that might occur, progress in strength happened because of practising specific judo techniques with specific judo methods such as uchi komi and nage komi in which all body muscles must be included.

Specific endurance was not improved during the first year of training process but after the three year training process one noticed the significant changes also in this aspect of motor abilities. It is well known that the specific training can't be the main goal of training process of judokas in the first years of their training but with constant improvement of their technical and tactic knowledge this ability also improved. Development of static strength after only one year of training (table 3) is explained with increase of stress because of use of grips which are first and basic condition for execution of every technical element in judo. Good and firm grip understand progress of static strength in hand, forearm, upper arm and shoulder region.

If the independent groups of 11 and 12 year old judokas are compared one can not notice any statistically significant difference [Sáez de Cosca *et al.* 2002].

One can conclude that young judokas even after one year long training process can expect improvement in static strength of arm and shoulder region.

Frequency of motion, estimated with test 15 seconds hand tapping, was improved only after three year training process. In this period of training it is necessary to conduct speed training as often as possible.

„For development of frequency of motion it is important adequate training till the age of 15. That is the time when the process of mielisation of nerve paths, which conduct nerve impulses, ends“ [Franchini 2001].

Flexibility of back and upper leg was statistically significant improved after three year of training, but even after the first year judokas had better results than the boys non-athletes.

„Dynamic, active flexibility is also important for judo sport and can have great influence on certain techniques in offence and defense. Hip and back mobility (especially lumbal part of back) play important role in judo sport“ [Leveritt *et al.* 1999].

Aerobic abilities are the basis for all other functional abilities. Already in the first year judo training had great influence on this ability and after the three-year training process statistically significant difference in test F6 is even bigger. Comparison between experimental and control group between initial and final testing showed improvement of difference in benefit of young judokas.

## CONCLUSION

Upon analyzing the whole three-year training process it can be concluded that participation in judo program in adolescents significantly influences the positive development of all analyzed abilities and features. Structural, biomechanical, anthropometrical, motor and functional characteristics of judo imply that judo is sport of great complexity and that it can have strong influence on anthropological characteristics of young boys during the period of growth and maturation. Because of good progress in all tested abilities and characteristics it can be also concluded that the training process in judo sport schools is well planned and quality designed. Progress in technical and tactical knowledge can be the main goal for some other research.

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**Słowa kluczowe: cechy antropologiczne, dżudocy, sportowe szkoły dżudo, proces transformacji**

### **STRESZCZENIE**

Niniejsza praca jest podsumowaniem badań nad motorycznymi i fizjologicznymi zdolnościami oraz cechami antropologicznymi młodych dżudoków w ciągu 3-letniego szkolenia. Celem pracy było zidentyfikowanie rezultatów szkolenia dżudo i procesów transformacji wśród 17 chłopców w wieku do 11 do 14 lat. Rezultaty testu składającego się z 16 elementów wykazały znaczne pozytywne zmiany w analizowanych zdolnościach i cechach.

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