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Original empirical article

JUDO TRAINING IS MORE EFFECTIVE IN FITNESS DEVELOPMENT THAN RECREATIONAL SPORTS IN 7 YEAR OLD GIRLS

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Saša Krstulović[1], Mladen Kvesić[2], Mirsad Nurkić[3]

[1]Faculty of Kinesiology; University of Split, Teslina 6, 21000 Split, Croatia
[2]Faculty of natural science and education, University of Mostar, Bosnia and Herzegovina
[3]Faculty of sport and physical education, University of Niš, Serbia

Abstract. *In this paper we compared the effects of a nine-month judo program (JT; N=30) and recreational sports-games training program (SGT; N=49) on the fitness development of 7-year-old girls. Both programs were performed 3 times a week. Apart from body height (BH), body weight (BW) and skinfold thickness (SUM2SF), changes in muscular and cardiovascular endurance, flexibility, speed, agility and coordination were studied. Using the analysis of variance we found: (A) no differences between the groups at the onset of the study, (B) after 9 months, the JT participants achieved significantly better results in the shuttle run task used to test agility, the sit-up test for abdominal muscle endurance, the sit-and-reach test for flexibility, and flexed arm hang for muscular endurance. The JT group also maintained their SUM2SF over the 9-month period while the SGT showed a significant increase in SUM2SF. There was, however, no difference between the groups in terms of coordination, flexibility of the shoulder joint, speed, cardiovascular endurance, BH and BW. In conclusion, the specialized JT allowed the participants to improve more in their fitness capacities compared to non-specialized SGT.*

Key words: *motor abilities, morphology, longitudinal studies*

INTRODUCTION

Physical growth and maturation involves at least two components – status (size attained) and rate (tempo). Maturation status may be studied by means of a cross-sectional

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Corresponding author: Saša Krstulović
Faculty of Kinesiology; University of Split, Teslina 6, 21000 Split, Croatia
Tel: +385 91 583 5842 • Fax: +385 21 385 339 • E-mail: farajienator@gmail.com

investigation, but maturation rate variance can only be estimated by means of longitudinal observation. If genetics, which is hardly influential, is excluded, there are numerous factors including nutrition, socioeconomics, physical activity, etc. which definitely influence the maturation rate. When observed from the kinesiological (sport-science) point of view, physical activity should be recognized as the most interesting parameter. The age of 6-7 is one of the most dynamic periods of growth and maturation in a human's life (Rowland 1996; Violan et al. 1997; Beunen & Thomis 2000.), mostly characterized by a significant decrease in physical activity. More precisely, in this period children drastically modify their life habits, since a relatively active lifestyle is changed by 5-7 hours daily spent in sedentary practice. Such a significant decrease in physical activity negatively influences morphological status (e.g. by an increase in subcutaneous fat), and motor abilities (e.g. by decreasing the dynamics of biologically natural improvement in the motor status) (Katic, Males & Miletic 2002; Sekulic et al. 2006). In this study we will focus on 7-year-old girls. Since girls are known to be less physically active than boys, we are assuming that the decrease in their motor status development will be even more pronounced than the one found in their male peers (Parizkova & Adamec 1980).

For the purpose of this study the most interesting are the conclusions reached by Sekulic et al. 2006. Briefly, authors summarized the effects of the experimental training programs performed 3-times a week in 7 year old boys, and concluded that the judo program had been more effective in the development of agility and muscular endurance than the recreational sports-games training. Also judo training did not have a significant influence on subcutaneous fat, while the subjects who participated in the sports-games training increased their subcutaneous fat level significantly. Although there are no evidential differences in the motor development of the 7-yearolds regardless of their gender (Pissanos, Moore & Reeve 1983; Malina & Moriyama 1991; Rowland 1996; Malina, Bouchard & Bar-Or 2004 a.), we must not underestimate gender differences and specificities evident in all the phases of human development. Consequently, we decided to carry out the study presented hereand to establish the effects of the treatment which is basically similar to the one investigated in the study of Sekulic et al. (2006). However, herein we will present the effects on a sample of 7-year-old girls.

The authors were of the opinion that judo as a sport and a martial art is relatively interesting for the purpose of investigating the sample of young children given that a) judo training effects are not frequently studied in such a sample of participants; b) judo training is expected to be highly effective in the development of balance, coordination and muscular endurance (Bompa 1998; Perrin et al. 2002); c) judo training is relatively easy to organize and supervise for a substantial number of participants at the same time, using limited indoor space, and relatively cheap sports equipment (e.g. there is no need for expensive facilities and equipment). On the other hand, we were of the opinion that sporting games were appropriate as a control program because of the probable (compared to judo) differential influence on physical fitness. More precisely, sporting games are believed to be effective on cardiovascular endurance, agility and speed improvement (Bompa 1998; Malina et al. 2004 b.).

The aim of the present study was to evaluate any possible effects of judo on coordination, agility, flexibility, muscular and cardiovascular endurance, and body composition (subcutaneous fat) in 7-year-old girls with no previous martial arts experience and compared with a group of 7-year-old girls involved in recreational sporting games activities.

METHODS

Sample of participants and the experimental program

All of the participants were first graders, and their parents had given their informed consent for the study program and testing. Only those subjects who participated in 90 trainingsessions (90% of the 100 sessions in total) were included in the study. The control group (C) consisted of girls (N = 49; mean age 7.2 ± 0.4 years), who voluntarily chose to participate in different recreational sporting games (mini-volleyball, mini-basketball, mini-handball), 3 times a week (45 minutes per session), for 9 months. For the C group, all sporting games rules were simplified, the game lasted 2 x 20 min (5 min rest in between) while the courts were somewhat shortened (e.g. one regular basketball/handball court was divided into two mini-courts). Mini volleyball was played using a 2-meter-high net. The C training was not methodologically designed but simply consisted of a supervised recreational team-game. The C sessions were continuous in nature (free play), but occasional 1-2 minute breaks occurred (fouls, free kicks, etc.). Each C subject participated in all the mentioned sports equally.

The experimental group (E) included girls (N = 30; mean age 7.3 ± 0.2 years) who voluntarily chose judo and participated in nine-month programmed judo sessions (3 times a week; 45 minutes per session). Except for clinical health and voluntary participation, there was no additional criterion for inclusion into the E and/or C program. The E group had the same instructor for 9 months, and the sessions followed the methodology according to the classical judo style. The class consisted of the following parts:

1. Introduction – runs at different distances and/or different simple dynamic games – 4 to 5 minutes
2. Preparatory part – preparation of the whole locomotor system including - foot/ankle rotation, extensions and flexions; knee rotation and squats; leg kicks and rotation of the hips; trunk/waist rotation; shoulder/arm rotation and double crossing; neck rotation; etc. – 7 to 8 minutes
3. The main part 1 – the study and practice of judo elements (postures – "shisei"; grips – "kumi kata"; movements – "shintai"; falls – "ukemi waza"; throws – "nage waza"; lying techniques – "ne waza"; free play or sparing – "randori") – 15 minutes
4. The main part 2 - elementary judo, wrestling and other combat-related games – 10 minutes
5. Cool down, relaxation and stretching – 4 to 5 minutes

All the paricipants were tested twice, initially - before the beginning of the E and C program (I), and finally - at the end of the 9-month program (F).

Measurements

The sample of variables (Sekulic et al. 2006) consisted of body weight (BW; measured in 0.1 kg), body height (BH; measured to the nearest 0.5 cm), sum-of-two-skinfolds (SUM2SF; triceps and subscapular; 0.1 mm), and 10 motor endurance tests (Katic, Bonacin & Blazevic 2001; Katic, Males & Miletic 2002; Malina, Bouchard & Bar-Or 2004 a.). Coordination was tested using the simple 10-meter polygon test which included backward crawling (A) over and (B) under the 35 cm high obstacles placed at (A) 3 meters and (B) 6 meters from the start line (POLYGON; 0.1 s); agility - using the 4 x 1.98 meter shuttle run test (SHUTTLE; 0.1 s); flexibility - maximal both-arm shoulders cir-

cumduction holding the measuring stick with both hands fully extended where a smaller distance between the palms denotes a better result (FLEX-SH; 1cm) and the sit and reach test (SIT-REACH; 1 cm); speed - electronically measured 20 meter dash (20M; 0.01 s); explosive strength - long jump from a standing position (L-JUMP; 1 cm) and distance overhand softball throw (THROW; 10 cm); muscular endurance - flexed arm hang (HANGING; 1 s), and 90-degree flexed knee sit-ups performed in one minute (SIT-UP); cardiovascular endurance - 3 minutes running (ENDUR; running distance measured to the nearest 5 meters).

The BW was measured by a digital scale when the participants were wearing shorts and no shoes, BH by a measuring scale fixed to the wall at maximum inspiration and the skinfolds using the Lange calliper. All the measurements were collected by experienced evaluators (Males, Sekulic & Katic 2003; Sekulic, Viskic-Stalec & Rausavljevic 2003)

All the tests (except for HANGING, SIT-UP and ENDUR) were performed three times, with an appropriate rest in between. The mean of three scores was used in the analysis.

Data analysis

The descriptive statistics for both groups were calculated separately (Means and Standard Deviations - SD). To establish the simple quantitative differences between (A) the initial and final measurement, and (B) the C and E at the initial and final measurement we used the repeated measures analysis of variance (ANOVA). For a detailed analysis of the achieved changes between F and I, we calculated the one-way ANOVA on the variables of the final-initial single measure differences, meaning that we first calculated the differences of each of the measured variables ($x_{diff} = x_{final} - x_{initial}$), and using these calculated variables (variables of the differences) performed an analysis of variance using the C – E criterion (Males, Sekulic & Katic 2003; Sekulic et al. 2006). All the coefficients were considered significant for $p < 0.05$. Statsoft's Statistica was used for all statistical procedures.

RESULTS AND DISCUSSION

In the initial measurement there was no single significant difference between the C and E group in the morphological nor in the motor-endurance variables.

Body height (BH) and body weight (BW) increased significantly during the nine month period in both groups. Meanwhile, the subcutaneous fat (SUM2SF) significantly increased in the controls only. The C and E group improved their motor-endurance status significantly in all the variables during the course of the study.

Quite opposite from the initial measuring, at the final measuring the C and E group differed significantly in flexibility, agility, muscular strength and muscular endurance. Since the SUM2SF increase (observed in the C group only) negatively influences most of the motor-endurance variables (Cureton 1982; Rowland, 1996; Katic, Males & Miletic 2002; Males, Sekulic & Katic 2003), we additionally performed ANOVA calculations while statistically controlling the SUM2SF differences between the groups at the final measuring. Briefly, apart from only negligible changes in the statistical significance, the groups differed significantly in the same variables as in the "non-controlled" approach.

Table 1. Descriptive statistics in the initial and final measuring (Means and Standard Deviations - SD); initial-final percent changes; ANOVA significance (Initial - final differences: [a] $p < 0.001$; [b] $p < 0.01$; Control – Experimental differences: ** $p < 0.01$; * $p < 0.05$)

	Control group			Experimental group		
	Initial Mean±SD	Final Mean±SD	Change %	Initial Mean±SD	Final Mean±SD	Change %
BH (cm)	127.9±4.5	131.8±4.8 [a]	3%	127.8±5.2	131.7±5.2 [a]	3%
BW (kg)	26.7±3.3	29.0±3.5 [a]	9%	26.3±4.3	28.7±4.2 [a]	9%
SUM2SF (mm)	25.7±7.4	27.3±7.7 [b]	6%	24.0±9.4	23.2±6.9	-3%
SIT-REACH (cm)	38.6±7.3	46.1±8.0 [a]	19%	37.0±7.1	53.7±6.9 [a **]	45%
FLEX-SH (cm)	55.0±7.1	46.6±8.0 [a]	18%	54.5±12.9	44.6±12.8 [a]	22%
POLYGON (s)	21.4±3.9	18.2±3.7 [a]	18%	20.7±4.7	18.3±3.6 [a]	13%
SHUTTLE (s)	15.5±1.4	14.5±1.6 [a]	7%	15.0±1.5	13.3±1.2 [a **]	13%
L-JUMP (cm)	112.2±18.1	128.4±19.7 [a]	14%	111.9±14.7	130.1±15.4 [a]	16%
THROW (m)	7.2±1.8	9.6±2.7 [a]	33%	6.8±1.6	9.0±2.0 [a]	32%
20M (s)	5.1±0.5	4.7±0.4 [a]	9%	5.0±0.4	4.6±0.3 [a]	9%
SIT-UP (f)	21.7±7.8	26.8±5.5 [a]	24%	21.9±6.0	32.0±6.4 [a **]	46%
HANGING (s)	11.0±8.4	17.2±9.1 [b]	56%	14.1±9.1	24.8±13.6 [a *]	76%
ENDUR (m)	455.5±52.1	474.5±56.5 [a]	4%	459.8±50.1	471.6±52.7 [b]	3%

Table 2. Descriptive statistics (Means and Standard Deviations - SD); ANOVA significance of the variables of the differences between the final and initial measuring for the control and experimental group (*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$)

	Control Final-Initial Mean±SD	Experimental Final-Initial Mean±SD
BH (cm)	3.8±1.3	3.9±0.7
BW (kg)	2.3±1.5	2.4±1.6
SUM2SF (mm)	1.5±3.9	0.8±2.1 **
SIT-REACH (cm)	7.5±6.7	16.7±6.5 ***
FLEX-SH (cm)	-8.5±4.5	-9.8±5.9
POLYGON (s)	-3.2±2.3	-2.5±2.6
SHUTTLE (s)	-1.1±0.6	-1.7±1.1 ***
L-JUMP (cm)	16.2±16.5	18.2±9.1
THROW (m)	2.4±2.5	2.2±1.4
20M (s)	-0.4±0.3	-0.4±0.2
SIT-UP (f)	5.1±5.5	10.1±6.2 ***
HANGING (s)	6.2±9.8	10.8±9.2 *
ENDUR (m)	19.0±20.9	11.8±19.3

When comparing the amount of change between the C and E groups, the statistical significance was noticeable in SUM2SF, hamstring flexibility (SIT-REACH), agility

(SHUTTLE), abdominal muscular endurance (SIT-UP) and arm muscular endurance (HANGING).

The authors are aware of certain limitations of the forthcoming discussion and conclusions since dietary intake, particularly fat intake data were not collected, and no calculations of daily energy expenditure were made. But, since (A) groups initially did not differ significantly in the BH, BW and SUM2SF, and (B) all of the participants came from the same school and lived in the same urban district during the course of the study, there is certain possibility that (A) their general eating habits, and (B) their life habits (especially time spent outdoors), were somewhat similar. However, these topics as well as the actual training activity (e.g. energy expenditure during the exercise sessions) should be considered and measured in some forthcoming studies.

Since flexibility is one of the motor dimensions which can be easily developed through training (Alter 2004), improvements in flexibility variables were expected. The judo training revealed more significant changes in flexibility, than the recreational sporting game (control) program (Table 1 and 2). Because of the disbalance of the bone and muscle-tendon growth dynamics (Malina, Bouchard & Bar-Or 2004 a.), flexibility training is particularly crucial in childhood and periods of increased growth and development. Therefore, apart from athletic performance, where flexibility is one of the essential factors, in this studied sample of participants the preventive value of the flexibility in injury prevention is more important (Violan et al. 1997). Since flexibility does not change significantly in girls aged 6 to 10 (Malina, Bouchard & Bar-Or 2004 a.), it is encouraging that we established a relatively large flexibility improvement in the E group although the flexibility training took only a minor part of a single training session (approximately 3-5 minutes).

Coordination and agility are motor abilities believed to be very important in functional and general motor development. It is already demonstrated that performance in agility improves considerably in girls between the ages of 5 and 9 and then continues to improve at a somewhat lesser but constant pace up to 14 years of age (Malina, Bouchard & Bar-Or 2004 a.). The authors of this study are of the opinion that those improvements in non-trained participants are mainly related to the increase in BH. Briefly, all agility-tests are comprised of short-time rapid running, and always consist of only a few steps in different directions. Naturally, because of their longer legs – the taller subjects are relatively advantaged in such tasks; we have already demonstrated this in some previous studies where the positive correlation between BH and agility results is established for non-trained adolescents (Sekulic, Viskic-Stalec & Rausavljevic 2003). But, contrary to some beliefs, when sport games like soccer and basketball are considered very useful in improving agility (Bompa 1998), we established judo as more useful for such a purpose (Table 1: E group improved in the agility test 13%, and C group – 7%; initially there was no significant difference between the groups). Meanwhile, general coordination was measured using a simple polygon test which included fundamental motor skills (backward crawling). Although only the E group performed some of the gymnastic elements on the floor (mat) – where some similarity with the biomechanics of backward crawling can be found, both groups improved their performance in the coordination test significantly, with no significant difference between these changes comparing the E and C group (Table 1 and 2). What we observed is possibly contrary to some suggestions where gymnastics and judo elements are considered highly effective in the development of coordination (Bompa 1998; Kioumourtzoglou et al. 1997). From our point of view, there

are two possible reasons which could lead to our observed results: (A) growth and developmental changes override the stimulus of training, as suggested in some previous studies (Andersen 1994), and (B) different sporting-games-related motor skills (performed by the C group), as well as the judo and gymnastics elements (regularly performed by the members of the E group) were equally effective in the development of coordination in this studied sample of participants.

Although a certain influence of coordination cannot be excluded, tests of jumping and the overhand throware commonly used as indicators of muscular power (explosive strength). Girls regularly improve their capabilities in such performances until the age of 14 (Malina, Bouchard & Bar-Or 2004 a.). Knowing that previous studies performed on twin pairs suggested that during the growth period explosive strength is under a moderate to moderately strong genetic influence (Beunen et al. 2003), significant improvement in both groups, with no significant differences between the final-initial changes was partially expected.

There is no doubt that only the C subjects regularly performed different short-distance running tasks during the course of the study. Although partially expected, such specific training did not result in a more significant improvement in speed – understandably so, knowing that running speed improves (in both sexes) sharply from 5 to 8 years of age (Malina, Bouchard & Bar-Or 2004 a.) which most likely does not leave space for a further training-induced improvement in this period. Also, we have to note that the C program consisted of free-play, with no controlled short distance running practice. Therefore, since speed improvement can be expected only as a result of the substantial use of high-intensity runs (Bompa 1998), there is certainly a possibility that the C training was not of sufficient intensity to cause additional improvements in speed.

Quite opposite to speed, where both groups improved their results equally, when compared with the improvement in muscular endurance, we found a clear dominance of the E group at the final measuring. Such a difference is interesting especially regarding abdominal muscular endurance, bearing in mind that the E program did not include any conventional abdominal strengthening exercises (like sit-ups, leg raises, leg scissoring, etc.). Most probably, the judo-lying-technique ("ne waza"), and sparing ("randori") consisted of some elements which indirectly strengthened the abdominals. Biomechanically, the dominance of the E group on the HANGING variable is relatively easy to explain, knowing that all judo duel-elements include pulling and gripping techniques – anatomically very comparable to the HANGING test. Meanwhile, the significant improvement of the C group is probably related to the developmental improvement in the muscular strength capacities, known to be constant in girls, up to adolescence (Malina, Bouchard & Bar-Or 2004 a.).

Albeit not directly measured by laboratory testing, it seems that both groups improved their endurance capacities significantly. Nonsignificant differences in the improvements of the E and C group did not surprise us as much as fact that the judo-group (E) improved their results by 3% (see Table 1) and the C group by 4% (note that the E group had no "distance running" exercise during the course of the study, something regularly performed in the C group). The only reasonable explanation for such "illogical" results we found in the quantity and character of the morphological changes. As stated in the Results section, the SUM2SF increased significantly only in the C group. So, although one could expect higher improvements of the C group in the distance running variable, it did not happen – probably because of the negative impact of the SUM2SF increase on running

economy (Cureton 1982; Pissanos, Moore & Reeve 1983; Rowland, 1996; Males, Sekulic & Katic 2003; Norman et al. 2005).

Finally, since previous studies established a regular decrease of the skinfolds of the preschool girls (from 3.5 up to 6 years of age) (Parizkova & Adamec 1980), skinfold increase in the C group (1st graders) indirectly confirmed our initial considerations about the possible obstructive influence of the inclusion in the school-system on the fitness status of children.

When comparing results presented herein, and the results discussed in the study by Sekulic et al. (2006) almost equal influence of the judo training and recreational sports-games during a 9-month period is evident in both genders.

CONCLUSION

According to the results presented and discussed herein the following conclusions can be drawn:

- A nine month judo training (JT) program performed 3-times per week is more effective in the development of flexibility, agility and muscular endurance than recreational sports-games-training (SGT) in 7-year-old girls.
- JT and SGT are equally effective in the development of coordination, speed, explosive strength and cardiovascular endurance.
- JT did not have a significant impact or influence on subcutaneous fat (SF), while the subjects who participated in the SGT increased their SF level significantly. Such an increase of the SF probably negatively influenced their endurance capacities.
- It seems that specialized JT allows 7-year- old girls to improve more of their fitness capacities compared to recreational SGT.
- Since we compared the effects of the specialized JT and recreational SGT in seven-year-old boys and girls, further studies have to compare the effects of the different - but specialized sports-training on the fitness status of children.

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DŽUDO KAO EFIKASNIJI METOD TRENIRANJA U RAZVOJU KONDICIJE OD REKREATIVNOG SPORTA KOD SEDMOGODIŠNJIH DEVOJČICA

Saša Krstulović, Mladen Kvesić, Mirsad Nurkić

U ovom radu smo poredili uticaj devetomesečnog džudo programa (JT; N=30) i rekreativno-sportskog programa (SGT; N=49) na kondicioni razvoj sedmogodišnjih devojčica. Oba programa sprovodila su se tri puta nedeljno. Pored visine tela (BH), težine tela (BW) i debljine kožnih nabora (SUM2SF), promene u muskulaturi i kardiovaskularnoj izdržljivosti, fleksibilnosti, brzini, okretnosti i koordinaciji su takođe proučavane. Koristeći analizu varijance utvrdili smo: (A) da nije postojala razlike između grupa na početku istraživanja, (B) nakon perioda od 9 meseci, JT učesnici postigli su značajno bolje rezultate u testovima okretnosti, testovima za izdržljivost abdominalnih mišića, testovima fleksibilnosti, i testovima mišićne izdržljivosti. JT grupa je takođe zadržala svoj SUM2SF tokom ovih devet meseci, dok je SGT pokazala značajan porast u SUM2SF. Međutim, nije bilo razlike među grupama u pogledu koordinacije, fleksibilnosti ramena, brzine, kardiovaskularne izdržljivosti, visine i težine tela. Možemo zaključiti da je specijalizovani džudo program omogućio učesnicama da poboljšaju svoju kondiciju u poređenju sa nespecijalizovanim rekreativnim sportskim programom.

Ključne reči: *motoričke sposobnosti, morfologija, longitudinalno istraživanje*