CHANGES IN GYMNASTS MOTOR ABILITIES DURING THE NINE MONTH TRAINING PROCESS OF FEMALE GYMNASTS 5-6 YEARS OF AGE

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Abstract

This study was aimed to determine changes in the development of some motor abilities of female gymnasts aged 5-6 years during the nine-month training process. Six gymnasts, members of gymnasts club „Novi Zagreb"from Zagreb aged from 5 - 6 years, volunteered in this study. They were involved in the training process, which was consistent of the elements of "B" (higher level) program for girls, for nine months. Changes in motor variables were recorded in the 7 time points for each subject. One way ANOVA for repeated measures determined if changes in measured motor abilities would appear through nine month training process. The primarily finding of this study supported our research hypothesis, with statistically significant improvement in all of measured motor abilities (power and flexibility), except in explosive power.

Keywords*: power, flexibility, training, development*

INTRODUCTION

Artistic gymnastic is one of the components of competitive gymnastics and is divided in men's and women's artistic gymnastics. There are four events in the women's artistic gymnastics: vault, uneven bars, balance beam and the floor. On the each of apparatus, except on vault, where is performed only one jump, gymnasts do links between the series of gymnastic elements which merge into one ententity (routine) of 30 to 90 seconds duration.

Each of gymnastic events imposes special requirements while performing some movements. Those movements are consisted of a numerous different simple and complex, static and dynamic elements with precisely defined techniques. Artistic gymnastic is characterized by a lot of random hand and leg supports while the body is in the flight phase. Namely, the majority of gymnastic elements are acrobatic. Ability to move body through the space, random activation of needed muscles, increased joint range of motion (ROM) while maintaining a high level of power and optimal level of precision of the body position and position of some parts of the body is needed while performing them. Considering that, in order to achieve quality, routine and safety while executing some of the elements. So, responsibility is primarily focused on gymnasts conditioning preparation in the training process.

In Artistic gymnastics gymnasts must have an incredible fitness, what is primarily seen in conducting training process, not on competitions, as in many other sports. High level of fitness enables basic prerequisites for successful learning and performing

gymnastic elements. The gymnasts differ from each other in motor abilities which are reflected in the performing quality of gymnastic movements, or accuracy of the techniques, levels of the elements, compositional possibilities of the realization of gymnastic exercises.

Gymnasts have incredible neuromuscular connections and they are also characterized by very high levels of strength, power, flexibility, and muscular endurance, combined with speed and coordination (Jemni et al, 2006).

The success of each gymnast is directly dependent on the level of her motor abilities, in particular strength. Strength occupies the highest place within the hierarchy in relation to other motor abilities, in all three basic forms (explosive, repetitive and static). Inconsistent strength training can explain the decline in performance, or at least the stagnation, of a number of athletes who had promising performances during the preparatory season. Most important for gymnastics is the insight that maximal strength can also be increased without increasing muscle mass (Bührle and Werner, 1984; Poliquin, 1991; Verchoshanskij, 1985 according to Major, 1996). It also has been noticed for some time that the very best gymnasts in the world have great strength with little muscle mass (Schwermann, 1986 according to Sands & McNeal 2000).

Strength training in artistic gymnastic is closely linked to the gymnastic skills, so we can talk about the development of specific strength that is comparable to other sports. When we look at children's artistic gymnastic, considering definitions of strength and power, we can not talk about strength, we can, only, talk about power, especially explosive.

Many authors have reported that modern Artistic gymnastics requires greater strength and power because of the ever-increasing technical difficulty required through revision of the Code of Points (FIG, 2005, according to Jemni et al, 2006), which changes every Olympiad (Brooks, 2003; French et al, Richards et al, 1999 according Jemni et al, 2006).

One of the most important problem in training process in Artistic gymnastic is that training process starts in young childhood (about 5 to 6 year). Therefore, it is very important to pay extraordinary attention to the conditioning process. Each training, and thus the training process, has to be precisely planned and focused on achieving the main goal, which is primarily the adoption of proper techniques of gymnastic elements. Continuous systematic tracking of each gymnast receives a constant review of its level and progress in basic and specific motor abilities.

According to everything we have mentioned before, and as well respecting the principle of specify in gymnastic training process, we hypothesized that our training program will increase an entire space of motor abilities important for Artistic gymnastics.

To our knowledge there is a lack of studies about effects of gymnast´s training programs on developing motor abilities. Therefore, the aim of this study is to determine changes in the development of some motor abilities of female gymnasts aged 5-6 years during the nine-month training process.

METHODS

Six gymnasts, members of gymnasts club „Novi Zagreb"from Zagreb, aged 5 to 6 years volunteered in this study. All subjects had been involved in gymnastic training process for the last two years. Trained six times a week with the length of training for 3 hours. Performing in the category "girl" in competition "C-program (CGF, 2006). Gymnasts were in preparation for a higher qualitative level, or "B-program competition during the transitive (control) measurements. Self–reported medical histories were received from all subject's parents, and any subject who reported any orthopaedic problem and/or taking any medicamentations on regular basis in the last year was not accepted into the study.

Before testing one of subject's parent signed informed consent. All procedures were approved by the Ethics Committee of the Faculty of Kinesiology University of Zagreb.

The training process lasted nine months from the 1st of August 2008 till the 1st of July 2009. They were measured 7 times during that period, on the first of each month except on December and January. All testing and training procedures were conducted by a trainer of Gymnastics club «Novi Zagreb». The trainer trained the same girls for two years.

Gymnasts were measured indoor, each time before training, after standard gymnasts warm up (5 minutes of running, and 10 minutes of dynamic stretching). They were measured on each test using a standard protocol of Croatian Gymnasts Federation.

The gymnasts were trained six times a week per three hours (from 5 till 8 pm). Their training processes were consistent of the elements of "B" program for girls. The introductory part of training lasted for 45 minutes. It was compounded of warm up (dynamic flexibility elements lasting 25 minutes) and specific gymnastics power exercises (hollow rock, hollow hold, hollow holding position) lasting for 20 minutes. In the main part of the training (lasting about 2 hours) they trained acrobatics (summersaults) in function of flashover. On the floor and balance beam they performed basic elements (bridges, hand stands) and rhythmic elements. Subjects trained uneven bars the most (50% of the training they trained uneven bars, 25% floor and 25% balance beam). The final part of training was lasting about 20 minutes. And it was compounded of specific power exercises (lasting about 15 minutes) and flexibility exercises in static form lasting for 5 minutes. The introductory and the final part of training were the same for all the gymnasts, but the main part was individualized in the intensity and extensity of the elements according to their capabilities and actual placement.

Gymnasts were measured at seven time points, by 12 different standard gymnast's motor tests during nine-month training process. Motility tests were selected to cover the field power of arms and shoulders, legs and trunk, and the flexibility of the hip joint. Two tests measured power of arms and shoulders, three tests for the power of trunk, three for the power of lower limbs, one test for the power of the entire body and three for the hip flexibility.

Table 1. *Names of motor tests, names of variables, measures, and motor abilities for each used test.*

Name of motor test	***Name of the variable***	***Measurement unit****	***Motor ability***
Legs lift from picked position	LLPP	number	Power (low abs and gauds)
Chin-up in 30 seconds	CU30	number	Power (arms and shoulder belt)
Legs lift in 30 sec	LL30	sec	Power (low abs and quads)
Rope climbing using legs/feet	RCL	sec	Explosive Power (arms and shoulder belt)
Tuck up trunk and leg flexion	TUTLF	sec	Power
Single leg squats (right)	SLSRL	number	Power (lower limbs)
Single leg squats (left)	SLSLL	number	Power(lower limbs)
Horizontal jump	HJ	cm	Explosive power
Split (right leg)	SRL	cm	Flexibility (hip and pelvic)
Split (left leg)	SLL	cm	Flexibility (hip and pelvic)
Canter split	CS	cm	Flexibility (hip and pelvic)
Press handstand	PH	number	Power of the entire body

*in figures are units in y axis

Statistic for Windows version 9.0 was used. The Kolmogorov-Smirnov (KS) test of Normality and Descriptive statistics were performed on all variables. All data were normally distributed according to KS-test. Hence the data were analyzed using One way ANOVA for repeated measures. Significance was considered to be achieved at $p<0.05$.

RESULTS

Table 1. *Results of One way ANOVA for repeated measures of motor tests.*

POWER MOTOR TESTS							
	LLPP	CU30	LL30	TUTLF	SLSRL	SLSLL	PH
F-value	12,39773	7,09830	8,1330	20,256	7,8068	7,0974	11,622
p-value	0,000001	0,000090	0,00003	0,0000	0,000041	0,00009	0,00000
EXPLOSIVE MOTOR TESTS							
	RCL			HJ			
F-value	0,91013			17,613			
p-value	0,53013			0,00000			
FLEXIBILITY MOTOR TESTS							
	SRL		SLL		SC		
F-value	5,5583		7,3038		6,8395		
p-value	0,00057		0,00007		0,00012		

Motor tests for assessing power

The results of motor tests (LLPP, CU30, LL30, TUTLF, SLSRL, SLSLL, PH) for assessing power presented in table 1., showed significant increase (F_{LLPP} = 12,396, F_{CU30} = 7, 0983, F_{LL30} = 8,1330, F_{TUTLF} = 20,256, F_{SLSRL} = 7,8068, F_{SLSLL} = 7,0974, F_{PTH} = 11,622; $p < 0,05$). Figure1 shows the dynamics of results measured on LLPP test. There is an increase between first and second time points, after that there is a plateau. The highest increase happened between fifth and sixth time points.

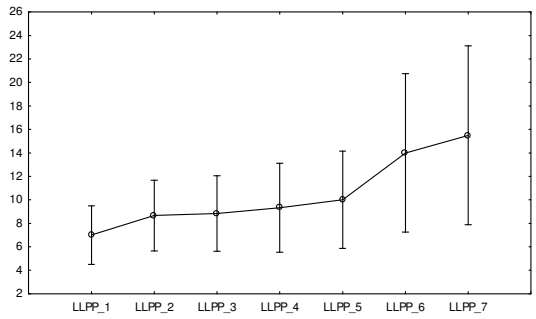

Figure 1. *Result's changes of LLPP test between each time point.*

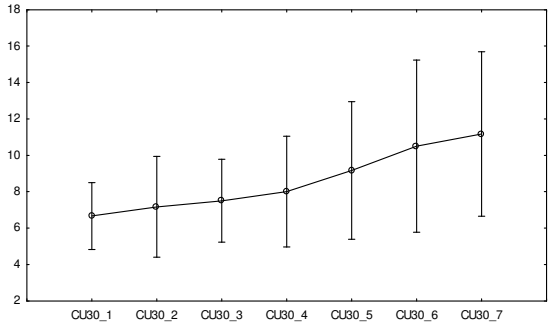

Figure 2. *Result's changes of CU30 test between each time point.*

Figure 2. shows a plateau between first and second time point, followed by notable increase of the results of CU30 test between second and sixth time points. It is seen a low increase, almost plateau between sixth and seventh points.

Results of LL30 show plateau between first and second, and sixth and seventh point, and significant increase between second and sixth time point, figure 3.

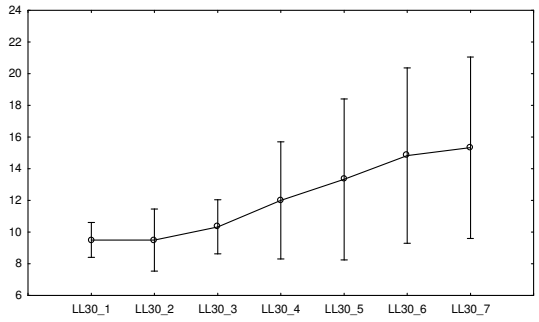

Figure 3. *Result's changes of LL30 test between each time point.*

There is a significant decrease between initial and final measuring of TUTLF test. We can see plateau until forth point. Afterwards there is a high increase until sixth time point, followed by lower increase, figure 4.

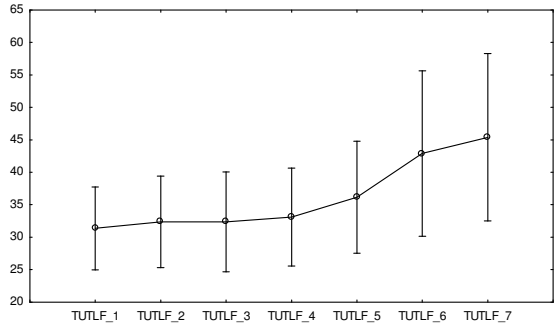

Figure 5. *Result's changes of TUTLF test between each time point.*

Results of single leg squats (SLSRL, SLSLL) shows almost identical dynamics through time. Strong increase between third and fourth, and fifth and sixth time point. There is a plateau between last two points on the dominant leg, and low decrease on non-dominant leg. There are one more plateau for non-dominant leg between fourth and fifth time points, figure 6 and 7.

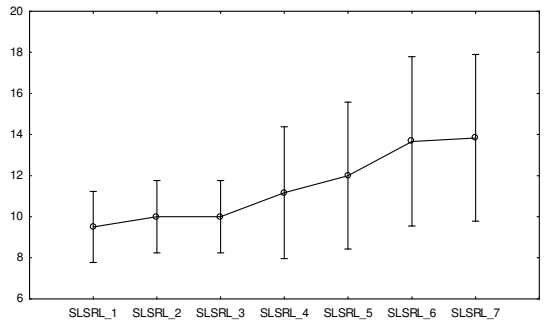

Figure 6. *Result's changes of SLSRL test between each time point.*

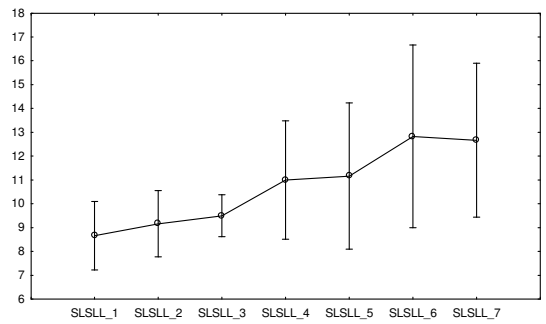

Figure 7. *Result's changes of SLSLL test between each time point.*

Results of PH test indicates minimal augment in the first two points, followed by significant increase until sixth time point, and notable decrease between last two points, figure 8.

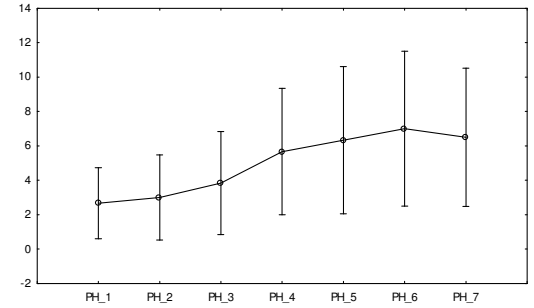

Figure 8. *Result's changes of PH test between each time point.*

Motor tests for assessing explosive power

We used two unspecific motor tests to assess explosive power, rope climbing and horizontal jump (RCL and HJ). The results of these tests are presented in table 2.

Rope climbing test indicates no significant changes between initial and final testing ((F_{RCL} = 0,91013, p= 0.53013), while distance jump shows minimal significant increase (F_{HJ} = 17,613, p < 0.05). There is a significant increase only between third and fourth time points, and plateau from first till third and between fourth and seventh points.

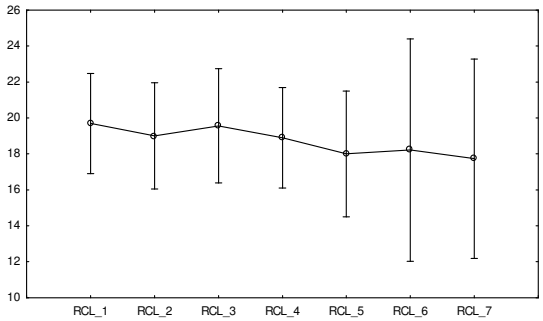

Figure 9. *Result's changes of RCL test between each time point.*

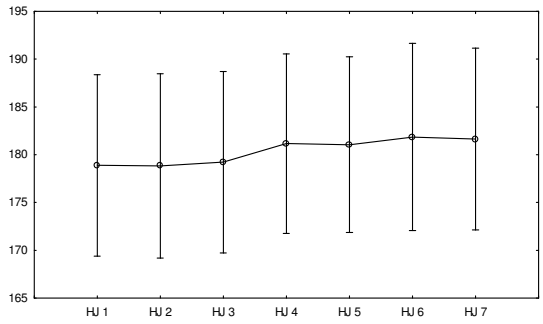

Figure 9. *Result's changes of HJ test between each time point.*

Motor tests for assessing flexibility

To assess flexibility we used three tests, respectively three types of splits, right, left and central split. Which results are presented in table 1. These variables are inversely scaled. All tests indicate significant increase in flexibility (F_{SRL} = 5,5583, F_{SLL} = 7,3038, F_{SC} = 6,8395, p < 0.05).

Figure 10 shows strong increase between first and second point, followed by short plateau. After that we can see high increase of results, followed by low decrease, and at the end, again, low increase. There is almost the same dynamics of results of SPLIT test, figure 11.

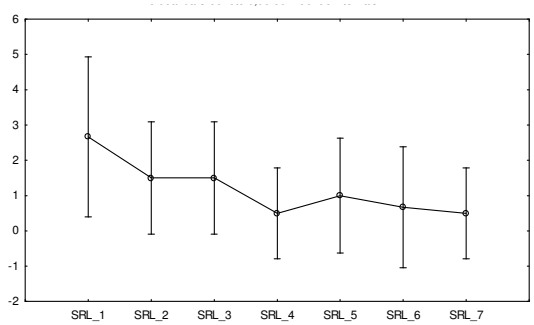

Figure 10. *Result's changes of SRL test between each time point.*

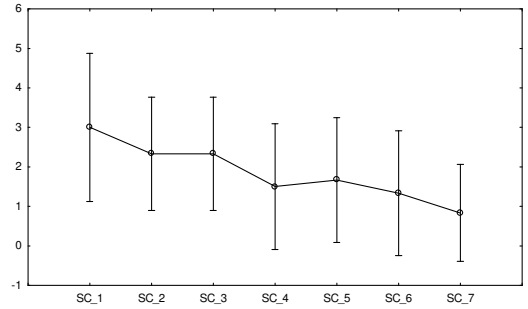

Figure 11. *Result's changes of SC test between each time point.*

Results of left split indicate almost linear increase through the time, except in last time point where is seen a plateau, figure 12.

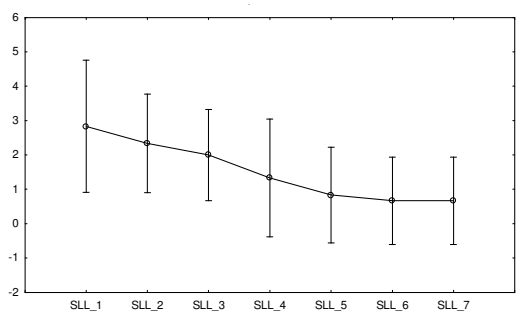

Figure 12. *Result's changes of SLL test between each time point.*

DISCUSION

The primarily finding of this study supported our research hypothesis, with statistically significant improvement in all of measured motor abilities, except in explosive strength (rope climbing, and minimal increase in horizontal jump). The explanation can be found in the knowledge of many previous studies.

It is well known that one of the most important principles of conditioning is – specificity. The principle of specificity means that conditioning should involve similar movements as those commonly found in gymnastics skills. However, specificity is sometimes "over-interpreted" to mean that the athlete should perform conditioning exercises exactly the same as seen in the actual movements, usually with added resistance. Of course, the only way to do a movement exactly the same is to do the movement itself. Adding resistance to sport movements may be appropriate at some times, but adding resistance to a skilled movement is usually not a good idea. Conditioning for particular gymnastics movements is specific to the ROM of the limbs, the speed of the movement, the type of movement, the duration of movement, the tension type and so forth. This further amplifies the importance of movement similarity between conditioning and performance movements (Siff, 2000).

Accordingly, gymnasts at this age mostly train acrobatics, basic elements on uneven bars (hanging and support position), and rhythmic elements (jumps, bounding, pirouettes and holding positions) on the balance beam and floor. That was also a content of our training program, fully respecting the principle of specificity. As we noted before our gymnasts trained elements from B program for girls, while they competed in C program for girls (National Award Regulations, 2005). However, in the last two measurements time points (May and July) started to compete in B program for girls. B program, as we mentioned before, is higher level than C program. B program means heavier elements on each apparatus, but the number of training hours remains the same. There is an increase in the number of repetitions of specific preparatory exercises (increase in intensity) for learning vault, acrobatic elements and new elements on uneven bars. The plateau or slight decreases in the last two time point of measuring in almost all motor abilities we can prescribe only to entry into the competition period. Accordingly, the gymnasts have already been adapted to training loading and were not showed progression any more. Many authors have already emphasized that once athletes started to compete, their results did not live up (Bührle and Werner, 1984 according to Major, 1996). Gymnastics experts have also warned, many times, against decreasing strength training during the competition season (Borrmann, 1978; Hartig and Buchmann, 1988; Plotkin, Rubin and Arkaev, 1983; Ukran, 1969 according to Major, 1996).

Contents of each of the gymnastic events are specificity in the way of exercising, and the type of elements and exercises. So this type of training results in specific developing of motor abilities.

The high rate of increasing results in our study we prescribe to the fact that they started to train elements of B program for girls which contains elements which require much higher level of power and explosive strength. Until then they trained in the beginner's C program for girls. There were highlights on basic power exercises, on the flexibility and acrobatic elements in the training process before that. Largest

increase was recorded in the results of LL30 test and LLPP test which is quite understandable considering that the most practicing elements are of the uneven bars.

It is known, the most important motor ability for gymnasts is strength and power, certainly, more precisely strength and power coupled with flexibility (Major, 1996). Importance of strength and power in artistic gymnastics is still debatable between the experts who have been explored that problem. So, some of them emphasize that the demonstration of the power of the muscles, being one of the most important skills in artistic gymnastics (Gaverdovskij et al, 1979; Kochanovicz, 1998; Savczyn, 2007 according to Koperski et al 2007). According to the definition of power, strength (force) is one of the components on account of which we can improve power (Markovic, 2008). As we mentioned before, when we talk about children's artistic gymnastic we can only talk about power, because they are too young for strength training with high loads. This insight is consistent with the results of our study, which show significant increase in all of six motor tests to assess the power, and also in each of two tests to assess flexibility. And also in consistent with our training principals, gymnasts trained power the most. Many authors studied importance and developing of strength/power in Artistic gymnastic (Major 1996; Sands et al, 2000; Sands et al 2005; McNeal et al, 2006). Many of them emphasize that special strength for gymnastics training must answer the demands of gymnastics (Shiff, 2000). The principle of specificity implies that the exercises used in training should be similar to the exercises that must be performed in the competition routine. Thus, our training program was composed of the elements of an official B program for girls (National award regulations, 2005). Therefore, many coaches and gymnastics experts imagine that the best training for gymnastics would be more gymnastics. However, long ago this was proven not to be the case (Borrmann, 1978; Oppel, 1967; Plotkin, Rubin, and Arkaev, 1983, according to Major, 1996). Special training is necessary to develop the strength and power in the athlete sufficient for correct technical performance of skills (Hartig and Buchmann, 1988; Oppel, 1967 according to Major, 1996), but there is also a need for conventional strength and power training.

Results of One way ANOVA for repeated measures shows minimal increase in the values of horizontal jump, and slight decrease in rope climbing. These results we can prescribe to the fact that horizontal jump is one of the tests which is used in the selection process. Thus, our gymnasts had a higher average value of the results from their counterparts (girls in the first class x_{HJ}= 120 cm) (Findak et al, 1992; Findak 2002), and even higher values from the results of the girls in the fourth class (x_{MSDM}= 145 cm) (Findak et al, 1992) who are not active athletes, at the onset of the training process. Rope climbing is a kind of specific gymnastics power exercises. They do rope climbing on each training, so they probably reached maximum of powerful capabilities for their age. But B program contains much demanding elements on uneven bars, and heavier acrobatic elements on the floor requiring higher lever of explosive power of arms and shoulder belt. So, there is a need for improving these capabilities in this age, already.

There is a need for improvement the explosive power of arms and shoulder belt, because as we already said, power and strength, while maintaining optimal ROM, are the most important motor abilities in gymnasts. We are inclined to say that the power is more expressed than strength, but the strength can be considered as a basis for developing power. Results of the study of Jamni and colleagues showed the high peak power values, placing the gymnasts near the top levels of power athletes (Jemni et al, 2006). An increase in maximal strength "is always connected with an improvement of relative strength and therefore with improvement of power abilities" (Schmidtbleicher, 1992 according to Sands et al 2000).

Each of two tests for accessing flexibility showed significant increase in the ROM. Making significant increases in flexibility will bring marked improvement in performance. Larger ROMs will allow for longer periods of applied force, improvement in technique, increases in biomechanical advantages and reduction in joint strain. Flexibility which promotes optimal ROM in the joints of the athlete, it is essential to both produce the most efficient movement, as well as protecting the athlete to a degree from the rigorous of the sport, particularly the repetitive nature of both training and competition. Most gymnastic coaches would agree that flexibility is an essential aspect of gymnastic training and performance (Sands and McNeal, 1999). In our training program gymnasts did flexibility exercises at the beginning, during warm up of the training (dynamic flexibility) and at the end of the training (static flexibility). But they trained much less flexibility compared to power. Which is in consistent with a numerous previous studies which showed that the main key to gaining flexibility is dedication and consistency (Sands, McNeal, 2000). No matter what method you use, if you do not stretch regularly, you will not gain flexibility. They didn't do much flexibility but they did it regularly. It is known that in the selection process for Artistic gymnasts we choose those who are flexible. So, our gymnasts were baseline more flexible than their counterparts. Namely, all of subjects were able to do all splits before they started to train gymnasts. Flexibility is frequently included in talent identification and screening measures for gymnasts, diver and dancers (Brodie et al, 1998; Hubley, 1982 according to Sands and McNeal, 2000).

Nowadays, the issue of flexibility is datable. No that much between gymnast´s coaches as well as between coaches of other sports. As scientists regularly investigating elite performance at the Olympic level (top eight in the world), we find that high-level coaches are beginning to question the role of stretching in performance, and no longer simply accept stretching as an integral part of an athlete preparation (McNeal et al 2006). Gymnastic coaches have found that athletes with extraordinarily large ROMs in static conditions are not able to show this range of motion in a dynamic setting (static split vs a split leap), and by adding resistance training in extreme positions the dynamic range of motion was improved (Jemni et al, 2006). Although documentation of the negative effect of stretching on acute maximal strength and power performance accumulates, the mechanisms by which this effect is produced are not clear (McNeal et al, 2006).

There is a lack of investigations about the effects of different training programs on motor abilities. So, there is a huge room for improvement and making gymnasts better even more.

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