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Original research article

EFFECTS OF STATIC STRETCHING OF VARIOUS DURATIONS ON THE VERTICAL JUMP AMONG FEMALE VOLLEYBALL PLAYERS

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Abstract. *A survey has been conducted on a sample of 61 female volleyball players of the women's volleyball club (WVC) "Novi Sad" (N=33) and WVC "NS Tim" (N=28) from Novi Sad (AGE=13.74±0.73SD, BH=171.12 ±4.33 BM= 48.72 ±6.54SD, years of experience 3.2±1.39 SD). The objective of the survey was to determine the effect of static stretching on the vertical jump among female volleyball players. Explosive leg strength was examined on the entire sample of female participants via a tensiometric platform "Probotics" 8602 Esslinger Court Huntsville Al 25802. This ability was assessed after 30, 60 and 90s of static stretching and use of standard volleyball warm-up exercises. The survey results indicate that static stretching with a duration of 30, 60 and 90s statistically significantly decreases the ability to express explosive strength of the lower extremities (p=0,00) among female volleyball players. There are no observed statistically significant differences in terms of explosive strength of the lower extremities depending on the duration of static stretching. The survey results indicate that static stretching leads to poorer explosive possibilities and strong muscle contraction of lower extremities in female volleyball players.*

Key words: *explosive strength, female volleyball players, static stretching.*

INTRODUCTION

One of the key objectives of warming up prior to a training session and competition is achieving the maximum performance and prevent injuries (O' Sullivan, Murray, & Sainsbury, 2009; Chaouachi et al., 2010; Fradkin, Zazryn, & Smoliga, 2010; O'Sullivan et

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al., 2009). Warming up usually consists of submaximal aerobic activity, stretching of the major muscle groups, however, it also includes general and sport-specific exercises performed in similar conditions to the training conditions – dynamic stretching (Taylor, Sheppard, Lee, & Plummer, 2008). Low to moderate aerobic activities increase muscle temperature, coordination and efficiency of the physiological response of the muscles (Bishop, 2003).

What belongs to the special group of muscle strength tests and anaerobic capacity are the measurings of specific or serial vertical jumps. Anaerobic capacity measured via these tests showed a significantly higher correlation with sport-specific achievement compared to other tests of anaerobic capacity. The most common testing protocol of the vertical jump ability on a contact and tensiometric platform includes performance of individual jumps from various basic positions and series of jumps of various durations (Ostojić, Stojanović, & Ahmetović, 2010). Variables obtained by measuring and calculations typically include jump height, jump duration and absolute and relative maximum jump strength, whereby this survey shall consider the jump height variable. A number of studies have shown significantly higher values of height and maximum vertical jump strength in top athletes as opposed to lower-ranked athletes.

Static warm-up provides positive effects on the manifestation of explosiveness in athletes and this approach ensures easy improvement of pliability in only a couple of weeks (Woolstenhulme, Griffiths, Woolstenhulme, & Parcell, 2006; O'Hora, Cartwright, Wade, Hough, & Shum, 2011). Static stretching can also increase the mechanics of movements, especially regarding the fast movements of athletes (Caplan, Rogers, Parr, & Hayes, 2009).

There are differences in expressing strength of vertical jumps depending on the duration of stretching (Donti, Tsolakis, & Bogdanis, 2014). These authors claim that shorter stretching exercises (15s of the static type stretching) do not show major effects on the performance of vertical jumps, but instead they do have significant effects after 30s of stretching. Use of the static and PNF (proprioceptive) stretching which includes a longer interval (longer than 30s) is usually associated with the decrease in performance of muscles and the vertical jump height, i.e. performance of explosive activities (Tsolakis & Bogdanis, 2012; Place, Blum, Armand, Maffiuletti, & Behm, 2013). What speaks in favour of decreasing performance of jumps observed following stretching are the surveys of such authors as Streepey et al., (2010) which indicate decreasing values of explosive leg strength immediately after stretching, i.e. that explosive movements need to be performed after a specific time and after stretching since no significant major differences regarding the jump height of athletes were observed. What is obviously required is a specific interval in order to enable the recharge of ATP in muscles. A study by the authors Bradley, Olsen, & Portas (2007) and Taylor, Sheppard, Lee, & Plummer (2008) proves that negative effects of static stretching are possible regarding the performance of explosive leg strength, i.e. jump height. The vertical jump height decreased after static stretching, i.e. the authors argue that static stretching should not be performed 15 min. before explosive movements. Jumping ability is inarguably one of the key biomotor abilities in monostructural, polystructural and complex sports disciplines (Nejić, Herodek, Živković, & Protić, 2010).

The warm up method can also affect the performance of explosive movements (ballistic, proprioceptive, static stretching, dynamic stretching); however, one can wonder which method is the best for achieving greater force required for performing a higher jump. The survey of Kirmizigil, Ozcaldiran, & Colakoglu (2014) indicates that the biggest impact is made by ballistic stretching, whereas static stretching comes in second, even though it has been proved that the participants achieved more jumps following the performance of all three indicated types of stretching. The most prominent property of muscle and tendon elasticity is the utilisation of elastic energy in the eccentric–concentric cycle. Contribution of elastic properties of muscle-tendon composition depends on the speed of such a transition. The transition needs to be as short as possible, and by all means shorter than 260 ms (Zatsiorsky, 1995).

The basic study design was based on determining the acute effects of static stretching and the warm-up on training parameters, i.e. explosive leg strength expressed via jump height, which are of great significance for the competing results of female volleyball players. The survey included testing in three moments, which is possible considering the fact that it is a matter of short-duration tests which do not lead to a significant or even acute fatigue. The survey's originality is reflected in the warm-up procedures which closely imitate a real volleyball warm-up routine for a match or training session as well as stretching protocols, especially static, which is also similar to the actual conditions of volleyball routine and concurrently poses the most questions on its potential negative effects when applied with a duration of 30, 60 and 90 s. The problem of the survey was the effect of static stretching of the lower extremities on the explosive leg strength of female volleyball players. The subject matter was explosive leg strength. The goal of the survey was to determine the differences in the effects of static stretching of the lower extremities of various durations on the vertical jump height among female volleyball players aged 13 to 15 from Novi Sad. The survey began with the hypothesis (H_1) that there are no statistically significant differences in the effects of static stretching of various durations on the vertical jumps among female volleyball players..

METHOD

The sample of participants included 61 female volleyball players: WVC "Novi Sad" (N=33) and WVC "NS Tim" from Novi Sad (N=28), aged 13-15. The female participants practiced volleyball for at least one year.

Explosive leg strength was tested for the survey's needs via the tensiometric platform "Probotics" 8602 Esslinger Court Huntsville Al 25802. It enabled collecting data on the values of explosive leg strength represented by the variables in the survey:

1) Squat Jump (SJ) (cm),
2) Counter Movement Jump - CMJ (cm) and
3) High Jump with Arm Swing (cm).

These three tests were measured three times, prior and following stretching of a duration of 30 s, 60 s and 90 s.

With respect to the female volleyball players, first there was a classical warm-up of volleyball players which consisted of running for a duration of 3 to 5 minutes, with a set of sprinter exercises. Shaping exercises were also applied by respecting the topological criterion of starting the exercises from the head and going to the extremities. Exercises did not include stretching and static stress. Later the on, female participants performed explosive jumps on the platform. After these jumps, they performed a set of stretching exercises with a duration of 30, 60 and 90 s. The performed exercises were the following>

1) crossleg – gluteus x 2 (Left and Right),
2) butterfly
3) sit and reach,
4) lunge-knee bent (iliopsoas stretch) - Left and Right (knee on the surface, with frontal pelvic movement followed by stretching of m. iliopsoasa),
5) lunge-knee bent and foot hold (quad stretch) - Left and Right
6) calf stretch by bending with hands on the floor (push a foot toward the floor, twice for each leg).

After performing static stretching exercises for a duration of 30 s on the first day, testing of explosive leg strength by applying the same tests was also conducted. The same procedure was used to perform warming up and testing female volleyball players on the second day, with the difference that the static stretching using the same exercises lasted for 60 s, whereas on the third day, it lasted for 90 s.

In terms of all analysed variables, descriptive statistics were calculated: arithmetic mean (AM), standard deviation (S), minimum (MIN) and maximum (MAX) values, CV (coefficient of variation). In terms of normal distribution testing, the Kolmogorov-Smirnov test (K-S test) was used. For the purpose of determining the effects of stretching on explosive leg strength, the t test for repeated measurements was applied, i.e. determining the changes occurring between the two measurements. ANOVA for repeated measurements was applied in order to determine if the changes occurred depending on the stretching duration.

RESULTS

Based on the descriptive properties presented in Table 1, it can be deduced that the female participants showed a similar level of explosive leg strength observed via the variables Semi-Squat Jump, Counter Movement Jump and Vertical Jump both during the initial and the final measuring. The most prominent homogeneity of the results was observed upon measuring the variable Hugh Jump with Arm Swing on the third day when the female volleyball players performed initial jumps before stretching for a duration of 90 s. The biggest variability was noticed regarding the variable Hugh Jump with Arm Swing in the final measuring after a static stretching of 90 s. What was observed in this variable was the biggest variability of the results regarding the level of explosive leg strength. A review of the results of normal distribution concerning all of the examined variables required for assessing the explosive strength of the lower extremities (Table 1) indicated that there were no statistically significant deviations of the obtained results from the normal (theoretical) distribution ($p>0,01$).

Based on the results of the t test for dependent samples (Table 2) it can be inferred that there are statistically significant differences ($p=0.00$) between the initial and final measurements in terms of all three assessed variables: Squat Jump, Counter Movement Jump and Hugh Jump with Arm Swing, in all of the three measuring sessions (after 30, 60 and 90 s) in favour of the initial measuring, since there is a decrease in the result values regarding the variables required for assessing the final condition, i.e. after applying static stretching of various durations, poorer results are achieved.

Table 1 Descriptive statistics of the assessed variables

Variable	AM	S	MIN	MAX	CV (%)	KSp
Squat Jump initial (cm)	34.70	4.99	25.44	45.39	14.38	0.74
Squat Jump stretching 30 s final (cm)	32.51	5.08	24.56	44.20	15.62	0.74
Squat Jump initial (cm)	34.40	5.35	24.33	44.81	15.55	0.81
Squat Jump stretching 60 s final (cm)	32.74	5.26	20.27	43.62	16.06	0.82
Squat Jump initial (cm)	34.93	5.32	22.40	47.65	15.23	0.97
Squat Jump stretching 90 s final (cm)	32.84	5.02	20.83	44.52	15.29	0.97
Counter Movement Jump initial (cm)	36.53	5.22	26.36	47.96	14.29	0.88
Counter Movement Jump stretching 30 s final (cm)	34.62	5.10	25.12	44.96	14.73	0.63
Counter Movement Jump initial (cm)	36.51	5.35	25.11	48.28	14.65	0.80
Counter Movement Jump stretching 60 s final (cm)	34.28	5.52	22.39	46.00	16.10	0.60
Counter Movement Jump initial (cm)	36.72	5.39	24.78	48.61	14.68	0.99
Counter Movement Jump stretching 90 s final (cm)	34.28	5.20	22.72	46.19	15.17	0.89
High Jump with Arm Swing initial (cm)	41.39	5.83	27.85	54.46	14.09	0.62
High Jump with Arm Swing stretching 30 s final (cm)	38.81	5.99	25.30	50.28	15.43	0.68
High Jump with Arm Swing initial (cm)	41.41	6.64	23.46	57.10	16.03	0.81
High Jump with Arm Swing stretching 60 s final (cm)	39.49	5.98	26.18	51.88	15.14	0.48
High Jump with Arm Swing initial (cm)	41.21	5.74	27.96	54.26	13.93	0.97
High Jump with Arm Swing stretching 90 s final (cm)	39.06	6.45	24.73	50.99	16.51	0.29

Legend: AM – arithmetic mean; S – standard deviation; MIN–minimal measuring results values; MAX–maximal measuring results values; CV- coefficient of variation; KSp – level of statistical significance of the Kolmogorov Smirnov test

Table 2 Differences between two measurements regarding the variables required for assessing explosive leg strength

Variable pairs	AM1	AM2	Difference AM (cm)	t	p
Squat Jump initial - Squat Jump stretching 30 s final (cm)	34.70	32.51	2.19	9.50	0.00
Squat Jump initial - Squat Jump stretching 60 s final (cm)	34.40	32.74	1.66	5.78	0.00
Squat Jump initial - Squat Jump stretching 90 s final (cm)	34.93	32.84	2.09	11.78	0.00
Counter Movement Jump initial - Counter Movement Jump stretching 30 s final (cm)	36.53	34.62	1.91	14.04	0.00
Counter Movement Jump initial - Counter Movement Jump stretching 60 s final (cm)	36.51	34.28	2.23	9.33	0.00
Counter Movement Jump initial - Counter Movement Jump stretching 90 s final (cm)	36.72	34.28	2.45	13.05	0.00
High Jump with Arm Swing initial - Hugh Jump with Arm Swing stretching 30 s final (cm)	41.39	38.81	2.58	8.13	0.00
High Jump with Arm Swing initial - Hugh Jump with Arm Swing stretching 60 s final (cm)	41.41	39.49	1.92	7.54	0.00
High Jump with Arm Swing initial - Hugh Jump with Arm Swing stretching 90 s final (cm)	41.21	39.06	2.15	6.06	0.00

Legend: t – value of the t test for dependent samples; p – level of statistical significance of the t test

Based on the results from the Table 3 (ANOVA for repeated measurements), it can be stated that with respect to the variable Squat Jump there are no statistically significant differences (P=0.49) in terms of the value F=0.72 in the period between the three measuring sessions, i.e. in terms of stretching with a duration of 30, 60 and 90 s. It can be inferred that there are no statistically significant differences when comparing the first, second and third measuring rounds when referring to each individual protocol of explosive leg strength with respect to the variable Squat Jump after applying various durations of stretching.

Table 3 Differences in variables for assessing explosive leg strength in various measuring sessions: the Squat Jump

Variable	AM1	SD1	AM2	SD2	Difference AM (cm)
Squat Jump after stretching 30 s/ Squat Jump after stretching 60 s (cm)	32.51	5.08	32.74	5.26	-0.23
Squat Jump after stretching 30 s/ Squat Jump after stretching 90 s (cm)	32.51	5.08	32.84	5.02	-0.33
Squat Jump after stretching 60 s/ Squat Jump after stretching 90 s (cm)	32.74	5.26	32.84	5.02	-0.10

F=0,72 P=0,49

Legend: F – Wilkson's F test; p – statistical significance of the F test

Based on the results found in Table 4, it can be stated that with respect to the variable Counter Movement Jump there are no statistically significant differences (P=0.39) in terms of the value F=0.95 in the period between the three measuring sessions, i.e. in terms of stretching for a duration of 30, 60 and 90 s. Considering the results of final measuring sessions, no major differences have been observed at the level of explosive leg strength among female volleyball players from women's volleyball clubs.

Table 4 Differences in variables for assessing explosive leg strength in various measuring sessions: the Counter Movement Jump (CMJ)

Variable	AM1	SD1	AM2	SD2	Difference AM (cm)
Counter Movement Jump after stretching 30 s/ Counter Movement Jump after stretching 60 s (cm)	34.62	5.10	34.28	5.52	0.34
Counter Movement Jump after stretching 30 s/ Counter Movement Jump after stretching 90 s (cm)	34.62	5.10	34.28	5.52	0.35
Counter Movement Jump after stretching 60 s/ Counter Movement Jump after stretching 90 s (cm)	34.28	5.52	34.28	5.20	0.01

F=0,95 P=0,39

Legend: F –Wilkson's F test; p – statistical significance of the F test

Results from Table 5 indicate that in terms of the variable High Jump with Arm Swing, likewise, there are no statistically significant differences (P=0.11) in terms of the value F=2.34 in the period between the three measuring sessions, i.e. in terms of stretching with a duration of 30, 60 and 90 s. It can be inferred that there are no statistically significant differences between the first, second and third measuring rounds when referring to each individual protocol of explosive leg strength with respect to the variable High Jump with Arm Swing after applying various durations of stretching.

Table 5 Differences in variables for assessing explosive leg strength in various measuring sessions: the High Jump with Arm Swing

Variable	AM1	SD1	AM2	SD2	Difference AM (cm)
High Jump with Arm Swing after stretching 30 s/ High Jump with Arm Swing after stretching 60 s (cm)	38.81	5.99	39.49	5.98	-0.68
High Jump with Arm Swing after stretching 30 s/ High Jump with Arm Swing after stretching 90 s (cm)	38.81	5.99	39.09	6.45	-0.25
High Jump with Arm Swing after stretching 60 s/ High Jump with Arm Swing after stretching 90 s (cm)	39.49	5.98	39.09	6.45	0.43

F=2,34 P=0,11

Legend: F –Wilkson's F test; p – statistical significance of the F test

DISCUSSION

Advantages of muscle stretching before any physical activity have frequently been questioned. Nevertheless, there is a rich body of evidence and moreover, it is well known that athletic performances and injury risks depend on the method of conducting the entire pre-training routine. Static stretching increases muscle mobility and concurrently, reduces the tendon stiffness even upon brief stretching (5-30 s). Explosive strength is a motor capacity of humans expressed via single movement and acyclical maximum muscle tension. Vertical Jump represents a strength test of lower extremities performed with the purpose of determining the strength level of the lower extremities. In order to improve such a performance, and thus reduce the risk of injuries but increase the amplitude of movements of female volleyball players, it is required to perform static stretching after each explosive strength training session, whereas before such training sessions it is recommended to perform dynamic stretching because of the active role of the CNS in body movements and body parts in general. Female volleyball players of two WVCs from Novi Sad performed Vertical Jumps upon the initial and final measuring sessions, i.e. Squat Jumps, Semi-Squat Jumps and Vertical Jumps. The results of this research have shown that static stretching with a duration of 30 s, 60 s and 90 s had a negative impact on the explosive strength performance, i.e. success of female volleyball players of two WVCs from Novi Sad with respect to the Vertical Jump, as the variable decreased after applying such types of stretching.

The survey was used to verify the proposed study hypothesis, since it has been confirmed that there are no statistically significant differences in terms of the effects of static stretching of various durations on the Vertical Jumps of female volleyball players. The survey also proved that static stretching with a duration of 30, 60 and 90 s reduces the chances of more powerful explosive activities when contrasted to the ones performed before such a stretching activity. Namely, the duration of stretching not exceeding 90 s is sufficient to realise the negative effect of static stretching on the Vertical Jump among female volleyball players. Since the evidence shows that in practice static stretching with a duration of approximately 30 s is most frequently applied per each muscle group, we can state that it seems desirable to adapt the warm-up method as well as the preparations for a volleyball match and training sessions, primarily from the aspect of applying other stretching methods. It is probable that another type of stretching should be applied in order to achieve better results, with particular emphasis on dynamic stretching.

It was determined that the level of explosive strength regarding the variables Squat Jump, CMJ and High Jump with Arm Swing significantly reduced in statistical terms after applying the static stretching. This phenomenon is best discernable in the variable CMJ where the stretching time lasted for 30 s each. This occurrence can be explained by faster discharge of creatine phosphate depots in the muscles and loss of strength required for maximum movement capacity. Having considered muscle and tendon elasticity, it should be known that they play a major role in increasing mechanical operations during movement. In case an active muscle or tendon elongate themselves, elastic energy will accumulate inside these biological structures and it will be used to increase the results in the concentric stage of eccentric and concentric cycle. On the account of the laws of physics, the degree of accumulated energy shall be proportional to the applied force and induce deformation. Since the muscles and tendons have serial positioning, the same force affects them, upon which the accumulated energy matches the level of deformation. Tendon stiffness is unchangeable, but, conversely, changeable stiffness of muscles depends on the applied force. The passive muscle is yielding, meaning that it can be easily elongated. The active muscle is stiff, and in order to elongate it, major force is required. The more intense the muscle strain, the bigger the muscle stiffness, i.e. the force giving resistance to stretching is greater. In top athletes, muscle stiffness in their active condition supersedes their tendon stiffness (Zatsiorsky, 1995). For this reason, elastic energy produced while jumping is primarily stored in tendons and not in muscles. Based on this, it can be deduced that tendon elasticity is of great importance. Speaking from the perspective of the nerves mechanism, the following can be stated: contraction depends on the changes in muscles controlled by the myotatic reflex or stretching reflex and the Golgy tendon organ. Receptors of myotactic reflex or muscle spindles are placed parallel to the muscular fibers. When a muscle stretches under the effect of external muscular force, muscle spindles stretch as well. For this reason, muscle spindles are stressed, and thus, alpha motor neurons get activated, and reflex contraction of the stretched muscle ensues, which supports the muscle in its effort to restore the initial length. Golgy tendon organs have serial positioning along with the muscular fibers, they are sensitive to forces developed within the muscle, and not to the length changes, which is the case with the muscle spindles. In case the muscular straining suddenly increases (e.g. static stretching), the Golgy tendon reflex prevents muscular contraction. Consequentially, a decrease in muscular straining prevents muscle and tendon damages (force feedback). Efferent discharges toward the muscle in the stretching phase in the eccentric-concentric cycle is modified by mutual functioning of two reflexes, i.e. by positive effects of the myotatic reflex and negative (inhibiting) effects of the Golgy tendon organ. It should be emphasised that the activity of extensor muscle during a vertical jump (m. quadriceps femorisa, m. tricepsa surea and others) is inhibited during the jump by the effects of the Golgy tendon organ which participated in the process of preventing injuries upon static stretching. It can be assumed that from the aspect of the nervous mechanism, static stretching leads to bigger activation of the Golgy tendon organ which does not allow for later performance of axially strong extensor muscular contraction during vertical jumps. Eccentric and concentric cycles represent an integral part of volleyball elements. The force created in the eccentric and concentric cycle, as well as the degree of energy accumulation, depends on the elastic properties of muscles and tendons, but also from the nervous control of muscular activity proving itself as the limiting factor in this study. Static stretching with a duration of 30, 60 and 90 s, predominantly activated two reflexes, the stretching reflex and Golgy tendon organ reflex. These two mechanisms predominately determine the nervous component within the eccentric and concentric cycle.

In energetic terms, parameters of explosive strength indirectly discuss alactic (phosphagen) anaerobic energy system. Activities of this type are frequent in sport competitions and polyvalent sport disciplines such as volleyball, and they typically last up to 8 s. It is possible that the genetic factor is responsible for the most successful achievement of these tests which determines the structure and functions of certain neuromuscular elements (e.g. content of fast-contracting muscular fibres) or acute, i.e. prolonged effect of the programmed training process (Carlock et al., 2004; Popadić-Gaćeša, Karaba-Jakovljević, Barak, & Drapšin, 2009).

Static stretching represents the gradual brining of a bodily segment into the maximally stretched position and its retention in such a stretched position during a certain period. Modern studies have shown that static stretching can reduce sport achievements and that they do not necessarily have to lead to a decrease in the frequency of sport injuries. The results of this survey indicate that this only reduces the maximum strength of muscles during an eccentric contraction and that the strength deficit endures even longer than 90 min after stretching. Muscular force produced by muscles upon strong explosive movements decreased after static stretching, while the strength deficit was obvious. It appears that whenever we make fast muscular contractions where eccentric (muscular stretching) and concentric contraction (muscular contraction) take turns, static stretching leads to reduced performances. This is the reason why other stretching techniques should be reconsidered, and why static stretching should deserve less attention than before.

This survey has confirmed the results of previous research done by such authors as Kokkonen, Nelson, & Cornwell (1998), Young & Behm (2003), Bradley et al. (2007) and Taylor et al. (2008), Streepey et al. (2010), who had also observed a decrease in the level of explosive strength after applying static stretching. It can be concluded that a certain amount of time is still required to have fully restored reserves of ATP in the muscles. This survey has also proved the possibility of negative effects of static stretching on the explosive leg strength performance. Jump height in female subjects showed statistically significant decrease after applying static stretching with a duration of 30, 60 and 90 s. Based on the obtained results from the research, it can be assumed that static stretching should not be conducted immediately before explosive movements, since the value of maximal explosive leg strength will decrease and the true effects will not be able to be achieved including good results. It has been established that after applying a series of exercises pertaining to muscular static stretching, a decrease in the explosive strength ensues in female volleyball players. This effect is called loss of strength caused by stretching. This loss is caused by stretching and has a nervous effect (Avela, Kyrolainen, & Komi, 1999) observed as a negative effect on the vertical jump value..

As for the stretching, there are various types of stretching and each has its own purpose and benefit. Upon choosing the stretching exercises it should be taken care that the exercises would be relevant for the activities and the sport practiced by an athlete. From the theoretical point of view, this survey should help upon choosing the stretching exercises to be applied as the obligatory part of the warm-up in younger age categories of female volleyball players, as well as the selection of adequate motor field tests for assessing the leg explosive strength. The accent is placed on the usage of other forms of stretching, primarily dynamic before applying training focused on the explosive strength of female volleyball players.

CONCLUSION

Note: static stretching should not be entirely avoided. It has its role after the performed training session, as well as in the training with the objective of developing flexibility. This type of stretching can be used before training in certain more progressive forms of training. In such a case, a person performs some form of static stretching with the objective of increasing mobility of certain body parts. This is when the person consciously performs this type of stretching in order to temporarily increase the movement volume and perform training on a larger scale.

Based on everything stated above, it is obvious that static stretching negatively affects performance of explosive activities such as jumping and this is why it cannot serve as the preparation for the main part of training. It has a negative effect on force and speed and explosive capacity (sprint, jumps) if performed immediately before such activities. Static stretching has its importance and it would be wrong to eliminate it completely. The ideal time for performing it is after the training session (final part of the training).

The author's proposal is stretching in the initial part of training which has to have a dynamic character and immediately followed by a warm-up to increase body temperature. In terms of dynamic stretching, there is no retaining of a particular position, but instead muscles have a dynamic operation mode. This means that muscular stretching and muscular contraction cyclically take turns, which is the same muscular operation mode occurring in jumps, and various strength exercises. Apart from this, dynamic stretching does not cause the occurrence of the abovementioned negative effects, recorded after static stretching used for the purpose of training preparation. Moreover, such a stretching type is more suitable as a training preparation in the initial training part and it has to have an advantage when compared to static stretching.

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UTICAJ STATIČKOG ISTEZANJA RAZLIČITOG TRAJANJA NA VERTIKALNI SKOK ODBOJKAŠICA

Istraživanje je sprovedeno na uzorku od 61 odbojkašice ŽOK „Novi Sad“ (N=33) i ŽOK „NS Tim“ (N=28) iz Novog Sada (GOD=13,74±0,73SD, TV=171,12 ±4,33 TM= 48,72 ±6,54SD, staža 3,2±1,39 SD). Cilj istraživanja je bio da se utvrdi uticaj statičkog istezanja na vertikalni skok odbojkašica. Na celokupnom uzorku ispitanica testirana je eksplozivna snaga nogu pomoću tenziometrijske platforme „Probotics“ 8602 Esslinger Court Huntsville Al 25802. Ova sposobnost je procenjena nakon 30, 60 i 90 s statičkog istezanja i primene standardnog odbojkaškog zagrevanja. Rezultati istraživanja ukazuju da statičko istezanje u trajanju od 30, 60 i 90 s statistički značjano umanjuje sposobnost ispoljavanja eksplozivne snage donjih ekstremiteta (p=0,00) odbojkašica. Ne postoje statistički značajne razlike u nivou eksplozivne snage donjih ekstremiteta u zavisnosti od dužine trajanja statičkog istezanja. Rezultati istraživanja ukazuju da statičko istezanje dovodi do slabijih eksplozivnih mogućnosti i snažnih kontrakcija mišića donjih ekstremiteta odbojkašica.

Ključne reči: *eksplozivna snaga, odbojkašice, statičko istezanje.*