

# Effect of 6-Month Fascia-Oriented Training on the Dynamics of Changes of the Height of Vertical Jump in Well-Trained Junior Female Volleyball Players

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## Abstract

Based on the research review, the fascia-oriented Fascial Fitness training (FF) may positively influence sports performance. Its component focused on the “catapult” mechanism can increase the capability of the connective tissue to store and release kinetic energy, thus enhance various movement actions, activities and skills in many sports, including the jumping skills in volleyball. The study was conducted to assess the effect of the 6-month fascia-oriented training on the height of the vertical jump in well-trained junior female volleyball players. 16 players (age  $17.31 \pm 0.98$ ; height  $173 \pm 5.26$ ; weight  $65.25 \pm 6.75$ ), the members of the team competing in the national league, were randomly assigned for the training group (TG) and control group (CG). TG participated in the supervised 25-minute fascia-oriented training twice a week for six months. To measure the height of the jump, the force plate Bertec FP6012-15-4000 was used. Three testing measures were executed: pre-test, mid-test and post-test with three trials of the standing vertical countermovement jump with all arm movement (CMJ). Based on the FF principles, the study presupposed that due to the fascia-oriented training, the height of CMJ may rise slightly more in TG than in CG after three months. After six months, a statistically significant increase was expected in TG comparing to CG. Based on the results of the study, we conclude that the 6-month fascia-oriented training focused on the development of the height of vertical jump in well-trained junior volleyball players neither complied with the assumed dynamics in changes nor was statistically significantly beneficial. However, by observing the results we purport that the dynamics of the changes of the height of vertical jump indicates that fascia-oriented training may positively influence the stability and efficiency of the jumping performance during the in-season.

**Keywords:** volleyball, fascia-oriented training, movement intervention, height of vertical jump, dynamics of changes

## INTRODUCTION

Volleyball is a popular team ball game requiring a specific level of fitness in combination with specific technical skills. Volleyball players need exceptional jumping abilities, and explosive strength is critical to the success in the game, as volleyball involves constant vertical jumping high above the net (Haník, Vlach, Lehnert, Ejem, Juda & Vorálek, 2008; Císař, 2005). In a 5-set game, an elite player is estimated to perform 250–300 attacking and blocking movements (Martinez, 2017). Ziv and Lidor (2010), who reviewed observational and experimental studies targeted on vertical jump performances in female and male volleyball players, concluded that players of more successful teams have higher vertical jumps. They also concluded that in female volleyball due to a greater disparity in jumping performance, the jumping ability seem to be more determinantal to success. Thus, our research project aimed to examine the effect of the fascia-oriented training called Fascial Fitness (FF) on jumping performance by monitoring and observing the dynamics of the changes in the height of vertical jump. If beneficial, FF may then enhance the training process as such.

In volleyball, the phases of the different types of vertical jump are similar, whether spiking, blocking and serving. Different authors define 3–8 phases, with three (takeoff, flight and landing phase) occurring in all three basic types of vertical jump. Some more phases can be involved, either the running approach and/or the counter-movement with or without the arm-swinging movement. Concerning the countermovement jumping actions, according to Turner and Jeffreys (2010), the phenomenon called the stretch-shortening cycle (SSC) is broadly agreed to occur. The SSC consists of three phases: eccentric, isometric transitional (amortization) and explosive concentric. When subjected to examination, it seems probable that the storage of the kinetic energy, nervous processes, active state, length-tension characteristics, pre-activity tension and enhanced motor coordination are the main mechanics employed in the SSC. If these components targeted in training, their improvement can bring enhancing effect in the performance of the SSC, and thus in jumping skills and activities. Turner and Jeffreys (2010) further conclude that training methods improving muscular pre-activity, such as plyometric and ballistic training, may be beneficial for the improvement of the jumping performance. They also state that the jumping capacity can be increased by SSC drills focused on the muscle-tendon cooperation, force-velocity relations, fast smooth landing, efficient storage and utilization of the kinetic energy in tendons performed with respect to an athlete's strength capacity and sport-specific variables. As the review indicates, in the SSC, the lower extremities demonstrate features similar to the ones of a spring. Regarding their findings, they closely correlates with the ideas and aims of FF.

Among the research studies aimed at the structures of the connective tissue, there are those focused on the role of fasciae and tendons in motion. They observe and examine muscle-fascia-tendon interactions and, the ability of the elastic structures of the connective tissue to store and release kinetic energy (the “catapult” mechanism) in both animals and humans. Some of the studies conclude that the observed elastic structures of the connective tissue are capable of storing and releasing kinetic energy highly effectively (Astley & Roberts, 2012; Roberts, 2006; Roberts & Konow, 2013; Kawakami, Muraoka, Ito, Kanehisa & Fukunaga, 2002; Purslow, 2002; Kram & Dawson, 1998). Humans are also capable of the mechanism (Fukunaga, Kawakami, Kubo & Kanehisa, 2002; Sawicki, Lewis & Ferris, 2009). Thus, if we try to enhance the utilization of the mechanism in sport more effectively, it may positively affect jumping performances.

The latest research findings show that the elastic structures of the connective tissue can play a very important role in movement (Schleip, Findley, Chaitow & Huijing, 2012). Schleip and Müller (2013) state that the connective tissue is trainable. It answers to strain-loading demands (El-Labban, Hopper & Barber, 1993), which may induce changes bringing both a desired and undesired adaptation of the tissue. According to Schleip et al. (2015), and Schleip and Müller (2013), the tissue reacts to different types of training or exercise, but the specifically-targeted fascia-oriented training Fascial Fitness appears to be more effective.

FF consists of different stretching techniques and self-applied massages, whose performance should be executed in accordance with the specific principles defining the duration, intensity and frequency of the training, as well as the involvement of stretching techniques and the arrangement of exercise (Schleip & Müller, 2013). FF aims to mechanically lengthen, architecturally remodel, hydrate and release various structures of the connective tissue. It further focuses on the proprioceptive stimulation, the stimulation of fibroblasts and their bio-chemical processes, and on the effective storage and release of the kinetic energy in the structures. Last but not least it directs at their elasticity (Myers, 2009; Schleip & Müller, 2013; Schleip et al., 2015).

As for the jumping performance potential, our research review showed that no practical, longer-lasting implication of FF and its potential beneficial effect on jumping skills in sport has been examined profoundly yet. Several studies observe the impact of selected FF techniques on different motion tasks, such as hopping (Lamontagne & Kennedy, 2013), foam rolling (Barnes, 1997) and running (Holt, Roberts & Askew, 2014). Thus, we determined to examine the effect of FF on jumping performance potential in volleyball. Based on our experience in volleyball training and the experience with FF employed in the exercise methods we teach, we aimed to assess the

effect of the applied 6-month FF training on the height of the vertical jump in well-trained junior female volleyball players. Based on the knowledge of the principles of FF, we focused on the dynamics of the changes of the height of vertical jump during the course of the research experiment. If our assumption verified, besides volleyball, FF may be included in training processes in other sports where jumping skills are essential as an enhancing component.

## **GOALS, METHODS AND FF PROGRAMME**

The goal of the research was to assess the effect of the 6-month fascia-oriented FF training on the height of the vertical jump in well-trained junior female volleyball players. The research also aimed to monitor and assess the dynamics of the changes of the height of the vertical jump in the course of the research project.

The research was conducted as a longitudinal experiment with the FF exercise programme applied to the experimental training group for the course of six month. The control group participated in the regular training programme of volleyball only without any special complementary programme, thus in the control group no interventionist, support factors are not implied.

For testing, the force plate Bertec with Simi Motion devise for 3D kinematic analysis was used to get detailed information available for future further analyses. Three testing measures were executed in the laboratory environment: pre-test, mid-test and post-test, applied before, in the middle and after the experiment respectively.

Each unit of the FF training programme lasted 25 minutes, and was applied at the end of their regular training unit twice a week to the experimental training group. The programme was designed in accordance with the principles of FF (Schleip & Müller, 2013). It included three different parts: the self-treatment massage of the feet with foot massage balls, the stretching part and the final slow self-treatment massage of the lower extremities on foam rollers, where the stretching part focused on the enhancement of the elasticity and the spring-like catapult mechanism of the connective tissue in the lower extremities primarily.

## **SUBJECTS**

The volleyball team for research project was selected intentionally. The participants had to meet the basic predefined requirements as follows: they had to be female volleyball junior players of one team aged 15–18, training regularly for one whole season. We cooperated with the sports club KPS Brno, as we assumed their participation in the elite division would guarantee a successful completion of the whole 6-month FF training plan. The group consists of 16 subjects from one female junior team just promoted to the elite division (age  $17.31 \pm 0.98$ ; height  $173 \pm 5.26$ ; weight  $65.25 \pm 6.75$ ). All the subjects were free of injury. All the subjects signed the informed consent about their voluntary participation in the research and agreement with the anonymous data analysis. The subjects were assigned to the experimental training (TG) and control group (CG) by their coach randomly. Both TG and CG consist of eight subjects each. One subject of TG did not participate in the mid-test due to serious family problems, but the subject participated in the whole FF training programme. For that reason, we decided not to exclude the subject from the research. Finally, 14 participants completed the experiment, seven from the TG and seven from the CG. During the experiment, two subjects had to be excluded for the health reasons.

## TESTING PROTOCOL

The force plate Bertec FP6012-15-4000 operating at a sampling frequency of 360Hz was used to test the height of the vertical CMJ with all arm movement, with the synchronous 3D kinematic analysis Simi Motion version 9.0.5 recording it. The markers placed on the right and left iliac crests recorded the execution of the jump. To eliminate deviations in the differences between the right and left side, the height of the jumps was recorded as a virtual point. The centre of abscissa between markers located on the left and right iliac crests represented the virtual point. The height was calculated as the perpendicular distance of the virtual point along the plane Z towards the planes XY. To assess the effect of FF on the height of the jump, the participants performed three trials of the standing vertical countermovement jump with all arm movements. This jumping test is a variation of the Abalakov vertical jumping test, where the countermovement and the arm swing are considered as a more natural and functional approach for the increase in jumping performance (Laffayte, Wagner & Tomblason, 2014). In all the trials, the degree of knee-bend employed by the subjects was self-determined with the primary aim to jump as high as possible. The depth of the knee flexion and the amount of the arm movement were not preset. According to Laffayte et al. (2014), this functional approach is based on the assumption that skilled volleyball players choose their own course of knee-bend and arm swing to maximize the peak force and velocity, which will result in maximal jump height. When conducting the jumps, the subjects were encouraged to perform each trial with maximum effort to jump as high as possible.

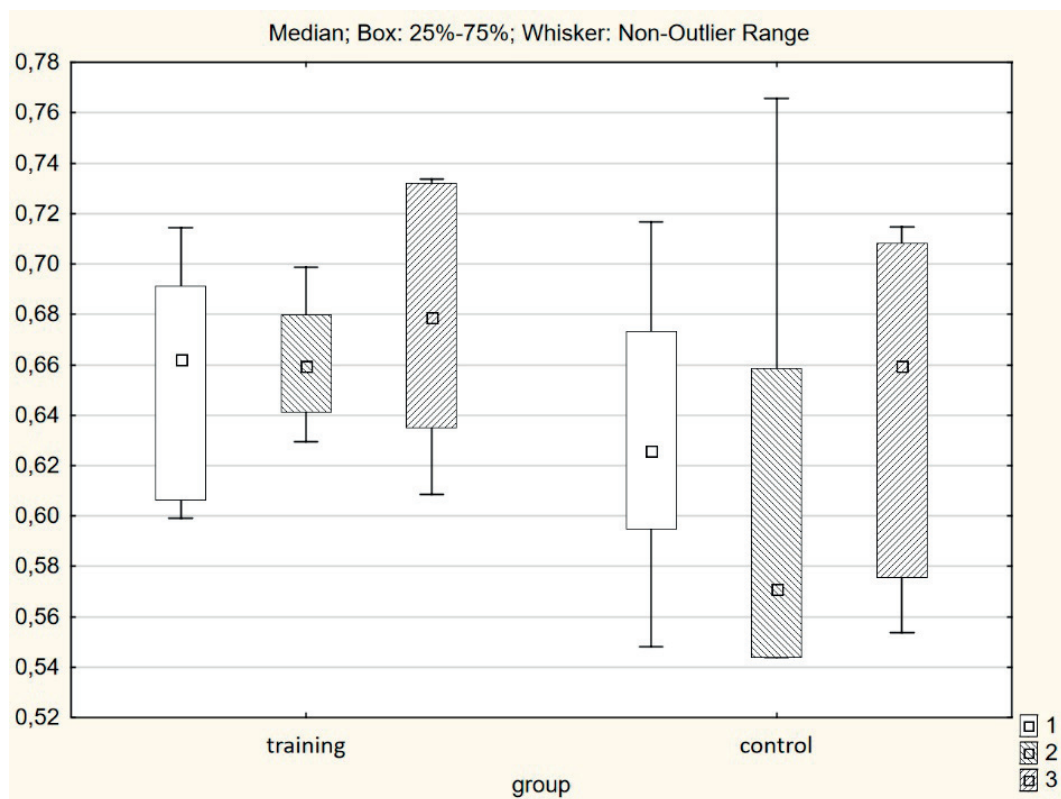
## STATISTICAL ANALYSES

The highest participants' trials in both the experimental training and control group were used for the statistical testing and analysis in all three testing measurements. The impact of the application of FF training on the height of the vertical jump is only expected in the experimental training group.

Due to the small number of participants, we used non-parametric methods. The results were statistically analysed by the non-parametric statistical test, Friedman's ANOVA. Friedman's ANOVA by ranks is an alternative to a one-way within-subjects analysis of variance. This test compares variables measured in dependent samples (repeated measures). The Kendall coefficient of concordance (effect size measure) essentially denotes the average rank order correlation between the cases. .

## RESULTS

Figure 1 illustrates the basic values of the height of the vertical jump for both the experimental training and control group in all three measurements. Table 1 and 2 outline and introduce the basic statistical characteristics. They depict the median, lower and upper quartile of the height of the vertical jump for both groups in all three measurements. Tables 3–5 present the key results.



**Fig. 1:** Basic values of the height of the vertical jump in all three measurements – TG and CG.

**Tab. 1:** Basic statistical characteristics – the height of the vertical jump in TG

Measurement	Descriptive Statistics - training group					
	Valid N	Median	Minimum	Maximum	Lower Quartile	Upper Quartile
1	7	0.662	0.599	0.714	0.606	0.691
2	6	0.660	0.630	0.699	0.641	0.680
3	7	0.679	0.609	0.734	0.635	0.732

**Tab. 2:** Basic statistical characteristics – the height of the vertical jump in CG

Measurement	Descriptive Statistics - control group					
	Valid N	Median	Minimum	Maximum	Lower Quartile	Upper Quartile
1	7	0.626	0.548	0.717	0.595	0.673
2	7	0.571	0.316	0.766	0.544	0.659
3	7	0.659	0.554	0.715	0.576	0.708

**Tab. 3:** Result of Friedman ANOVA – the height of the vertical jump in TG

Measurement	Training group Friedman ANOVA and Kendall Coeff. of Concordance ANOVA Chi Sqr. (N = 6, df = 2) = 1.333 p = 0 .513 Coefficient of Concordance = 0.111 Aver. rank r = -0.067			
	Average Rank	Sum of Ranks	Mean	Std. Dev.
1	1.666	10.000	0.653	0.050
2	2.000	12.000	0.661	0.027
3	2.333	14.000	0.667	0.043

**Tab. 4:** Result of Friedman ANOVA – the height of the vertical jump in CG

Measurement	Control group Friedman ANOVA and Kendall Coeff. of Concordance ANOVA Chi Sqr. (N = 7, df = 2) = 3.429 p = 0.180 Coefficient of Concordance = 0.245 Aver. rank r = 0.119			
	Average Rank	Sum of Ranks	Mean	Std. Dev.
1	2.286	16.000	0.629	0.055
2	1.429	10.000	0.568	0.136
3	2.286	16.000	0.639	0.066

Based on the value of p in both groups, we do not reject the hypothesis of equality of the mean values of three measurements. The differences are not large enough to be statistically significant. The coefficient of concordance indicates a small size effect in the experimental group (Kendall = 0.111). The coefficient of concordance shows a middle size effect in the control group (Kendal = 0.245) given by a drop in performance in the second measurement.

**Tab. 5:** Differences of the height of the vertical jump in all three measurements – TG and CG

Training group		Control group	
Measurement	cm	Measurement	cm
1-2.	-0.2	1-2.	-5.5
2-3.	1.9	2-3.	8.8
1-3.	1.7	1-3.	3.3

Table 5 shows that the dynamics of the changes of the height of the vertical jump demonstrates a slight worsening (-0.2 cm) between the first and second measurements, and the increase of the height of the vertical jump between the first and third measurements (1.7 cm) in the experimental training group. Given the higher measured input parameters of the experimental training group comparing to the control group, it can be stated that after the application of the 6-month FF training, the improvement was made, although it is not statistically significant. However, there was no improvement after the first three months.

The dynamics of the changes of the height of the vertical jump in the control group differs. After the first measurement, there was a relatively large worsening (-5.5 cm), but after the following three months the height of the vertical jump improved. Comparing the input and output results, there is an improvement of 3.3 cm.

Concerning the absolute results, there is still a difference between the experimental training and control group in favour of the training one as shown in Figure 1.

## DISCUSSION

Schleip and Müller (2013) state that the changes and improvements in the structure and functioning of the connective tissue that FF aims at are expected to appear within the course of 6–24 months, if trained regularly. Latest references (Meinl, 2016) suggest that the desired changes may already occur after three months of regular FF training. Based on this knowledge, we expected that the fascia-oriented training applied systematically during the course of six months would induce a statistically more significant increase of the height of the vertical jump in the experimental training group comparing to the control group finally. We further expected a moderate improvement after the first three months, and a more significant change of the height of the vertical jump was assumed in the training group compared to the control one.

As the results of our study show, both groups worsened after the first three months. Although, the worsening of the experimental training group was not so significant comparing to the control group. After six months, both groups improved. Even though the improvement of the control group was slightly higher compared to the experimental training group, neither was statistically significant and the absolute results showed a difference in favour of the experimental training group. Based on the results of the experiment, our research study concludes that the 3-month FF training did not bring the expected improvement regarding the changes of heights of the vertical jump in the experimental training group. Furthermore, despite the fact that the 6-month application of FF shows the improvement of the height of the jump in the experimental training group, the improvement is not statistically significant.

When observing the dynamics of the changes of the height of the vertical jump, based on the results of the mid-test in both groups we can propose that the application of FF for the first three months did not confirm our assumptions. However, it seems to stabilize the efficiency of the jumping performance in the experimental training group during the in-season, which should not be overlooked. In elite players whose sports performances and efficiency can be demanding to improve, this impact may bring an appreciable effect and become a stabilizing factor.

Concerning the non-confirmed dynamics of the expected changes of the height of the vertical jump and the lack of significant impact, there may be different possible reasons and explanations. As for the duration of the experiment, as written above, the most frequent recommendation of the minimum-maximum length is 6–24 months and some references even suggest three months as a sufficient period. Based on the results of our study, we propose that the duration of FF training application longer than six months may be more beneficial, and might bring the desired and statistically more significant changes, as the connective tissue reacts slowly (Schleip & Müller, 2013; Myers, 2009).

Moreover, regarding the contents of the FF training programme, there are many elaborated principles explained clearly about FF (Schleip & Müller, 2013; Schleip et al., 2015). However, there are no programmes designed in detail. When setting up the FF training programme, we proceeded from our training experience. We focused on the specific needs in jumping skills in volleyball, and on the principles of FF. We propose that in the future, more studies with elaborated designs applied in different sports could bring more profound and expert perspectives about the involvement of FF in sport.

Concerning the other extrinsic factors, the size of the group was small, which might also limit the results of the study. Additionally, the players' training history could also have an impact, as their training records showed that individual players started playing at different age.

Regarding the intrinsic factors, motivation is an extremely important factor in sport, as well as genetic predispositions. As for motivation, the cooperation with sociologists may enhance further research in the field of FF. As for genetic factors, only little research has been done in connection with FF and its impact on sports performance and efficiency. Our research did not include these aspects, but we think that further research focused on these factors could extend the current knowledge about FF in sport and support the idea of the importance of the involvement of FF in the field of sport.

## CONCLUSIONS

In conclusion, the results of the current study showed that the 6-month FF training did not produced statistically significant changes in the height of the vertical jump, and the dynamics of the changes of the height of the vertical jump did not confirm our assumption. However, it seems to stabilize the efficiency of the jumping performance during the in-season. Thus, the results of the study cannot support the presupposition suggesting that the fascia-oriented training FF may be a beneficial and significantly effective complement to volleyball training to enhance jumping skills unambiguously. As the results indicate some possible beneficial impact, we further conclude that more profound applied research seems to be desirable to conduct to observe and examine potential importance and applicability of FF in sport.

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