International Journal of Human Sciences
ISSN:1303-5134

Volume: 5 Issue: 1 Year: 2008

Acute effects of static stretching on vertical jump performance in children

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Abstract

This research has been made to define the acute effects of static stretching on vertical jump performance in children. The research has been applied on 49 healthy male volunteer athletes who have been taking basketball education for 2.1±0.2 years.(age:12.6±0.7 years, height: 157.9±6.9 cm, weight: 49.7±6.7 kg) Two different protocols have been made in this research. In the first protocol, 5 minutes aerobic density and 5 x 10 m forward, backward, side general warming up exercise in submaximal level has been applied on each child and in the second protocol, after general warming up, static stretching practice has been applied to the same children. After each warming up and stretching practice, countermovement jump performances have been measured. Active static stretching practice has been applied in a stretch sensitivity for 3 times 30 seconds and 15 seconds brakes between repetitions. Descriptive statistical methods and Paired-Samples T test have been applied on statistical analysis of vertical jump data that belong to children. Children jump 28.6 ± 1.1 cm. after a general warming up without any stretching practice whereas the children who have made static stretching application after warming up jump 27.1 ± 1.3 cm. The1.5 cm. difference (%5.2) has been found significant (t = *-10.476; $p<0.001$*). As a result, static stretching practice after general warming up effects vertical jump performance negatively.

Keywords: static stretching, warming up, vertical jump

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Introduction

Because warming up exercise increases heat of the body and blood flow, it prepares a person to exercise and increases the performance (3,5,1,27). Children are warned to use one of the warming up methods before starting dense physical activity. Generally, static stretching application is suggested after a few minutes aerobic exercise. But, there is very little research on stretching upon warming up which is one of the most important elements of training.

Static stretching is the most preferred method of warming up as, it is easy to apply. It is determined that the static stretching increases muscle skeleton flexibility by effecting the characteristics of muscletendinous unit (MTU) both mechanic (21,22,19) and neurologic (15,32) But, long time belief about static stretching exercise before the competition has started to be interrogated in recent years.

Recent researches show that static stretching practice inhibits the performance by reducing the production of power and speed instead of being useful to the athletes (2, 3, 9, 14, 18, 26, and 35). The most acceptable explanation about this performance reduction is that the static stretching exercises soften MTU, reduce power and speed production by decreasing muscle stiffness (2, 14). This decrease of MTU stiffness causes acute neural inhibition and paves the way for reduction in stimulus that goes to the muscles (2, 17, 19, and 26). These results naturally attract the attention of trainers, athletes and sports scientists.

When he difference in the answers of stretching protocols for adults before various competitions (3,18,26,34) and observations of harmful effects of static stretching on adolescent children's power performances (11,23) have been taken into consideration, the passionate need for a study that evaluates the different stretching exercises for children is seen. This kind of information can be useful for physical education teachers and trainers who deal with children and young people. The aim of this research is to define the Effects of static Stretching after warming up exercises on Vertical Jump Performance in Children who are taking regular basketball education. In this direction, because the bad effects of static stretching applied on adults are known, it is suggested that static stretching protocol after general warming up can affect vertical jump performance of children negatively.

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Material and Methods

Experimental

The research has been applied on 55 healthy male volunteer athletes who have been taking basketball education for 2.1±0.2 years. Six athletes are taken out of the experiment because they cannot join the last part. The age, height and body weight of male athletes who complete the research in order are 12.6 ± 0.7 yıl, 157.9 ± 6.9 cm, 49.7 ± 6.7 kg (mean ± standard deviation). Athletes also join basketball training 3 days in a week (6 hours/week), besides physical education and sports lessons in their school. The experimental male athletes are not full of legal age, so permission is taken from their families and "Declaration of Helsinki" is adapted in all levels of experiments.

Warming up- Stretching Protocol

A presentation and trial session are prepared about warming up and stretching practice and vertical jump test for each athlete including in the research. The presentation and trial session are carried out in order to eliminate the learning difference of warming up-stretching practice and vertical jump test. Two different protocols have been made in this research. In the first protocol, general warming up is put into practice by each athlete and in the second protocol, static stretching after general warming up is applied by the same athletes. Each warming up-stretching practice and vertical jump test is carried out every other day in order to remove tiredness factors. Warming up stretching practice is carried out at the same time in each protocol (10 a.m.) General warming up practice is fulfilled by a physical education and sports teacher with 10 people groups. Vertical jump test is applied five minutes after completing warming up stretching practice. In five minutes break, each athlete is passively (sitting in a bank) rested.

In the first protocol, as general warm up, athletes are made densely aerobic and are made run in the sports hall for five minutes till their heartbeat reach 110 per minute. Two people are chosen randomly in each group and heartbeat monitor (Polar Electro Inc., Finland) are attached and the density of stretching is followed. After one minute resting walk, each child is made 5x10 m forward, backward and side speed run in submaximal level. For submaximal level speed run, active resting (walking by normal steps) for 20 seconds among barriers are given.

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In the second protocol, after general warming up practice, static stretching starts. Static stretching applications (active stretching) are carried out in a stretched sensitivity point (pain threshold) for 3 times throughout 30 seconds and 15 seconds brakes between repetitions. Static stretching practice for determined muscle groups are applied as Alter's (1) method (quadriceps #17, hamstring #10, calf #7).

Athletes stand opposite the wall with arm distance for stretching application of quadriceps (#17) muscle group. One hand holds the wall for the balance of the body, the other hand holds the same side's ankle by bending the leg and draws the ankle near hip. After bending the support leg, breath is given out and ankle is pulled to the hip and it's stretched. The same procedure is applied on the other side. For stretching application of hamstring (#10) muscle group, after sitting in a position of both legs stretched and the body straight, the right knee is bent in order to draw ankle near hip. At that time, the right thigh and the outside of the hip come close to the floor. The opposite right heel is placed in the left thigh. So that, there is a 90 degree angle between stretched left leg and the bent right leg. After breathing out, the left leg is kept stretched and the body is made closer to the thigh. For stretching application of calf (#7) muscle group, athletes stand straight position 1.5- 2 steps from the wall. One foot is bent forward, the other foot is kept stretched. Head, neck, back and ankle is directed towards the wall. The foot behind is on the floor straight and is kept parallel to hip. After breathing out, the body weight is transferred forward by bending the arms. At that time, the heels stay stable on the floor. The same procedure is applied on the other side (1).

Vertical Jump Test

Athletes jump with countermovement jump technique. The jumps are applied in jumping platform (Newtest, Oulu, Finland) where flight and touching the floor periods are measured. The height of jumping is measured by "$h = g \times t^2 / 8$" ($g = 9.81\ ms^{-2}$) formula with the use of flight time. Athletes' hands are on their waists from the beginning to the end of the test, they are encouraged to jump at the highest level. Every athlete jump three times and the highest record are used to analyze of jumping performance.

Statistical Analysis

Defining statistic methods (mean ± standard deviation; min/max) are used in analyzing statistical analysis of athletes' vertical jump data. After that, the difference between two warming

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up and stretching protocols are calculated with Paired-Samples T test. All the statistical procedure is made by SPSS 10.0 (SPSS Inc., Chicago, IL) program and 0.05 significant level.

Results

The structural characteristics of the athletes including in the research are presented in Table 1. In the light of the data, 49 male athletes' age 12.6±0.7 years (12-14 years), height 157.9±6.9 cm (144-170cm), weight 49.7±6.7 kg (33-68kg), are determined.

Table 1 General Structural Characteristics of Athletes

	Mean	Standard Deviation	Minimum	Maximum
Age (year)	12.6	0.7	12.0	14.0
Height (cm)	157.9	6.9	144.0	170.0
Body Weight (kg)	49.7	6.7	33.0	68.0

Vertical jump height of athletes is shown in Table 2. Athletes jump 28.6 ± 1.1 cm after general warming up without any stretching practice. After static stretching practice during general warming up, athletes jump 27.1 ± 1.3cm. 1.5 cm difference (% 5.2) between two practices is found significant statistically. ($t = -10.476;$ $p<0.001$). As a result, static stretching practice after general warming up affects vertical jump performance negatively.

Table 2: Acute Effects of Static Stretching on Vertical Jump Performance

	NS	SS	MD	PD
	M (SD)	M (SD)	M (SD)	%
Vertical Jump (cm)	28.1 (1.1)	27.1 (1.3) *	1.5 (0.9)	5.2

Note. NS = no stretching, SS = static stretching, MD = mean difference, PD = percentage difference, M = Mean, SD = standard deviation.

(*) Significant difference $p< .001$.

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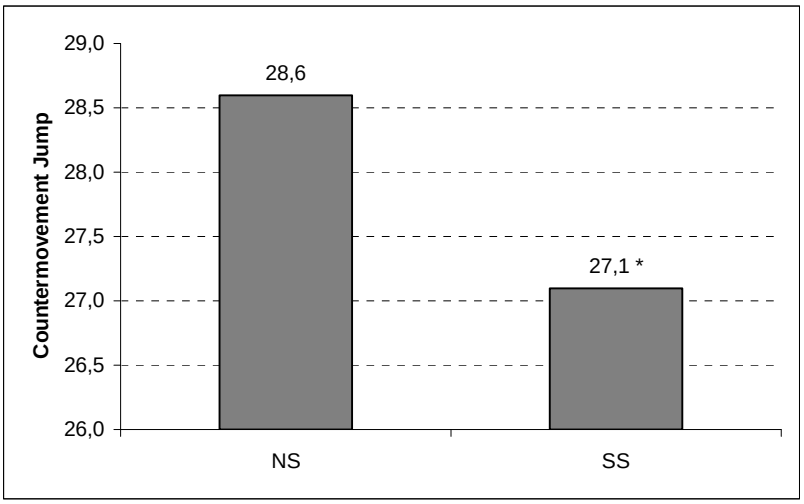

Figure 1: Mean value of vertical jump height for both two measurements. Star (*) shows the statistical difference *($p<0.001$)* between two measurement.

Discussion

This research is aimed to define the effects of static stretching after warming up exercises on vertical jump performance in children who are taking regular basketball education. The results of this research shows that static stretching practice applied on athletes' lower extremity can affect vertical jump performance on a large scale. At the same time, proof is submitted for static stretching is found insufficient to prepare athletes for high power production activities (as vertical jump).

According to the results of the research, there is % 5.2 decrease between general warming up and static stretching after general warming up. This result is as a supporter of the researches that are made before on children (11,12,23,28) and adults (13,18,20,24,25,29,30,33) about static stretching decreases the performance of power and speed.

The mechanisms that are responsible for the observation of decrease in power, strength and speed performance after static stretching are not definite. But, the researchers try to explain the acute negative effect of static stretching on performance by neuromuscular transmission of muscle and/or the differences in biomechanics characteristics (2, 18, 19, 30, and 31).

Kubo *et al.* (19) suggest that static stretching changes the biomechanical structure of muscle tendon and make it compliant and causes delay in muscle activation by decreasing power

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production speed indirectly. This change in muscle stiffness is very important in jumping technique that is used in this research. Kokkonen *et al.* (18) conform that stiff MTU can cause better transmission of power production during muscular contraction instead of compliant MTU. Avela *et al.* (2) and Wallmann *et al.* (30) support this point by documenting the decrease of electromyography excitation during muscular contraction. Wilson *et al.* (31) set forth that contraction elements of concentric muscle activities for more stiff system make the characteristics like muscle length and contraction speed suitable, increase the power production speed and specifically bring power-speed and power-length lines in a better place in muscle contraction. In this research, static stretching practice applied after general warming up block the studies on power-speed and power-length lines of quadriceps, hamstring, and calf muscle groups and may affect vertical jump performance negatively.

When countermovement jumping technique which is used in this research is analyzed, MTU gets lengthy in the front stretch section (eccentric stage) and momentary elastic energy is collected. Extra energy that is collected in eccentric stage of the jumping technique determines the vertical jump performance by combining with the power in the concentric stage (6, 7, and 8). Cornwell *et al.* (9), try to explain the decrease that is observed on vertical jump performance after the application of static stretching depends on MTU's decrease in ability of collecting elastic energy. After static stretching, the more compliant the muscle is, the less elastic energy is collected in eccentric stage (7, 8). In this research, it is thought that static stretching after warming up exercises affect the eccentric stage of movement essentially and decrease elastic return of stretch shortening cycle.

One of the probable mechanisms is, after stretching in joint proprioceptors (golgi tendon organs) muscles may form inhabitation as reflex on muscles and synergists. Knudson *et al.* (17), state that parallel to the results of this research, static stretching practice effects vertical jumping performance negatively. Because they cannot determine expressive differences in movement kinematics after static stretching practice, they suggested that the negative effect observed in vertical jump performance depends on the decrease in neural transmission. They bring to a conclusion of acute neural transmission inhibition caused by, in other sense, neural excitation that goes to the muscles decrease. According to Rosenbaum and Henning's (26) studies, there may be a relationship between the decrease in observed power production after static stretching

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and neuromuscular factors. This symptom supports the neurological definition of performance decrease caused by stretching.

This research shows that acute static stretching can decrease vertical jump performance whatever the responsible mechanisms are. The result of this research mustn't be accepted for the other stretching methods. In this research, a specific stretching method of 30 seconds stretching for lower extremity agonist and antagonist muscle groups is examined. Same results may not be taken with a program that stretches a muscle for a long or short time passively or actively. Of course, there is a need for advanced studies in order to define responsible mechanism of these results. But still, in order to achieve success in sports branches based on power production, dense static stretching exercise for specific movement intended for basic muscle should be done before the competition.

References

(1) Alter, M. J., "Science of Flexibility", Champaign, IL: Human Kinetics, pp. 311-313, 1996.

(2) Avela, J., H. Kyrolainen, and P.V. Komi, "Altered Reflex Sensitivity After Repeated and Prolonged Passive Muscle Stretching", J. Appl. Physio, 86, pp.1283–1291, 1999.

(3) Behm D.G., D.C. Button and J.C. Butt, "Factors Affecting Force Loss with Prolonged Stretching", Can. J. Appl. Physiol., 26, 262-272, 2001.

(4) Bergh U. and B. Ekblom, "Physical Performance and Peak Aerobic Power at Different Body Temperatures", J. Appl. Physiol., 46, pp. 885-889, 1979.

(5) Blomstrand, E., V. Bergh, B. Eseen-Gustavsson, and B. Ekblom, "The Influence of Muscle Temperature on Muscle Metabolism During Intense Dynamic Exercise", Acta Physiol. Scand., 120, pp. 229-236, 1984.

(6) Bosco, C., and P.V. Komi, "Potentiation of the Mechanical Behavior of the Human Skeletal Muscle Through Prestretching", Acta Physio. Scand., 106, pp. 467 – 472, 1979.

(7) Bosco, C., I. Tarkka, and P.V. Komi, "Effect of Elastic Energy and Myoelectrical Potentiation of Triceps Surae During Stretch Shortening-Cycle Exercise", Int. J. Sports Med., 3, pp. 137 – 140, 1982.

(8) Bosco, C., J.T. Viitasalo, P.V. Komi, and P. Luhtanen, "Combined Effect of Elastic Energy and Myoelectrical Potentiation During Stretch – Shortening Cycle Exercise. Acta Physio. Scand., 114, pp. 557 – 565, 1982.

(9) Cornwell, A., A. Nelson, G. Heise, and B. Sidaway. "Acute Effects of Passive Muscle Stretching on Vertical Jump Performance" J. Human Mov. Stud., 40, pp. 307-324. 2001.

(10) Ellis L., P. Gastin, S. Lawrance, B. Savage, A. Buckeridge, A. Stapff, D. Tumilty, A. Quinn, S. Woolford and W. Young, "Protocols for the Physiological Assessment of Team Sport Players, In: Physiological Tests for Elite Athletes. C.J. Gore, eds.", Champaign, IL: Human Kinetics, pp. 128 – 144, 2000.

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(11) Faigenbaum, A.D., M. Bellucci, A. Bernieri, B. Bakker, and K. Hoorens, "Acute Effects of Different Warm-Up Protocols on Fitness Performance in Children", J. Strength Cond. Res., 19(2), pp. 376-381, 2005.

(12) Faigenbaum, A., J. Kang, J. McFarland, JM. Bloom, J. Magnatta, NA. Ratamess and J. Hoffman, "Acute Effects of Different Warm-Up Protocols on Anaerobic Performance in Teenage Athletes", Pediatr. Exerc. Sci., 18(1), pp. 64-75, 2006.

(13) Fletcher IM. and B. Jones,"The Effects of Different Warm-Up Stretch Protocols on 20 Meters Sprint Performance in Trained Rugby Union Players", J. Strength Cond. Res., 18(4), pp. 885-888, 2004.

(14) Fowels J.R., D.G. Sale, and J . D . Macdougall, "Reduced Strength After Passive Stretch of the Human Plantarflexors", J.Appl. Physiol., 89, pp. 1179-1188, 2000.

(15) Guissard N., J. Duchateau and K. Hainault, "Mechanisms of Decreased Motoneuron Excitation During Passive Muscle Stretching", Exp. Brain Res., 137, pp. 163–169, 2001.

(16) Karvonen, J., "Warming Up and its Physiological Effects", Pharmacol. Physiol., 6, pp. 31-39, 1978.

(17) Knudson, D., K. Bennett, R. Corn, D. Leick, and C. Smith, "Acute Effects of Stretching Are Not Evident in the Kinematics of the Vertical Jump", J. Strength Cond. Res., 15, pp. 98–101, 2001.

(18) Kokkonen, J., A.G. Nelson, and A. Cornwell, "Acute Muscle Strength Inhibits Maximal Strength Performance", Res. Quar. Exerc. Sport, 69, pp. 411–415, 1998.

(19) Kubo K, H. Kanehisa and T. Fukunaga, "Is Passive Stiffness in Human Muscles Related to the Elasticity of Tendon Structures?", Eur. J. Appl. Physiol., 85, pp. 226–232, 2001.

(20) Little T. and AG. Williams, "Effects of Differential Stretching Protocols During Warm-Ups on High-Speed Motor Capacities in Professional Soccer Players", J. Strength Cond. Res., 20(1), pp. 203-207, 2006.

(21) Magnusson S, E. Simonsen, P. Aagaard, H. Sorensen, M. Kjaer., "A Mechanism for Altered Flexibility in Human Skeletal Muscle", J Physiol., 497, pp. 291–298, 1996.

(22) McHugh M, I. Kremenic, M. Fox, G. Gleim, "The Role of Mechanical and Neural Restraints to Joint Range of Motion During Passive Stretch", Med Sci Sports Exerc., 30, pp. 928–932, 1998.

(23) McNeal, J., and W. Sands, "Acute Sstatic Stretching Reduces Lower Extremity Power in Trained Children", Pediatr. Exerc. Sci., 15, pp. 139-145, 2003.

(24) Nelson AG., NM. Driscoll, DK. Landin, MA. Young and IC. Schexnayder, "Acute Effects of Passive Muscle Stretching on Sprint Performance", J. Sports Sci., 23(5), pp. 449-454, 2005.

(25) Power K., D. Behm, F. Cahil, M. Carroll and W. Young, "An Acute Bout of Static Stretching: Effects on Force and Jumping Performance", Med.Sci.Sports Exerc., 36 (8), pp.1389-1396, 2004.

(26) Rosenbaum, D. and E.M. Hennig, "The Influence of Stretching and Warm-Up Exercises on Achilles Tendon Reflex Activity", J. Sports Sci., 13, pp. 481–490, 1995.

(27) Shellock, F.G., and W.E. Prentice, "Warming Up and Stretching for Improved Physical Performance and Prevention of Sports Related Injuries", Sports Med., 2, pp. 267-278, 1985.

(28) Siatras T., G. Papadopoulos, D. Mameletzi, V. Gerodimos and S. Kellis, "Static and Dynamic Acute Stretching Effect on Gymnasts' Speed in Vaulting", Pediatr. Exerc. Sci., 15, pp. 383-391, 2003.

(29) Unick J., HS. Kieffer, W. Cheesman and A. Feeney, "The Acute Effects of Static and Ballistic Stretching on Vertical Jump Performance in Trained Women", J. Strength Cond. Res., 19(1), pp. 206-212, 2005.

(30) Wallman HW., JA Mercer and W. McWhorter, "Surface Electromyographic Assessment of the Effect of Static Stretching of the Gastrocnemius on Vertical Jump Performance", J. Strength Cond. Res., 19(3), pp. 684-688, 2005.

(31) Wilson, G.J., A.J. Murphy, and J.F. Pryor, "Musculotendinous Stiffness: Its Relationship to Eccentric, Isometric, and Concentric Performance", J. Appl. Physio., 76, pp. 2714–2719, 1994.

(32) Vujnovich A. and N. Dawson, "The Effects of Therapeutic Muscle Stretch on Neural Processing", J. Orthop. Sports Phys. Ther., 20, pp. 145-153, 1994.

(33) Yamaguchi T. and K. Ishii, "Effects of Static Stretching for 30 Seconds and Dyanimic Stretching on Leg Extension Power", J. Strength Cond. Res., 19(3), pp. 677-683, 2005.

(34) Young, W., and D. Behm, "Should Static Stretching Be Used During a Warm-Up for Strength and Power Activities?", Strength Cond. J., 24, pp. 33-37, 2002.

(35) Young. W., and S. Elliot, "Acute Effects of Static Stretching, Proprioceptive Neuromuscular Facilitation Stretching and Maximum Voluntary Contractions on Explosive Force Production and Jumping Performance", Res. Q. Exerc. Sports, 3, pp. 273-279, 2001.