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The Effects of Core Stability Exercise on the Dynamic Balance of Volleyball Players

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Abstract

Dynamic balance is a key component of injury prevention and rehabilitation in sports. Training the core muscles has been hypothesized as an intervention for improving balance. However, there is a lack of current scientific evidence to support this claim. The purpose of this study was to evaluate the effects of a core stability program on dynamic balance of volleyball players as measured with the Star Excursion Balance Test (SEBT). Thirty healthy participants were divided into 2 groups: control and exercise groups. All participants performed the SEBT before and after 8-week exercise time. During the 8-week time, the exercise group performed a core stability program, whereas the control group abstained from any new exercise. These results also illustrated there was significant differences in the scores for pre-test and post-test of all direction according SEBT in the experimental group. An independent sample t-test was conducted to compare experimental and control group (F=43.573, Sig=0.000). These results were a significant difference in the scores for control and experimental groups. Maximum excursion distances improved for the exercise group, compared with the control group. This result justifies the hypothesis that core strengthening can improve dynamic postural control during landing of volleyball players significantly.

Keywords: Core stabilization; volleyball player; dynamic balance; SEBT;

Introduction

Dynamic balance is the ability to maintain stability while in motion or in movement of the body or part of the body from one point to another and in maintaining stability (Miller, 2006).

Dynamic balance causes the center of gravity to move in response to muscular activity. This muscular activity may happen through any source of external or internal disturbance. During dynamic activity, the center-of-pressure moves between the base of support boundaries and sometimes outside the base of support (Kahle & Gribble, 2009; Kinzeyand Armstrong, 1998). Various studies have shown that there is closely relationship between unbalance and lower body injuries in volleyball players (Khaleghi, Sadeghi, Shojaadin, & Abbasi, 2007; Marquez, et al., 2007; Verhagen, et al., 2004). Greater protection from the forces and loads experienced by lower-extremity joints during landing is affected by muscle strength (Kean, Behm, & Young, 2006).

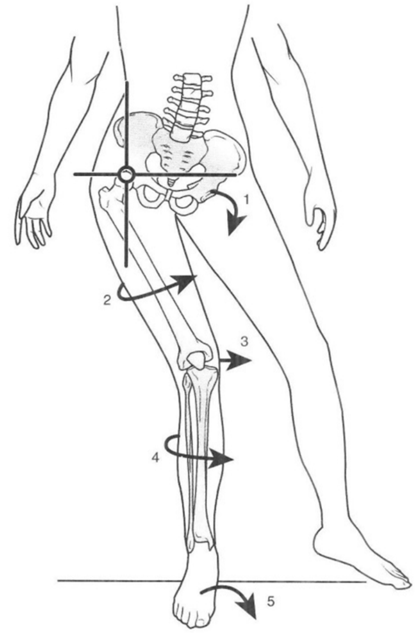
The stabilization of the pelvis and trunk is necessary for all movements of the extremities (Willson, Dougherty, Ireland, & Davis, 2005). Jacobs, et al., (2007) defined both clear relationship between hip muscles and lower extremity abilities, and the important role of hip abductors and external rotators to lower extremity alignment. They declared the maintenance of a level pelvis and the prevention of movement into hip adduction and internal rotation during single limb support. Furthermore, recent biomechanical studies (Jacobs, et al., 2007; Leetun, Ireland, Willson, Ballantyne, & Davis, 2004) indicate that hip muscle activation significantly affects the ability of the quadriceps and hamstrings to generate force or resist forces experienced by the entire leg during landing. Another study proclaim that greater protection from the forces and loads experienced by lower-extremity joints during landing is influenced by muscle strength (Kean, et al., 2006).

Core stability is the ability of the lumbo-pelvic hip complex to prevent buckling and to return to balance after disorder (Willson, et al., 2005). Core stability is the product of motor control and muscular capacity of the lumbo-pelvic-hip complex (Leetun, et al., 2004). Muscular stabilization of the abdominal, par spinal, and gluteus muscles leads to provide better stability and control (Carpes, Reinehr, & Mota, 2008). Muscles firming one after the other produce desired movement and are contrasted to help produce movement, balance, and spine stabilization. Each joint and muscle senses position and links to joints and muscles to react building body as a unit. Produced improvements support athletic, dynamic movements and full body activities (Collins, 2008).

The core is important because it is defined as the lumbo-pelvic-hip complex where a person's center of gravity is located and all movement begins (Gracovetsky & Farfan, 1986). The key is to control the body's center of gravity, the point around which the body balances most perfectly. By keeping the center of gravity between the bases of support, the athletes can more easily change direction. In addition, lowering the center of gravity adds stability. Great athletes in almost every sport have excellent control over the center of gravity and therefore achieve superior dynamic balance (Roetert, 2001). Implementation of core stability also increased control of center of mass. As the center of mass moves away from the base of support, there is an increased potential for biomechanical deviations to occur in the lower extremity (Kilber, et al, 2006). An improved ability to control this movement has the potential to decrease excessive forces on the lower extremity.

Abdominal and pelvic muscles are the segmental links between the upper and lower body and act as the fulcrum, whereas the upper and lower body acts as the movable levers (Kreighbaum & Barthels, 1985). So the core stability can be important in the balance, physical activity and performance. Unstable or weak core can also lead to lower body injuries and weak of the balance during the performance. "Balance comes from core; strong core equals good balance" (Faries & Greenwood, 2007). Lack of enough harmonization in core musculature and decreased muscular cooperation (synergy) of the trunk and hip stabilizers can lead to decreased efficiency of movement, and compensatory patterns which cause strain and overuse injuries (Akuthota, Ferreiro, Moore & Fredericson, 2008). According to their suggestion, the knee may be a "victim of core instability" with respect to lower extremity stability and alignment during athletic movements (figure 1).

Therefore, in order to overcome the possible problems such as injuries and knee extra load, educating athletes on the proper exercise techniques and focusing on the right exercise will help increase the balance and decrease the number of injuries which are evident with volleyball players. In order to overcome the possible problems, this study aims at testing how much core stability exercise effects on the dynamic balance as well as helping the coaches and athletes to identify the best types dynamic balance exercise.



Schematic showing kinetic chain reaction to abnorm. functional alignment potentially related to weakness or structur. malalignment, or both: *1*, contralateral pelvic crest drop, *2*, excessiv femoral internal rotation, *3*, knee adduction/valgus, *4*, excessive tibi. internal rotation, *5*, excessive foot pronation.

Methodology

Experimental approach to the problem

The design of this study is simple pre-test and post-test experimental research utilized to compare the effects of core stability exercise on the dynamic balance of volleyball players. In this study, one independent variable (IV) and one dependent variable (DV) are considered. The independent variable is core stability exercise and the dependent variable is dynamic balance.

Subjects

Thirty male subjects participated in this study. Subjects were divided into two groups of 15 each. One group was assigned to experimental and second group was applied as the control group. The subjects were trained within three days of a week for total of eight-weeks.

All subjects were given a pretest as well as post-test. Pre-test score were subtracted from the post-test scores for each measure and the difference was treated using T-test. The comparison of the pre-test and post-test of the control group includes the testing effects as well as the comparison of the pretest and posttest for experimental groups.

This study covers all university volleyball players who practice three days of week at Shiraz University, Iran during the May until July of 2013. The subjects are with the minimum of three years volleyball experience and are in the 19-22 age range. The method of sampling was random sampling through which two groups of volleyball players were selected. They were free of lower and upper extremity injuries, pathology, and visual disorders. The subjects became informed of the objectives of the study and potential risks were also explained to the subjects (Shariat Kargarfard, & Sharifi, 2012).

Procedure

Initial testing included all demographic and anthropometric assessments of height, and limb length. Subjects were interviewed to determine prior injury history .Subjects participated in two test sessions for pretest and posttest assessments of dynamic postural control using the SEBT. During the pretesting session, dominant leg and non-dominant leg were determined. The stance leg was determined as the leg the participants would use to stand on while kicking a ball. Dominant leg (stance leg) length was measured from the anterosuperioriliac spine to the middle of the medial malleolus while the participants lay spine with a standard tape measure. The leg length measure was used to normalize reach distance data (Gribble and Hertel, 2003). The experimental group participated in eight weeks and thrice a week core stabilization training, while the control group did not participate in the other training outside of their normal activities. Post training testing occurred eight weeks after the pre training test session.

Constructing and Performing of the Star Excursion Balance Test (SEBT)

The SEBT, introduced by Grey as cited in Earl and Hertel (2001), challenges an athlete's postural control system. Olmsted, et al., (2002) in their studies concluded that the SEBT, on the one hand, is a simple, cheap, rapid, reliable, and valid tool that does not require special equipment and, on the other hand, it shows locomotory performance, lower extremity functional performance, multiplanar excursion and postural control (Akuthota and Nadler, 2004; Gribble and Hertel, 2003).

The Star Excursion Balance Test (SEBT) is best described as a functional test that quantifies lower extremity reach whereas it challenges an individual's limits of stability. Subjects stand on one leg in the middle of a grid. The grid is made of eight lines of athletic tape, extending at 45-degree increments from the center of the grid (Anterior-Lateral (AL), Anterior (A), Anterior-Medial (AM), Medial (M), Posterior-Medial (PM), Posterior (P), Posterior-Lateral (PL), Lateral (L). Once in place, the subjects try to reach to the furthest point of each line with their lower extremity. On reaching the furthest point, subjects lightly touch the point, so that the weight is not distributed to the leg, and then return their leg back to the center of the star. The point which is reached is marked and the distance from the center of the grid is measured. The distance is used as the balance score. The examiner manually measures the distance from the center of the grid to the touch point with a tape measure in centimeter. Three reaches in each direction are recorded. Subjects are given 15 second of rest between reaches. The best of the three reaches for each leg in each of the eight directions was recorded (figure2).

Figure2: Constructing and Performing of the Star Excursion Balance Test (SEBT).

Core stabilization exercise Protocol

Subjects were tested using the Star Excursion Balance Test, which tests dynamic balance. It is applied one week prior to the beginning of the core stabilization training program (pre-test) and one week after the conclusion of the core-stabilization training program (post-test).

This study consisted of a control group and one experimental group that performed a core stabilization- training program for eight-weeks. The subjects in the experimental group met three times per week on alternating days to perform the training program. The estimated time for completing the core stabilization-training program was approximately 30 minutes per session. Control group: The control group did not perform any of the training exercises. Subjects in this group were explained the guidelines of their group and asked to answer all questions accurately and honestly. This increased the application of the guidelines and helped control variables that may skew the results of the study.

Core stabilization-training group: Subjects performed a core stabilization-training program. This program consisted of three levels with some exercises at each level. The subjects began at exercise level one and proceeded to the next core stabilization-training program level according to the protocol for that day. The subjects performed the core stabilization-training program three times per week on alternating days. They performed repetitions and sets according to the specific exercise. They progressed to the next level of the core stabilization-training program according to the specific day of the week.

A systematic literature review was completed for exercise selection, with the inclusion criteria of any type of study that used the key words of, core, stabilization, and/or strengthening. A general protocol was found to be consistent across the reviewed studies (Fredericson and Moore, 2005; Kahle and Gribble, 2009; Nesser and Lee, 2009), thus the exercise protocol to be used in this study (Kahle and Gribble, 2009) was derived from those sources.

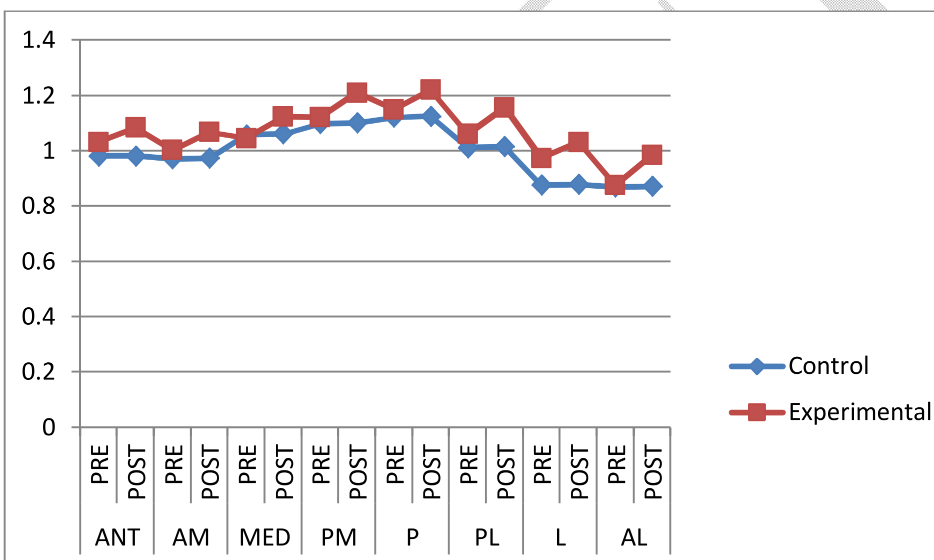
Results

To analysis the effect of core stability exercise, the multivariate tests along with repeated-measure ANOVA was conducted to determine the difference between the control and experimental group. The significance level was smaller than 0.05. The results gathered with this study by comparison in pre-test and post-test between control and experimental groups showed that core stabilization exercise had significant effect (F=43.573, Sig=0.000) on dynamic balance in volleyball players (table 1).

Graph 1 demonstrated the significant differences of pre and post-test among control and experimental group in eight direction of (Anterior-Lateral (AL), Anterior (A), Anterior-Medial (AM), Medial (M), Posterior-Medial (PM), Posterior (P), Posterior-Lateral (PL), Lateral (L).

Table1: Differences in control and experimental groups in pre and post-test

Group	ANT		AM		MED		PM		P		PL		L		AL	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST	PRE	POST
Control	0.9812	0.9803	0.97	0.9729	1.0577	1.0609	1.0976	1.1003	1.1211	1.125	1.011	1.015	0.8754	0.8777	0.8688	0.871
Experimental	1.0313	1.084	1.0025	1.0679	1.0454	1.1231	1.1208	1.21	1.1499	1.2206	1.0603	1.1563	0.9737	1.032	0.875	0.984



Graph1: Differences in control and experimental groups in pre and post-test

Discussion

In sports such as volleyball and basketball, jumping and landing are important for successful performance of both defensive and offensive skills. Making the transition from a jump to another skill is also important for successful performance, thus landings need to occur in a balanced position and with correct technique. For volleyball players the core can play an integral role in movement and dynamic balance. Thus, the results are in line with other study of (kahle, et al, 2009) which has emphasized the effect of core stability on the dynamic balance. The core is comprised of the lumbo-pelvic-hip complex and is activated first prior to gross body movements. Hip and trunk weakness reduces the ability which has noted by (Leetun, et al., 2004). Core stability can improve strength of hip and trunk muscle which is important to increase dynamic balance (Iwamoto, 2009). Dynamic balance is a key component essential in volleyball players especially the ability to landing. Since holding dynamic stabilization, good balance and ability to stabilize quickly after landing might help decrease the risk of knee and ankle injury in athletes like volleyball player (Faries & Greenwood, 2007).

Dynamic balance, pelvic stability and trunk control are required for good landing, Therefore, core strengthen play important role to stability of pelvic and trunk (Kilber et al, 2006). This study has warranted the effects of core exercise on the dynamic balance of volleyball players. Akutota, et al, (2008) demonstrated that lack of sufficient coordination in core muscular can lead to decrease efficiency of movement and injury.

This study has chosen dynamic balance instead of a direct measurement of core stabilization. Dynamic balance was influence by core exercise and was measured in this study via SEBT, which is proposed in the study of (Herrington, Hatcher, Hatcher, & McNicholas, 2009; Plisky, Rauh, Kaminski, & Underwood, 2006), as a dynamic balance measurement tool. The findings of the current study are consonant with previous research; provide clinicians with a method of improving dynamic balance by improving core strength and applying the SEBT.

All the eight excursions (Anterior-Lateral, Anterior, Anterior-Medial, Medial, Posterior-Medial, Posterior, Posterior-Lateral, Lateral) are the most important in human movement. This data denote that, all eight excursions were significant between pre and post-test for time, indicating that core stabilization-training improves dynamic balance and movement, which can get better athletes' performance.

The core includes the lumbo-pelvic-hip complex and its governing musculature which work synergistically to produce force, reduce force, and provide dynamic stabilization throughout the movement (Akuthota 2008, Kilber, et al, 2006). Akuthota et al, (2008) alleged that hip muscles are important for lower extremity stability during athletic movements. Lack of stability lead to lower extremity injuries which is called "victim of core instability". Mills, Taunton, and Mills, (2005) suggested that the stability of the pelvis and trunk is essential for all movements of the extremities. Pelvic stability also helps equilibrium during performance. Hence, the stability of core was suggested as compulsory to lower extremity injury prevention (Jacobs et al, 2007, and Leetun, et al, 2004).

The abdominal muscles which are important in core stability include transverse abdominus, internal and external obliques, and rectus abdominus. All contract to provide stabilization for the spine and therefore a stronger base of support for lower extremity movement (Kilber, et al, 2006). The transverse abdominus has several functions such as main anterior muscle that control spinal stability, normalize motor control which would include timing dysfunction (Lederman, 2010). Marshall and Murphy, (2005) warranted core stability exercise to improve muscle abdominal. That exercise was used in this study.

Colston, Taylor, and Minnick (2005) indicated that, the traditional sit-ups alone do not enhance and are unsafe for lower back stability, because they create extreme compressive forces in the lumbar spine. They also have proposed that the training surface might also play a role in recruitment. The stability training on unstable surfaces might be more positive than conventional floor exercises in maintaining stability and dynamic movements. According to the study by Duncan (2009), muscle activity was greater when exercises were performed on a Swiss ball in comparison to a stable surface. Therefore, unstable exercise such as Swiss ball exercise is useful to enhance core stability, balance and dynamic movement.

Conclusion and Suggestions

Core stability is a key component in athletic activities. It is best understood as a highly integrated activation of multiple segments that provides force generation, proximal stability for distal mobility, and creates interactive moments. It is difficult to accurately quantify by isolating individual components, but its function or dysfunction can be approximated by evaluations that reproduce the three-planar motions that are used by the core to accomplish its functions. Better understanding of the complex biomechanics and muscle activations will allow more detailed evaluations and more specific rehabilitation protocols (Kibler, et al, 2006).

Dynamic postural control as measured by the SEBT maximum excursion distances demonstrates a significant increase across the eight reach directions of Anterior-Lateral, Anterior, Anterior-Medial, Medial, Posterior-Medial, Posterior, Posterior-Lateral, Lateral for the core strengthening group.

The results of this study indicated that there was a significant difference in dynamic balance from pre-test to post-test. Although there was not a significant difference for group, the differences in means were more evident in the experimental group who underwent a core stabilization-training program. The findings of the current study, coupled with previous research, provide clinicians with a method of improving dynamic balance by improving core strength and implementing the SEBT. It is important that researchers and clinicians be concerned about not only improving a patient's balance through rehabilitation after an injury, but also strengthening their core to prevent an injury.

The most powerful tools for increasing core strength have been Swiss ball, Pilates and Yoga training that hierarchically depends on level of person fitness. This allows carrying out an exercise utilizing body. This training helps you in real life situations that require contributions from all muscle groups. Rather, the benefit of his program may be a reduction in knee adduction and abduction moments due to advanced postural adaptations of the hip abductors and external rotators before landing from a jump.

Our results suggest that core stability training could be beneficial for improving balance by strengthening core muscles most often associated with lumbar spine control to improve dynamic balance. More research is needed to determine the effects of a core stabilization-training program on dynamic balance. Future research should be including to core stability and biomechanical aspect of hip, knee, and ankle during the performance and landing from jumping. In conclusion, core stabilization-training may be used to enhance dynamic balance in volleyball athletes.

References:

Akuthota, V., Ferreiro, A., Moore, T., &Fredericson, M. (2008).Core Stability Exercise Principles. Current Sports Medicine Reports, 7(1), 39-44.

Akuthota, V, and Nadler, SF. (2004).Core strengthening.Archives of Physical Medicine and Rehabilitation, 85(Supplement 1), 86-92.

Carpes, FP, Reinehr, FB, and Mota, CB. (2008). Effects of a program for trunk strength and stability on pain, low back and pelvis kinematics, and body balance: A pilot study. Journal of Bodywork and Movement Therapies, 12(1), 22-30.

Duncan, M. (2009). Muscle activity of the upper and lower rectus abdominis during exercises performed on and off a Swiss ball. Journal of Bodywork and Movement Therapies, In Press, Corrected Proof.

Fredericson, M, and Moore, T. (2005).Muscular Balance, Core Stability, and Injury Prevention for Middle- and Long-Distance Runners. Physical Medicine and Rehabilitation Clinics of North America, 16(3), 669-689.

Faries, M., & Greenwood, M. (2007). Core training: Stabilizing the confusion. Strength & Conditioning Journal, 29(2), 10.

Gracovetsky, S., &Farfan, H. (1986).The Optimum Spine.Spine, 11(6), 543.

Gribble, and Hertel, (2003). Considerations for Normalizing Measures of the Star Excursion Balance Test. Measurement in Physical Education and Exercise Science, 7(2), 89-100.

Herrington, L., Hatcher, J., Hatcher, A., &McNicholas, M. (2009). A comparison of Star Excursion Balance Test reach distances between ACL deficient patients and asymptomatic controls. The Knee, 16(2), 149-152.

Iwamoto, M. (2009).The relationship among hip abductor strength, dynamic balance, and functional balance ability.Unpublished M.S., California University of Pennsylvania, United States -- Pennsylvania.

Jacobs, C., Uhl, T., Mattacola, C., Shapiro, R., &Rayens, W. (2007). Hip abductor function and lower extremity landing kinematics: sex differences. Journal of Athletic Training, 42(1), 76.

Kahle, N. L., & Gribble, P. A. (2009).Core stability training in dynamic balance testing among young, healthy adults. Athletic Training & Sports Health Care: The Journal for the Practicing Clinician, 1(2), 65-73.

Kean, C. O., Behm, D. G., & Young, W. B. (2006). Fixed foot balance training increases rectus femoris activation during landing and jump height in recreationally active women. Journal of Sports Science and Medicine, 5, 138-148.

khaleghi, M, Sadeghi, H, Shojaadin, SS, and Abbasi, A. (2007). Relationship between supinated and pronated foot with dynamic stability in jump-landing. Journal of Biomechanics, 40(2), 203.

Kibler, W. B., Press, J., &Sciascia, A. (2006).The Role of Core Stability in Athletic Function. Sports Medicine, 36(3), 189-198.

Kinzey, SJ, and Armstrong, CW. (1998).The reliability of the star-excursion test in assessing dynamic balance. J Orthop Sports PhysTher, 27(5), 356-360.

Kreighbaum, E., &Barthels, K. M. (1985). Biomechanical relationships in the trank Biomechanics: A Qualitative Approach for Studying Human Movement (pp. 260-265): Burgess Pub. Co.

Leetun, D. T., Ireland, M. L., Willson, J. D., Ballantyne, B. T., & Davis, I. M. (2004).Core Stability Measures as Risk Factors for Lower Extremity Injury in Athletes.Medicine & Science in Sports & Exercise, 36(6), 926.

Marshall, and Murphy,. (2005). Core stability exercises on and off a Swiss ball. Archives of Physical Medicine and Rehabilitation, 86(2), 242-249.

Marquez, W, Masumura, M, and Ae, M. (2007). Effects of augmented jumping distance and ball hit on landing after a volleyball spike. Journal of Biomechanics, 40(2), 202.

Marshall, P., & Murphy, B. (2005). Core stability exercises on and off a Swiss ball. Archives of physical medicine and rehabilitation, 86(2), 242-249.

Mills, JD, Taunton, JE, and Mills, WA. (2005). The effect of a 10-week training regimen on lumbo-pelvic stability and athletic performance in female athletes: A randomized-controlled trial. Physical Therapy in Sport, 6(2), 60-66.

Lederman, E. (2010). The myth of core stability. Journal of Bodywork and Movement Therapies, 14(1), 84-98.

Olmsted, LC, Carcia, CR, Hertel, J, and Shultz, SJ. (2002). Efficacy of the Star Excursion Balance Tests in Detecting Reach Deficits in Subjects With Chronic Ankle Instability. Journal of Athletic Training, 37(4), 501.

Plisky, P., Rauh, M., Kaminski, T., & Underwood, F. (2006). Star Excursion Balance Test as a predictor of lower extremity injury in high school basketball players. The Journal of orthopaedic and sports physical therapy, 36(12), 911.

Roetert, E. P. (2001). chapter 7: 3-D Balance and Core Stability. In B. Foran (Ed.), High-Performance Sports Conditioning (pp. 119-137). USA: Human Kinetics.

Shariat, A., Kargarfard, M & sharifi, G. (2012). The effect of heavy resistance exercise on circadian rhythm of salivary cortisol in male body building athletes. Journal of isfahan medicalschool (i.u.m.s), 29(167), 2400.

Verhagen, E, van der Beek, A, Twisk, J, Bouter, L, Bahr, R, and van Mechelen, W. (2004). The effect of a proprioceptive balance board training program for the prevention of ankle sprains: a prospective controlled trial. The American Journal of Sports Medicine, 32(6), 1385.

Willson, J. D., Dougherty, C. P., Ireland, M. L., & Davis, I. M. (2005).Core stability and its relationship to lower extremity function and injury. Journal of The American Academy Orthopaedic Surgeons, 13(5), 316-325.