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Research Article

Effects of Plyometric Training on Sand Versus Grass on Muscle Soreness and Endurance among Football Players

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Abstract

Background of the study: Plyometric training is commonly performed on firm surfaces (eg. grass and wood), but more recent study has shown that drop jumps on sand induce less muscle damage when compared to a firm surface. However, jumping on sand causes lower reuse of elastic energy and energy loss due to feet slipping during the concentric action. This might induce different training effects compared to training on a firm surface. The lower impact on the musculoskeletal system induced by plyometric training on sand might be useful during rehabilitation programmes.

Aims and objectives of the study: The aim of the study is to find the effectiveness of plyometric training on sand versus grass on muscle soreness and endurance among football player.

Methodology: Subjects were randomly divided into two groups, grass training group (n = 15) and sand training group (n = 15). After the baseline measurements of endurance by using RAST test, plyometric training was given for 4-weeks, three sessions per week. Muscle soreness was assessed at the end of each training session on a 7-point likert scale. Post-readings of muscle endurance and muscle soreness were taken after the 4-week training programme.

Result: Data when compared after plyometric training revealed significant changes between two groups ($p<0.0001$), however players in the sand group experienced less muscle soreness ($p < 0.0001$) than grass group.

Conclusion: The results of this study shows that while the plyometric training performed on sand surface reduces muscle soreness and indicates a lowered fatigue index.

Keywords: Plyometric Training; Sand; Grass; Likert Scale; Muscle Endurance; Soccer Players; Muscle Soreness

Introduction

Soccer is one of the most widely played and complex sports in the world, where players needtechnical and physical skills to succeed. A successful performance is dependent on basic abilities, in particular repeated explosive burst, strength, power, kicking, tackling, and other derivatives such as jumping, turning, sprinting, and changing pace all making important contributions to the performanceof the soccer players [1-3].

Plyometrics are training techniques used by athletes in all types of sports to increase strength and explosiveness [4]. Plyometric training consists of a rapid stretching of a muscle (eccentric action) immediately followed by a concentric or shortening action of the same muscle and connective tissue [5-8]. Plyometric training involves hops and jumps used to capitalize on the stretch shortening cycle of the muscle [9].

The stored elastic energy within the muscle is used to produce more force than can be provided by a concentric action alone. It is distinguished by a rapid deceleration of mass followed bya rapid acceleration in the opposite vertical direction. For the lower limbs, plyometric training initialize exercises such as hopping, bounding,

drop jumping from a raised box or platform and immediate jump vertically after an amortization (short resting period) of ground contact [10-12].

Plyometric exercises vary in both complexity and intensity. They are classified into four types, viz, low intensity, medium intensity, high intensity and shock exercises. High intensity plyometric are vigorous, time taking, exhaustive training regime with a very rapid amortization phase in comparison with low intensity plyometric which is gentle and has a longer amortization phase [13].

This type of training has shown to improve performance in explosive sports that rely on moving speed and power such as hockey, basketball, track and field, football, and volleyball [14].

The issues with plyometrics is the eccentric loading phase of the movement (landing). Absorbing the shock of hitting the ground is tough on joints and the intensity level of the neural signal required to instantaneously activate musculature over the entire body to effectively stabilize, and then redirect force in another direction, which is extremely taxing on the central nervous system (CNS).

Training power movements in the sand is a way to mitigate the high risk that goes with the high reward of plyometric training like Mel Siff suggests. The forgiving nature of sand is easier on the body during the eccentric phase of the movement. The high shock absorptive qualities of sand can decrease the impact forces experienced during high intensity activity, potentially leading to reduced muscle damage and soreness [15].

Sand absorbs force much better than a hard surface making it easier on the joints. Because sand absorbs more force, sinking when body lands in the ground, both the rate and strength of the signal from the central nervous system needed to decelerate, stabilize and then transition force in another direction are not as great, therefore not taxing on the CNS. Hence the aim of the study is to find the effectiveness of plyometric training on sand versus grass on muscle soreness and endurance among football players.

Methodology

- **Study design:** Experimental study. STUDY DURATION: 4 weeks.
- **Study setting:** YMCA.SAMPLE SIZE: 30.
- **Sampling method:** Convenient sampling.

Inclusion criteria

- Males with age group 18 to 25.
- Voluntary participation.
- Atleast 1 year experience of playing football.
- Not involved in plyometric exercises previously.
- Normal range of motion at lumbar spine, hip, knee, ankle and a normal cardiofitness level.

Exclusion criteria

- Fracture.
- Injury.
- Pain during the regime.
- If they were irregular

Outcome measures

- Likert scale.
- RAST test.

Likert scale

- Muscle soreness was assessed at the end of each training session on an Italian version of 7 point likert scale of muscle soreness.
- It consists of 7 point ranging from 0-6, where 0 means complete absence of soreness and 6 indicates severe pain, restricting the ability to move.
- The reliability and validity of likert scale ranges from 0.65 to 0.94.

Running anaerobic sprint test

Purpose

- To find out the level of endurance.

Procedure

- To complete the RUNNING ANAEROBIC SPRINT TEST participants were required to perform six maximal 35 m sprints on an AstroTurf pitch with 10 s rest periods between each sprint.
- Players were instructed to wear their normal training footwear (this was moulded football boots in all cases).
- The time for each sprint was recorded using a stopwatch.
- The participant started each sprint 0.3 m behind the timing gate and performed repeated sprints in alternate directions.
- The 10 s rest periods were timed using a stopwatch and a

tester gave the participant a 3 scount down prior to each sprint.

- Weather conditions during testing were dry and cold (3-6°C) with little wind.

The power produced during each sprint was determined by the following formula

Power = (Body Mass × Distance 2)/Time 3.

- Peak power was defined as the power obtained during the fastest sprint and average power (for all six sprints) was calculated by taking the mean.
- The reliability and validity of RAST test ranges from 0.74 - 0.95.

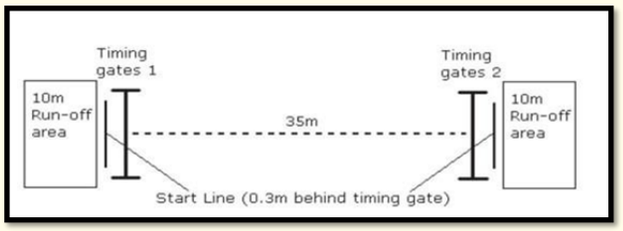


Figure 1

Procedure

In the current study, a 4-week plyometric programme was employed, using set × repetitions.Training was completed on a grass pitch and on a 0.2 m deep dry sand surface. 30 persons were selected based on the inclusion and exclusion criteria were selected and informed consent was taken from them, before starting the study.

- The plyometric training sessions were given during off-season, 3 times a week in addition to the conventional training. Participants were asked to exert a maximal intensity during all the training sessions.
- Muscle soreness was assessed on each session of the training period using 7-point Likert scale of muscle soreness.
- During the training all the subjects were under direct supervision and were instructed how to perform the exercises.
- Prior to the training, in each session, the players first performed a general body warm up by doing light jogging for 5-10 minutes and stretching for 5 minutes.

Following this the subjects were asked to perform 20 hops and 20 bounds, in order to acclimatize the subjects with jumping and the landing procedures.

Exercises	Week 1	Week 2	Week 3	Week 4
Vertical jumping	15 (10)	20 (10)	25 (10)	25 (10)
Bounding	3 (10)	4 (10)	5 (10)	5 (10)
Broad jumping	5 (8)	5 (10)	8 (10)	8 (10)
Drop jumping	3 (5)	5 (9)	6 (15)	6 (15)
Exercises	Week 1	Week 2	Week 3	Week 4
Vertical jumping	15 (10)	20 (10)	25 (10)	25 (10)
Bounding	3 (10)	4 (10)	5 (10)	5 (10)
Broad jumping	5 (8)	5 (10)	8 (10)	8 (10)
Drop jumping	3 (5)	5 (9)	6 (15)	6 (15)

Table 1

Plyometric training

Vertical jumping

- It is an effective exercise for building both endurance and explosive power.
- A vertical jump or vertical leap is the act of jumping upwards into the air.
- The person will perform rapid movement of the legs and the movement of the arms to the side constitute to counter movement.
- The counter movement of the legs, along with the quick bend of the knees will lower the centre of the mass prior to springing upwards, has been shown to improve jump height by 12% compared to jumping without the counter movement.

Bounding

- Bounding is a higher intensity running drill designed to improve power and efficiency.
- Essentially bounding is an exaggerated run with lots of vertical and horizontal displacement.
- Go for both height and distance with each stride.
- It consists of single leg jump exercises characterised by a stretch shortening cycle.
    - Eccentric pre- stretch phase
    - Amortization phase
    - Concentric shortening phase
- This stretch-shortening cycle strengthens the elastic properties of the connective tissue therebyimproving the eccentric and concentric strength thereby allowing the muscles to accumulate (pre-stretch/eccentric phase) and release (concentric phase) energy.

Broad jumping

- The benefit of the broad jump is that it helps to improve the lower body power.
- The person will keep his shoulder width apart, good posture, with knees slightly bent.
- The person will then gets into the squat position, now their muscles are in a stretched position.
- In this part of the movement the person is in the beginning to go through the stretch shorteningcycle, potentially helping them spring forward with the maximum amount of force.
- As the person goes through a full extension of the hip, knee, and ankle joints while simultaneously throwing their arms forcefully forward, the person propels their arms forcefullyforward, the person propels their body through the air.
- At the end of the jump the person will then quickly flex the hips, knees, and ankle joints whiletrying to land softly in a balanced position.

Drop jumping

- A drop jump is attempted by dropping from an elevated surface and attempting to make a vertical jump for maximum height after landing on the ground.
- A characteristic pattern is observed while the muscle elastic energy is retained and used during a drop jump.
- The gravitational force causes the body to move downward, the energy is retained in the elastic components of the stretched muscles during the eccentric process.
- Furthermore, when the body moves up during the concentric process, it uses the muscles storedenergy.

Vertical jumping

Figure 2: Vertical jump.

Bounding

Figure 3: Bounding.

Broad jumping

Figure 4: Broad jumping.

Drop jumping

Figure 5: Drop jumping.

Data analysis and interpretation

Statistical analysis was performed by using IBM SPSS for window version 20 (IBMSPSS statistical for window version 20.0 IBM corp. Armonk, NK, USA). The mean and standard deviation (SD) were used to describe the continuous data.

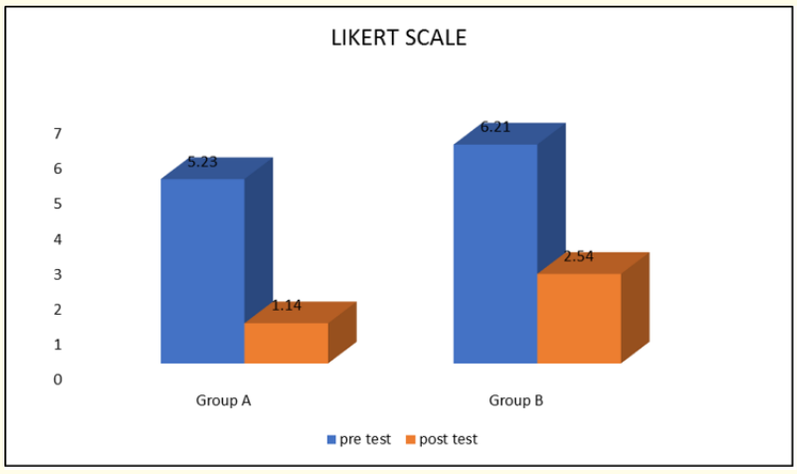
The mean, standard deviation, the post mean value of group A is found to be 1.14 and group B is found to be 2.54, which has been calculated by the paired t test. It has been found to be statistically significant $p < 0.0001$ for group A who received plyometric training on sand. Both the group were statistically significant but the mean of group B who received plyometric training on grasswas found to be less when compared to group A, for evaluating Likert scale for muscle soreness.

Likert scale

The mean, standard deviation, the post mean value of group A is found to be 16.25 and group B is found to be 13.12, which has been calculated by the paired t test. It has been found to be statistically significant $p < 0.0001$ for group A who received plyometric training on sand. Both the group were statistically significant but the mean value of group B who received plyometric training on grass was found to be less when compared to group A, for evaluating Running Anaerobic Sprint Test.

Group	Mean		SD			
	Pre-test	Post-test	Pre-test	Post-test	T value	P value
Group A	5.23	1.14	2.54	0.25	3.2547	<0.0001
Group B	6.21	2.54	2.64	1.02	2.0645	<0.0001

Table 2: Comparison between pre and post-test mean values of likert scale among footballplayers.

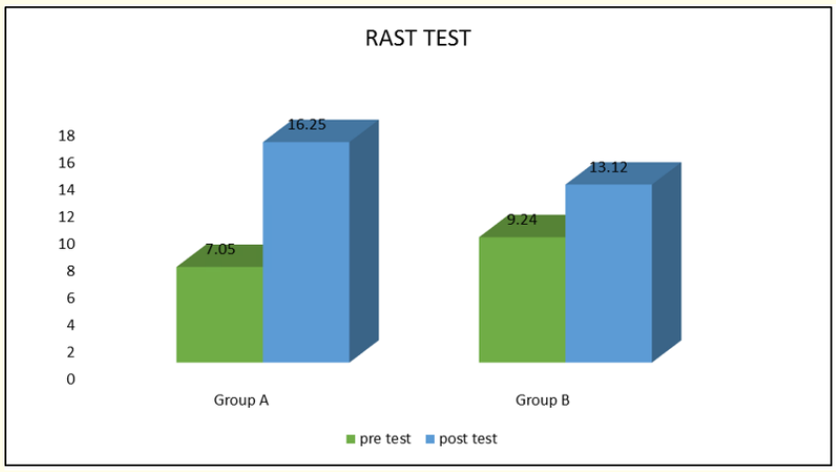


Graph 1: Comparison between pre and post test mean values of likert scale among football players.

Running anaerobic sprint test

Group	Mean		Sd			
	Pre-test	Post-test	Pre-test	Post-test	T value	P value
Group A	7.05	16.25	2.25	3.24	3.2457	<0.0001
Group B	9.24	13.12	2.12	3	2.2457	<0.0001

Table 2: Comparison between pre and post-test mean values of running anaerobic sprint testamong football players.



Graph 2: Comparison between pre and post-test mean values of running anaerobic sprint test among football players.

Discussion

This study is an attempt to address the effect of plyometric training on two different training surfaces-sand and grass on muscle soreness and endurance. Jumping on sand causes lower reuse of elastic energy and energy loss due to feet slipping during the concentric action. This might induce difference in training effects compared to training on a firm surface. The lower impact on the musculoskeletal system induced by plyometric training on sand might be useful during rehabilitationprogrammes.

The current study employed a 4-week plyometric program with 3 sessions per week. Themain findings in the study indicate that a short-term plyometric training on sand (non-rigid) surface resulted in similar changes in endurance, as in grass group but induced less muscle soreness and damage than the grass group.

Plyometric training has commonly been performed on firm surfaces such as grass, athletic tracks and wood. Risks of increased delayed-onset muscle soreness (DOMS) and damage caused by forces generated during ground impact and intense plyometric contraction may be reducedwhen plyometric training is performed on non-rigid surface such as sand or in aquatic conditions. Available evidence suggests that short-term plyometrics on non-rigid surface (i.e. sand-based or aquatic) could elicit similar increases in jumping and sprinting performance as traditional plyometrics,but with substantially less muscle soreness [16].

The mean value of muscle soreness for sand group (2.5) was lower than grass group (3.1). This result is in Lieu with the findings of [17] who showed that plyometric training on sand induced less muscle soreness than jumping on a firm surface, and also chains the findings of [18] who demonstrated a similar comparative study in soccer players,comparing the jumping and sprinting ability. There was progressive reduction in muscle soreness in both groups during the training period, despite the fact that the exercise intensity was increased eachweek. This reduction can be attributed to the repeated bout effect, as demonstrated by reduced symptoms following consequent bouts of training

During a plyometric training, the muscles undergo a rapid change from the eccentric phase to the concentric phase. This stretch shortening cycle decreases the time of amortization phase that is in turn allows for greater than normal power production which was supported by [19].

The muscles stored elastic energy and stretch reflex response are essentially exploited in this manner, permitting more work to be done by the muscle during the concentric phase of movement which was supported by [20].

Training programs that have utilized plyometric exercises have been shown to be positively affect performance such as jumping which was concluded by [21].

The increase in power following a plyometric training program could be due in part to increase in muscle fiber size. Improvements in muscle force production have been associated with increase in muscle fiber size which was supported by [22].

Fatigue index, which is a measure of endurance, decreased in both groups after plyometric training, indicating a better endurance. However, plyometric training did not revealed anysignificant differences in endurance in both sand and grass groups.

The result is also consistent with the study conducted by *Ademola O. Abass* which focused on the relationship among strength, endurance and power performance characteristics of untrained university following three different modes of plyometric and showed that there were no significant relationships among the groups in strength and endurance performance characteristics. Results of the previous study was conducted by [23] they concluded that the plyometric training indicate a lowered fatigue index (flexion/extension) in sand group (0.79%), decrease in the fatigue index indicates a better endurance.

The present study showed that during 4-week training period, the sand group experienced less muscle soreness, as measured by the likert scale, and therefore support the hypothesisthat a short-term plyometric training on sand induces less muscle soreness and damage.

Limitations of the study

- Small sample size.
- Study duration is short.
- Study sample was limited to 18 to 25 years of age.
- Long term effects of treatments were not assessed.

Recommendations of the study

- The sample of this study was small and it can be done on larger sample.
- Further study can be done with varying age group.
- Long term effect of treatment can be assessed with these treatment.

Conclusion

This study concludes that short term plyometric training on sand induces similar improvements in endurance as on firm surface and also significantly less muscle soreness. From the statistical analysis a highly significant difference is found between the pre and post-test values of bothgroup A and B with a p value <0.0001 but comparing both the mean values group A is found to be more significant after applying the short-term plyometric training on sand. The result of this study shows that while the plyometric training performed on sand surface reduces muscle soreness and indicates a lowered fatigue index than performed on a grass surface, whereas lowered fatigue index indicates a better endurance performance.

Bibliography

1. Bangsbo J., *et al.* "Physical and metabolic demands of training and match-play in theelite football player". *Journal of Sports Sciences* 24.07 (2006): 665-674.

2. Wang YC and Zhang N. "Effects of plyometric training on soccer players". *Experimental and TherapeuticMedicine* 12.2 (2016): 550-554.

3. Afyon YA. "The effect of core and plyometric exercises on soccer players". *The Anthropologist* 18.3 (2014): 927-932.

4. Chu DA. "Jumping into plyometrics". *Human Kinetics* (1998).

5. Häkkinen K., *et al.* "Changes in isometric force-and relaxation-time, electromyographic and muscle fibre characteristics of human skeletal muscle during strength training and detraining". *Acta Physiologica Scandinavica* 125.4 (1985): 573-585.

6. Bobbert MF. "Drop jumping as a training method for jumping ability". *Sports Medicine* 9.1 (1990): 7-22.

7. Baechle TR and Earle RW. "Essentials of strength training and conditioning". *Human Kinetics* (2008).

8. Miller MG., *et al.* "The effects of a 6-weekplyometric training program on agility". *Journal of Sports Science and Medicine* 5.3 (2006): 459.

9. Impellizzeri FM., *et al.* "Effect of plyometric training on sand versus grass on muscle soreness and jumping and sprinting ability in soccer players". *British Journal of Sports Medicine* 42.1 (2008): 42-46.

10. Boocock MG., *et al.* "Changes in stature following drop jumping and post-exercise gravity inversion". *Medicine and Science in Sports and Exercise* 22.3 (1990): 385-390.

11. Carter AB., *et al.* "Effects of high-volume upperextremity plyometric training on throwing velocity and functional strength ratios of the shoulder rotators in collegiate baseball players". *The Journal of Strength and Conditioning Research* 21.1 (2007): 208-215.

12. Schulte-Edelmann JA., *et al.* "The effects of plyometric training of the posterior shoulder and elbow". *The Journal of Strength and Conditioning Research* 19.1 (2005): 129-134.

13. Shankar R., *et al.* "Effect of high intensity and low intensity plyometric on vertical jump height and maximum voluntary isometric contraction in football players". *Journal of Exercise Science and Physiotherapy* 4.2 (2008): 81.

14. Miller MG., *et al.* "Comparisons of land-based and aquatic-based plyometric programs during an 8-week training period". *Journal of Sport Rehabilitation* 11.4 (2002): 268-283.

15. Miyama MO and Nosaka KA. "Influence of surface on muscle damage and soreness induced by consecutive drop jumps". *Journal of Strength and Conditioning Research* 18.2 (2004): 206-211.

16. Singh A., *et al.* "Effect of plyometric training on sand versus grass on muscle soreness and selected sports specific performance variables in hockey players". *Journal of Human Sport and Exercise* 9.1 (2014): 59-67.

17. Binnie MJ., *et al.* "Sand training: a review of current research and practical applications". *Journal of Sports Sciences* 32.1 (2014): 8-15.

18. Rubley MD., *et al.* "The effect of plyometric trainingon power and kicking distance in female adolescent soccer players". *The Journal of Strength and Conditioning Research* 25.1 (2011): 129-134.

19. Vickers AJ. "Time course of muscle soreness following different types of exercise". *BMC Musculoskeletal Disorders* 2.1 (2001): 5.

20. Katherine E Burgess., *et al*. "Reliability and validity of running anaerobic sprint test among soccer players". *Journal of Sports Sciences* 5.2 (2016): 25-29.

21. Rohit Kumar Thapa., *et al.* "Effect of drop height on different parametersof drop jump among soccer players". *TRENDS in Sports Sciences* 27.1 (2020): 13-18.

22. Young W., *et al.* "Relationship between strength qualities and performance in standing and running up vertical jumps". *Journal of Sports Medicine Physical Fitness* 39.4 (2000): 45-48.

23. Beneka A., *et al.* "Muscle performance following an acute bout of plyometric combined with low or high intensity weight exercises". *Journal of Sport Sciences* 21.7 (2012): 1-9.