The Effects of Aquatic Plyometric Training on Lower Limb Power and Agility of University Rugby and Soccer Athletes

S Roopchand-Martin[1], B Gayle[1], D Evelyn[2], S Creary-Yan[1]

ABSTRACT

Objective: To determine the effects of aquatic plyometric training on lower limb power and agility of rugby and soccer players at The University of the West Indies.

Methods: Subjects were recruited from the University's soccer and rugby teams and following completion of informed consent, baseline measures were taken for the Illinois Agility, the Vertical Jump and Running Based Anaerobic Sprint Tests (RAST). Aquatic plyometric training was done three times per week for six weeks followed by post-test measures.

Results: Statistically significant changes were achieved for all variables tested. The mean change in Illinois Agility scores was 0.72 ± 0.72 seconds, p = 0.001. Vertical Jump height increased (mean change = -105.28 ± 82.22 cm; p = 0.00) and the mean anaerobic power on the RAST also increased at the end of training (mean change = -86.97 ± 129.66 watts; p = 0.011).

Conclusion: Aquatic plyometric training shows the potential to be an effective method of training for University level Rugby and Soccer Players. Further research is needed to compare this method of training with other approaches to power and agility training.

Keywords: Agility, anaerobic power, aquatic training, plyometrics, rugby, soccer

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From: [1]Mona Academy of Sport, Faculty of Sport, The University of the West Indies, Kingston 7, Jamaica and [2]Therapy by Terri, 15 Rochester avenue Kingston 19, Jamaica.

Correspondence: Dr S Roopchand-Martin, Mona Academy of Sport, Faculty of Sport Administrative Annex, University Place, Mona Campus, Kingston 7, Jamaica.
Email: sharmella.roopchandmartin@uwimona.edu.jm

INTRODUCTION

Sports are a great unifying factor throughout many societies within the Caribbean. In Jamaica soccer, locally referred to as football, saw its first club formed in 1893 and by 1962 the Jamaica Football Federation (JFF) was formed and accepted by Fédération Internationale de Football Association [FIFA] (1). In 1998, Jamaica became the first English-speaking Caribbean Country to ever qualify for the world cup and has in general achieved fair success. Rugby, though not as popular a sport as football, has infiltrated our society building a progressive reputation through the Jamaica Rugby League Association (JRLA) established in 2004. Jamaica has participated in international matches and tournaments with recent successful qualification for the 2018 Rugby World Cup Sevens (2). More university level players are afforded the opportunity of entering the national programmes so developing the skills of these players would significantly aid in raising the standard of the respective national teams.

Plyometric exercise is used to build power and speed, improve coordination and agility and effectively improve sports performance (3). It trains the nervous system to react quickly and activate muscles rapidly as they move from an eccentric to a concentric contraction, enabling the muscles to increase the speed and force with which they perform (4–5). The goal of plyometrics is to shorten the amortization phase, train muscles to move rapidly and load contractions, thereby allowing the movement to be completed in a shorter amount of time and consequently leading to a greater power and explosiveness (6). Rugby and football are two sports that require sudden changes in direction, sprinting and explosive force generation and so it is possible that persons participating in these sports may benefit from plyometric training. Benefits from plyometric training also include improved joint function and stability, reduced incidence of serious knee

injuries and running economy, however, this type of training on land carries risks of injury to various structures, including the vertebrae, muscles and osteo-articular surfaces (7–8).

It is suggested that aquatic plyometric training has the potential to provide similar or better improvements in skeletal-muscle function and reactive and explosive sport-related attributes than land-based plyometric training (9–12), with less delayed-onset muscle soreness (9–10). The buoyant force provided by water decreases weight in relation to the degree of submersion and therefore, decreases the degree joint compression during landing. This results in a potential decrease in overuse injuries compared with land plyometrics (7, 13). The sensation of the water moving against the skin during aquatic plyometric training enhances proprioception in a manner that cannot be matched with land-based training (14).

Most of the research comparing effects of aquatic and land plyometric training has reported similar gains in both groups for both sedentary and athletic populations. However, aquatic plyometric training seemed to be better than land plyometric training with regards to reducing muscle soreness (7, 9, 15, 16). A study comparing the effects of land and aquatic plyometric training on power, torque, velocity and muscle soreness in women showed equal performance benefits with reduced muscle soreness being observed in the aquatic group (9). Similar findings were reported for another study six-week study exploring peak power and agility (16). An eight-week training programme exploring sprint speed and strength in basketball players showed no difference between aquatic and land-based training (7). Martel *et al* reported a relative improvement in counter movement jump performance by 8% in female high school volleyball players following six weeks of aquatic plyometric training combined with regular preseason training (10). No study on aquatic plyometric training has been found in the Caribbean population exploring aquatic plyometric training in either rugby or soccer athletes. This study

examined the impact of a six-week aquatic plyometric training programme on vertical jump performance, agility scores and anaerobic power of Rugby and Soccer athletes at The University of the West Indies.

SUBJECTS AND METHODS

A single group pre-test post-test design was used to evaluate the objectives of this study following ethical approval by the University's Ethics Committee and informed consent by the participants.

Sample

The targeted sample for this study was eighteen [effect size 1.4, alpha 0.05 and beta 0.8] (17). Persons were excluded based on self-reports of the following: knee surgery within the last two years; current musculoskeletal injuries leading to pain at the knee, back or ankles; already involved in a plyometric programme; medical condition for which high intensity exercises was contraindicated and aquaphobia/ hydrophobia.

Instrument

Agility was evaluated with the Illinois Agility Test which looks at acceleration, deceleration, turning in different directions and running in different angles (5). The instrument has been shown to be a reliable measure of agility [r = 0.86] (19). Lower limb power was evaluated with the Vertical Jump Test. This test has been used by numerous researchers to investigate power and has been shown to have good validity (r > 0.95) and reliability [r > 0.97] (5, 21–22).

The test looks at how high the athlete can jump with the best of three values being recorded. The Running Based Anaerobic Sprint test (RAST) was used to measure the anaerobic capacity and power and was originally adapted from the Wingate Anaerobic test (WAnT) to assess the anaerobic power and capacities for running sports. The RAST had a significant correlation with the WAnT [peak power r = 0.46; mean power r = 0.53; fatigue index r = 0.63] (20). The testing protocols followed for this study are described on the Topend Sports website www.topendsports.com (27).

Procedure

Potential participants were recruited by physiotherapy students who were playing on the University's Rugby and Soccer teams. Baselines values for height and weight were obtained following which the athletes completed the RAST, Vertical Jump, and Illinois Agility Tests. Following this they were oriented to the pool which was located at the Faculty of Medical Sciences Teaching and Research Complex. All athletes engaged in one week of practice sessions to master technique. Three training sessions were conducted per week for six weeks following which reassessments were done. Evaluations were done by the principal investigator.

Aquatic training programme

Aquatic plyometric training sessions were conducted in waist deep water with a five-minute warm up and cool down phase in the pool. Each session lasted between thirty and forty-five minutes. Training began with low intensity exercises and intensity was progressed each week resulting in high intensity training be weeks five and six. The aquatic plyometric training protocol and warm-up and cool down exercise was modeled from previous studies (5, 23–24).

Training sessions were conducted by physical therapy students who were trained to deliver the protocol.

Data analysis

Data was analysed using SPSS version 12 for windows. A Paired *t*-test (alpha level 0.05) was used to determine the mean change in all variable scores.

RESULTS

Eighteen participants were recruited and all completed the study with no reports of injuries or muscle soreness. The mean age was 20.89 years ± 1.78 years, mean height of 176.9 cm ± 4.71 cm and mean weight of 164.1 lbs ± 20.60 lbs.

Agility scores decreased for all participants except eleven (Fig. 1) and vertical jump height increased for all participants (Fig. 2).

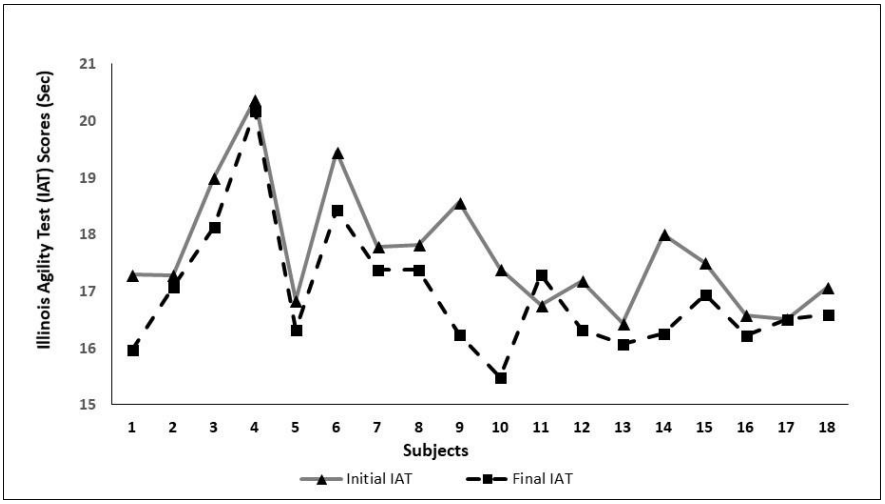

Fig. 1: Illinois agility test scores at baseline and at final assessment.

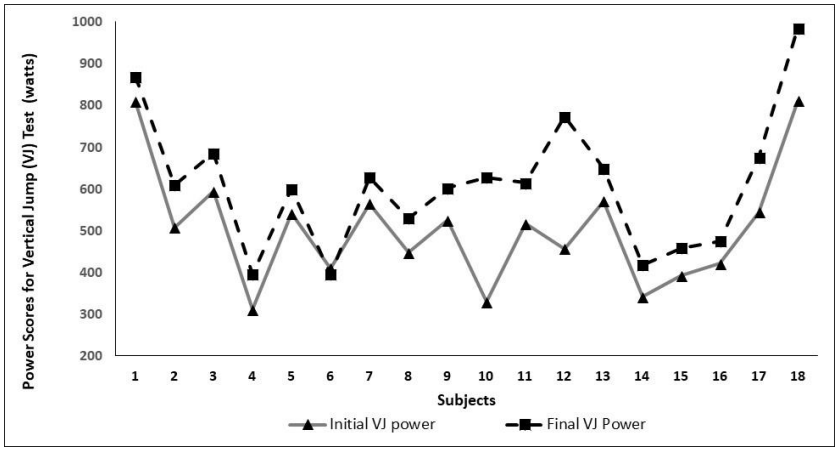

Fig. 2: Vertical jump scores at baseline and final assessment.

Subjects 16 and 17 were the only two participants who demonstrated a decrease in average power (Fig. 3).

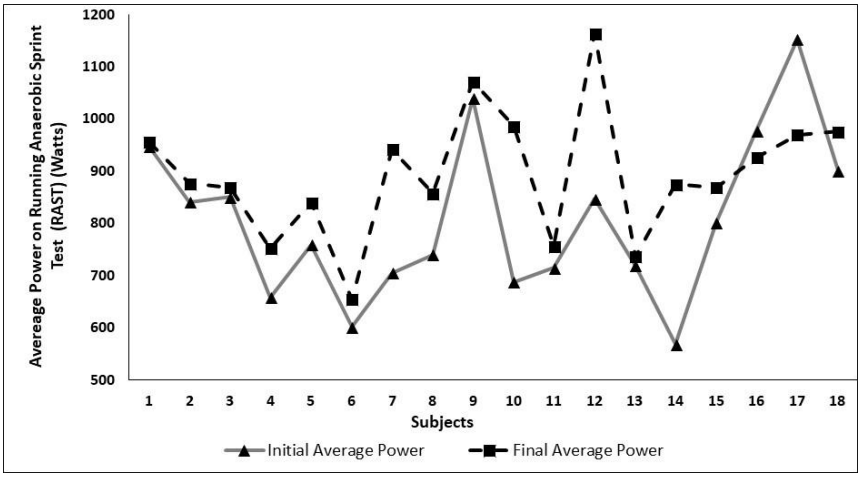

Fig. 3: Average power on RAST baseline and final assessment.

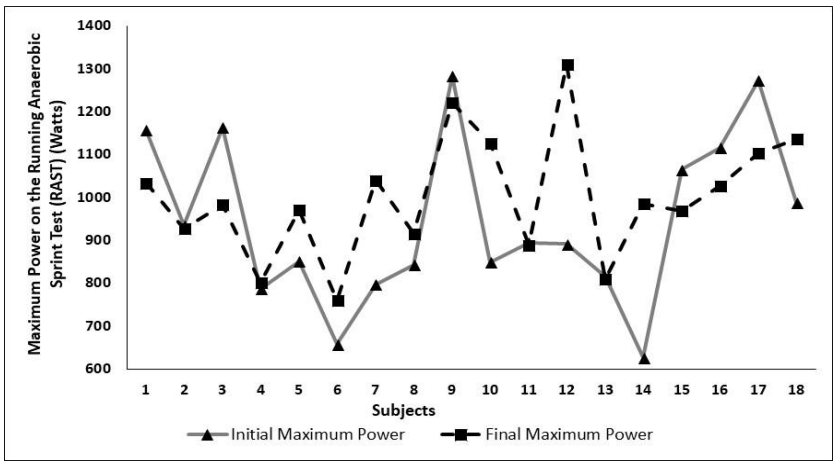

Fig. 4: Maximum power on RAST baseline and final assessment.

Five subjects showed a reduction in the mean maximum power on the RAST (Fig. 4). Statistically significant improvements were noted for all variables except for mean maximum power on the RAST (Table. 1).

Table 1: Mean and standard deviation (SD) for all outcome variables

Variable	**Initial Mean ± SD**	**Final Mean ± SD**	**Mean Change ± SD**	***p*-value**
Illinois agility score (Sec)	17.66 ± 1.08	16.93 ± 1.11	0.72 ± 0.72	0.001
Vertical jump (cm)	505.40 ± 140.23	610.67 ± 157.65	-105.28 ± 82.22	0.000
Maximum power RAST (Watts)	944.38 ± 194.30	1000.99 ± 144.50	-56.61 ± 176.98	0.193
Average power RAST (Watts)	805.67 ± 154.27	892.64 ± 123.65	-86.97 ± 129.66	0.011

DISCUSSION

The results of this study showed improvement for all variables of interest with the maximum anaerobic power score on the RAST being the only one that did not reach statistical significance. The findings of this study were like that reported in the literature where improvements were seen with minimal or no muscle soreness (7, 9, 15, 16).

The improvements noted in the vertical jump scores for this study was greater than that reported Miller *et al* (5). In their study persons who trained in waist deep water had slight, non-significant differences in the vertical jump height compared to persons who trained in chest deep water. The differences may be due to the type of exercises utilized. The athletes in this study performed several exercises requiring vertical jumps. The optimal depth for performing aquatic plyometric training to enhance power and force production is still inconclusive (13) and still appears as a fundamental factor when training to increase muscle power (12). In addition to affecting the athlete's ability to maintain proper body control and coordination, it may also influence the stretch-shortening cycle reaction time

The changes in agility scores in our study was like that reported for adolescent rugby players whereby they showed significant improvement in scores on the Illinois Agility Test following aquatic plyometric training (24). All but one of the rugby and soccer athletes that participated in our study had an improved agility time which is a crucial component of their training and performance.

The temperature of the water in this study could have also had an impact on outcomes. The participants complained of the water being cold and it may have influenced the pace of their workout with possibility a more vigorous pace of movement, to remain warm, as compared to athletes who may have done training in warmer pools.

There were a few limitations in this study that could have also affected performance. The athletes trained bare feet however, use of aquatic shoes may have been better for improved floor contact and less slippage, especially with horizontal jumps. Many of the athletes wore loose fitting swim trunks which sometimes hindered their jumps as the water tugged at the suits. Swim tights would be more appropriate for this type of training since it would minimize drag.

Our pool was small so the distance they were able to cover when doing sprints in the water was quite short. It is possible that if the pool was longer we may have obtained better results for the maximum power on the RAST which requires the athlete to sprint over a 35-meter distance. During training athletes should maintain adequate distance between each other to avoid creating a current, as strong current will enable following athletes to be pulled across the water with minimal physical exertion, thereby decreasing the training effect (14). Sometimes there were larger numbers of athletes during training and this effect may have been experienced. Though the pool was covered it was not enclosed and evaporation at times resulted in fluctuations in the water level. Attempts were made to keep this constant however, there were some days that it could not be maintained.

CONCLUSION

This study has shown favorable results for the inclusion of aquatic plyometric training for rugby and soccer players. The results must be interpreted with caution however, since it is a single group pre-test post-test study. Further research is required exploring training at different depths and temperatures as well as comparing aquatic training with other traditional methods of power training.

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