

Effect of Individualized Mat Pilates Exercises on Speed, Agility and Back Extensor Endurance in a Deconditioned Athlete – A Case Study

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Abstract

Introduction: An athlete's life revolves around their sport. Retirement from sports is a unique transition that influences significant identity, body, and lifestyle changes [1]. While competitive athletes exceed recommendations for physical activity, this only translates into regular physical activity after retirement from sports. Research suggests the nature of competitive sports participation may need to be more conducive to lifelong physical activity [2] Falling out from sports and physical activity leads the body into deconditioning. The study aims to analyze the effectiveness of Pilates in improving speed, agility and back extensor endurance in a deconditioned athlete.

Materials and Methods: The clinical setup for the case study was arranged at VAPMS College of Physiotherapy in Visakhapatnam. The pre and post-tests were performed on the premises of the institution. The subject is a male athlete, a middle-distance runner. The subject received Pilates training four sessions/week for eight weeks for 40 minutes. Speed, Agility and Back extensor endurance were assessed with the outcome measures 20-meter sprint, Illinois agility test and Biering Sorensen test.

Results: Results obtained from the present case study indicate that eight weeks of Mat Pilates improved speed, agility and back extensor endurance. Based on this study, there is a difference in the values recorded pre and post-Pilates training. Two trials were performed for each outcome measure, and the better of the two trials was considered.

Conclusion: The results from the present case study concluded that the Mat Pilates exercise training is effective in the improvement and enhancement of the speed, Agility and back extensor endurance of the athlete. Overall, it shows that an athlete's re-conditioning is possible with Pilates training.

Keywords: Pilates training; speed; Agility; back extensor endurance

Introduction

An athlete's life revolves around their sport. Retirement from sports is a unique transition that influences significant identity, body, and lifestyle changes [1]. Even though competitive athletes exceed recommendations for physical activity while competing in sports, this only translates into regular physical activity after retirement. Research suggests the nature of competitive sports participation may not be conducive to lifelong physical activity [2]. Falling out from sports and physical activity leads the body into deconditioning.

Pilates has been marketed to athletes to improve their "core" and "functional fitness." [3] Pilates training engages core musculature and utilizes controlled repetitions of various movements to improve muscular strength and endurance, flexibility, balance, and posture [4]. His method is total coordination of body, mind, and spirit, promoting the uniform development of the body, restoration of good posture and physical activity, and revitalization of the mind and spirit [5].

Even though several studies investigated the effect of pilates on improving an athlete's performance, there is less evidence regarding the effect of pilated on motor abilities in the re-conditioning of a former athlete. Running is one of the most popular sports in the world. The running performance depends on a range of physical qualities such as Speed, Agility, and Back Extensor endurance [6].

Speed helps the athlete move at a specific resistance level as quickly as possible. Agility is an essential quality for quick footwork and precision [7]. Core endurance influences the ability to run intermittently and exert maximum power and strength in different actions related to a better quality of movement [8].

The clinical setup for the case study was arranged in the VAPMS College of Physiotherapy. The pre and post-tests were performed on the premises of the institution. The institution has a spacious ground for the tests to be completed. The clinical department can perform the Pilates Mat exercises without any disturbances. In this case study, the properties of Pilates to strengthen the core is used, and a former athlete is re-conditioned whose body has been deconditioned due to physical inactivity.

Materials and Methodology

This is a single-case study of a male athlete, a middle distance runner in a deconditioned state. Three days before the baseline measurements, the subject visited the VAPMS College of Physiotherapy clinical setting for familiarization with the pre-test. The athlete was required to avoid vigorous physical activity 24 hours before the study. Also, the subject was recommended for enough sleep. In order to investigate the effects of the 8-week Pilates training on Speed, Agility and Back Extensor endurance, 20 Meter Sprint test, Illinois Agility test and Biering Sorensen test were performed. Before the start of the Pilates program, the pre-test values of the subject were recorded and trained through the 8-week training protocol.

For the training, the subject came to the clinical setup during every session, and the pre-test and post-test values were recorded on the grounds of the VAPMS College of Physiotherapy. After completion of the training period, post-test values were recorded, which were compared to the pre-test values for the analysis of the result.

Outcome measures:

Speed, Agility and Back extensor exercises were measured by 20- the meter sprint test, Illinois Agility test and Biering Sorensen test.

20-Meter Sprint Test

The test involves running a maximum sprint over 20 meters, with the time recorded. A thorough warm-up should be given, including some practice starts and accelerations. Start stationary, with one foot in front of the other. The front foot must be on or behind the starting line. This starting position should be held for 2 seconds before starting, and no rocking movements are allowed. The tester should provide hints to maximizing speed (such as keeping low and driving hard with the arms and legs) and be encouraged to continue running hard past the finish line. Two trials are allowed during this and the best time is recorded rounding off to the two decimal places. The timing begins from the first movement or when the timing system finishes when the chest crosses the finish line or the finishing timing gate is triggered.

Illinois Agility Test

The Illinois agility test is a fitness test designed to test agility. It is a simple test which is easy to administer and requires little equipment. It tests the ability to turn in different directions and at different angles.

To conduct the test, adequate space, a timer and eight cones are required. The individual starts by lying face down by the first cone. Staring at cone 1, he needs to run to cone 2, which is placed at a distance of 10 meters from the first. The participant then runs 10 meters to cone 3. At this point, the individual has to weave around cones 3,4,5,6. After this, the participant has to go through 5, 4, 3. Then the participant will run to cone 8. The time to complete the task is then recorded with a stopwatch.

Biering Sorensen Test

The Biering Sorensen test is “measuring how many seconds the subject can keep the upper body unsupported (from the upper border of the iliac crest) horizontal, while placed prone with the buttocks and legs fixed to the couch by three wide canvas straps and the arms folded across the chest.”

- To begin this test, an examination plinth, stopwatch and three to four straps are needed. The starting position is the patient/client adopting a half-prone lying on a plinth with the superior edge of the iliac crest at the edge of the plinth and the arms crossed over the chest. The lower limbs are strategically stabilized with straps. The patient/client is asked to maintain the upper body horizontally, and the timer is started.
- The test ends if the patient/client can maintain the said position for 4 minutes (240 seconds) or can no longer maintain the set position before 4 minutes elapses. The stop time is recorded.

Interventions

Program level

Contents

Results

Parameters collected are speed (20 Meter sprint test), Agility (Illinois agility test) and back extensor endurance (Biering Sorensen test). The data is collected on the 1st day and at the end of the 8th week after completing the Pilates intervention.

Program level	Contents (3sets with 10 rep/set)
Warm up (5 min)	<ol style="list-style-type: none"> 1. Purse lip breathing 2. Hip release 3. Jogging on spot 4. Arm circles
Main exercise (40 min)	<ol style="list-style-type: none"> 1. Side kick kneeling 2. Double leg stretch 3. Hip twist 4. Spine twist 5. One leg circle
1-2 weeks	<ol style="list-style-type: none"> 1. Roll up 2. Roll over 3. One leg circle 4. Hundred 5. Shoulder bridge
3-6 weeks	<ol style="list-style-type: none"> 6. Double leg kick 1. Bicycle 2. Scissors 3. Side kick kneeling 4. Double leg kick 5. Shoulder bridge 6. The hundred 7. Double leg stretch
7-8 weeks	
Cool down (5 min)	<ol style="list-style-type: none"> 1. Neck stretches 2. Knee to chest bend 3. Child pose 4. Standing quadriceps stretch

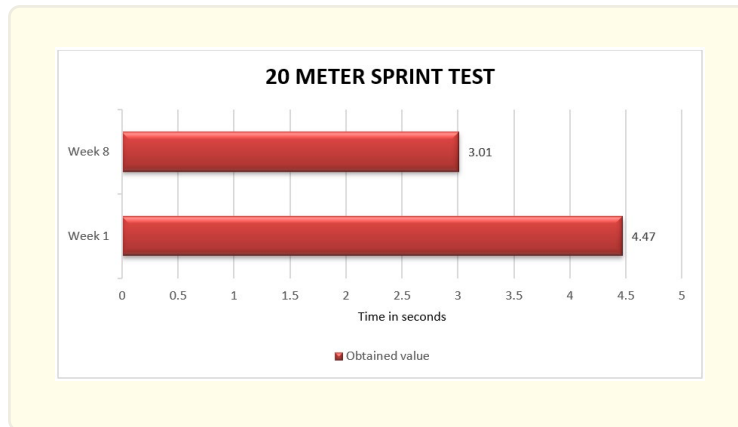
Table 1: Pilates training program.

TEST	OBTAINED VALUES			
	PRE-TEST		POST-TEST	
	1st trial	2nd trial	1st trial	2nd trial
20 METER SPRINT TEST	4.56 sec	4.47 sec	3.10 sec	3.01 sec
ILLINOIS AGILITY TEST	19.88 sec	19.78 sec	18.36 sec	17.90 sec
BIERING SORENSEN TEST	1.7.95 min	1.01.83 min	2.1.15 min	1.47.03 min

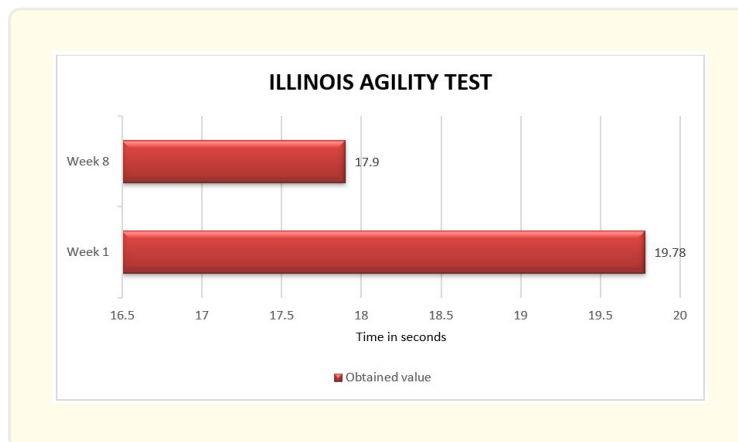
Table 2: Results obtained.

The best value of the two trials is taken from the prior and post-tests.

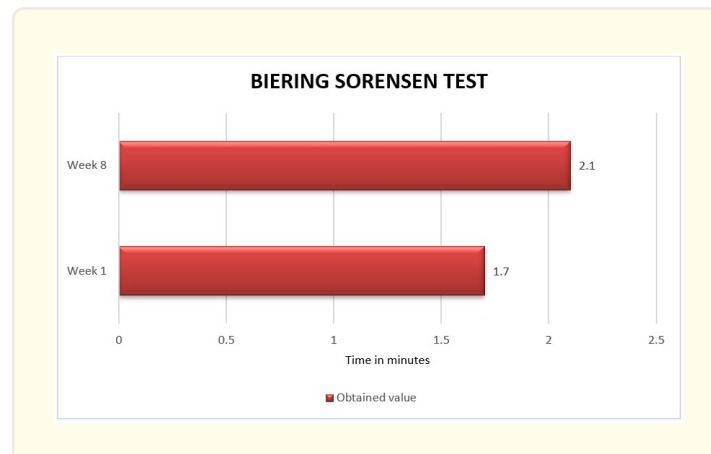
- The pre-test and post-test values for the 20 Meter Sprint test were 4.47 seconds and 3.01 seconds.
- The pre-test and post-test values for the Illinois Agility test were 19.78 seconds and 17.90 seconds.
- The pre-test and post-test values considered for the Biering Sorensen test were 1.70 minutes and 2.10 minutes.



- A value difference of 1.46 seconds was observed between the values obtained during Week 1 and Week 8.
- Pre-test value 4.47 seconds.
- Post-test value 3.01 seconds.



- A value difference of 1.97 seconds was observed between the values obtained during Week 1 and Week 8.
- Pre-test value is 19.78 seconds And Post-test value is 17.90 seconds.



- A value difference of 40 seconds was observed between the values obtained during Week 1 and Week 8.
- Pre-test value is 1.70 minutes.
- Post-test value is 2.10 minutes.

Discussion

Results obtained from the present case study indicate that eight weeks of Mat Pilates produced improvements in speed, agility and back extensor endurance. Based on this study, there is a difference in the values recorded pre and post-Pilates training. Two trials were performed for each outcome measure, and the better of the two trials was considered.

Speed was measured with 20 Meter sprint test; the pre-test values were 4.56 seconds and 4.47 seconds during 1st trial and 2nd trial, respectively. The post-test values were 3.10 seconds and 3.01 seconds. A difference of 1.46 seconds was observed between the best deals of the pre and post-test values which are 4.47 seconds and 3.01 seconds, respectively.

Previous studies reported that flexibility increases the speed of a runner as it increases muscle performance [25-28]. According to Swanson and Caldwell (2000), while running, lower limb muscles activate with the hamstring muscle activated first before foot strike, followed by Gluteus maximus and Gastrocnemius and finally, Soleus, Vastus lateralis and Rectus femoris [15].

Many studies show that Pilates exercise training can improve the flexibility of a muscle as well as muscular strength [17, 19, 20]. Neurophysiologic properties of contractile tissues respond to stretching exercise. When the Pilates stretching position is applied, slow stretch to soft tissues (i.e., skin, tendon, joint capsule) and muscles activate the Golgi tendon organ. This sensory receptor detects differences in the tension generated by passive stretch or active muscle contraction. The Golgi tendon organ inhibits alpha motor neuron activity due to decreased muscle tension, permitting sarcomeres to lengthen [35].

Segal et al. (2004) conducted an observational, prospective, repeated measures study to assess the effects of Pilates training on flexibility, body composition, and health status of healthy adults. A power analysis was calculated for a sample size of 16 subjects. All subjects participated in 1-hour weekly Pilates mat class for six months. Exercises progressed in difficulty.

Outcomes measured at baseline, 2, 4 and 6 months were composite flexibility BMI body mass, segmental fat, and lean body mass Composite flexibility improved from baseline to 6 months ($P < 0.01$). There was no statistically significant change in body composition or the AAOS questionnaire Positive comments were improved posture, flexibility, and morning stiffness cessation, among others. The authors concluded that Pilates exercises may improve truncal flexibility in healthy adults [20].

All the above studies support that Pilates training improves a muscle's flexibility, leading to enhanced running speed by enhancing lower limb muscle performance. The present case study also shows an improvement in speed performance by 1.46 seconds, which aligns with the above studies' findings.

The back extensor endurance was measured with the Biering Sorensen test, the values of the pre and post-test being 1.70 minutes and 2.10 minutes, respectively. There was a value difference of 40 seconds between the pre and post-test, which shows an increased endurance capacity of the back extensors.

The Pilates method has been considered an optimal exercise modality for improving the strength and endurance of back muscles [25]. Sewright (2006) performed six weeks of Pilates training on sixteen ($n=16$) collegiate tennis players to measure the effects on muscular endurance. The results showed an increased muscular endurance of 44.57 seconds at the end of training [32].

According to Behm et al. (2009), an increase in back extensors' muscular endurance helps the athlete run for a prolonged time. Because of the increase in muscular endurance, speed and Agility are improved [29].

An improvement was also observed in the speed and Agility of the athlete in this case study. The present case study showed improved muscular endurance by 40 seconds and is in line with the findings of the above studies.

The agility performance of the athlete was tested with the Illinois Agility test. The value of the pre-test is 1.75 minutes, and the post-test value is 2.70 minutes. The value difference observed between the pre and post-test is 1.97 minutes. Agility depends on factors of perceptual and decision-making and change of direction speed. Change of direction speed depends upon the sprinting speed, strength and power [33].

Pilates is known to increase the speed, strength and power of muscles. According to Jae-Ho Yu et al. (2012) study, Pilates training increases muscle strength and enhances motor performance skills [34]. Another study by Santos et al. (2011) on the effects of Pilates on dancers describes that practicing Pilates exercises improved the muscular strength of muscles [19].

Also, results from the tests on speed and endurance in this case study support that Pilates effectively improves speed and muscle performance. Also, few studies support that Pilates implies a positive effect on mental health, which may enhance the athlete's decision-making ability, which might improve agility performance [37].

An improvement in agility performance was obtained through the present case study, which showed a difference of 1.97 minutes. This implies that Pilates is an effective training for agility performance. Overall, results reported in this study indicate that Pilates exercise training can be included in athletic training, especially in deconditioned male middle distance runners.

Worthy to note is that before the 8 weeks of Pilates training, the subject had difficulty running for a more extended period. After running for a shorter distance, he suffered breathlessness and muscle cramps in the lower leg. Being inactive for more than two years drastically affected the athlete's abilities, and the athlete's performance declined.

After the completion of the 8-week Pilates exercise training, the athlete was able to overcome these difficulties. He could run for a more extended period without running out of breath and cover longer distances within a shorter amount of time.

The increased running speed would cause more lumbopelvic movements and consequently greater instability, requiring greater neuromuscular control to achieve stability during cyclical activities such as running [35].

The results of this study are similar to the survey by Yeole UL et al., The effect of core strengthening on dynamic balance and Agility in badminton players showed that compared to the groups that performed conventional exercises.

Higher core stability performances allow optimal and long-sustained contraction of the deeper spinal stabiliser muscles. Due to their proximity to the spine, these stabiliser muscles are responsible for better control of the intersegment motion of the spine and, thus, better control of the body's COG [36].

During the study, a few difficulties were faced. Although many athletes were available, finding a subject suitable to the case study took a lot of work. Even though the institution has a ground of its own, the condition of the ground could be better, and it has faced problems due to uneven surfaces.

It has been problematic to convince the subject to come to the clinical setup for every session as the subject resides at a farther distance. Initially, the subject faced a problem coping with the intensity of exercise protocol, as the athlete had no physical training for a certain period. Apart from other difficulties, the Covid pandemic has been a primary concern. The subject had a problem with travelling amidst the pandemic due to the rules and regulations of the government.

Several limitations should be considered in the application of the findings of this case study. First, due to a single sample, future high-quality investigations are strongly needed. As this study was a case study including only treatment, we cannot ensure that the results were due to the Pilates training. Thus, further studies should include control groups with a larger sample size to investigate the interaction effects.

Second, as the personal nutrition of the athlete could not be controlled, it cannot be assured that the results were entirely attributable to the Pilates training program. Therefore, further studies tracking the daily food intake of the athlete, which could have occurred

during the treatment period, are needed to establish the effects of Pilates training. Further research could compare practitioner training and exercise selection to determine the most effective approach for specific physical functions.

The post-test was carried out immediately after the eight weeks of Pilates exercise training without any subsequent follow-up testing. Thus, it remains to be seen how long the improvement in the athlete's performance from the eight weeks of training will last after the study is terminated. Moreover, the results of this case study should be related only to the Mat Pilates exercises. Because of the infrastructure limitations, only Mat Pilates activities were used.

Conclusion

The present case study indicates that Pilates training is efficient enough to re-condition a deconditioned athlete. Pilates training engages core musculature and utilizes controlled repetitions of various movements to improve muscular strength and endurance, flexibility, balance and posture. The study findings suggest that there were noticeable improvements in the athlete's speed, agility and back extensor endurance as measured by the 20-meter sprint test, Illinois agility test and Biering-Sorensen test.

Limitations and Suggestions

The size of the sample is too small. Studies with larger pieces could be better evidence for further research. The exercises included in the protocol were mat exercises with no equipment included. Performing exercises with equipment might yield better results with noticeable differences in outcome values within the short time period compared to the present case study.

Author's Contribution

J Pratyusha reddy and CH Roopa sri have contributed in conception and design of the work and have contributed in data, supervising the treatment protocol and interpretation of data. Draft analysis and final revision of the article was done by Sashikala Bandaru.

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