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Analyzing the issues of asymmetry in the strength of fencers bodies and the effectiveness of combining Aerobics with Fencing on their muscles by a new sport AeroFencing

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Abstract. This paper attempts to introduce Aerofencing as a young kind of sport in which athletes perform combining rhythmic choreography with footwork and handwork of fencing with elements of aerobic and aerobic dance to music. Additionally, it reports the results of an experiment that aimed to combine aerobic exercise and fencing as a new field called AeroFencing for improving asymmetric fencing exercise and helping reduce injuries. Fencers from the experimental group underwent four-week AeroFencing training, while those from the control group underwent regular fencing training. The fencers' performance was analyzed two times: before the practical training (pretest)and after four weeks of training (posttest) in the Columbus Fencing & Fitness. Participants passed three tests that just studied the anaerobic power and speed of the dominant and non-dominant sides of the body. The fencers from the experimental group generally performed better in posttests than in pretests. The results showed that the training protocol of the present study caused a significant improvement in the anaerobic power, hand speed at the time of the attack, and leg speed of the participants in the experimental group compared to the control group.

Keywords: Fencing, AeroFencing, Anaerobic power, Hand speed and foot speed, Aerobic

1.Introduction

Physical fitness and fencing have made significant progress in recent years and have not been far from diversity, change, and development. Fencing has a lot of popularity worldwide; while it increases the number of athletes and interest in sports, it also increases sports-related injuries. Damage is inevitable in any sport. Especially in fencing, the continuous use of the dominant side results in weakness in the non-dominant side of the athletes. So, the rate of injuries will be increased.

AeroFencing (AF) is a relatively young kind of sport in which athletes perform combining rhythmic choreography with footwork and handwork of fencing with elements of aerobic and aerobic dance to music. AeroFencing was created by Mina Esfanjani first researcher of this article . This paper attempts to introduce Aerofencing for improving asymmetric fencing exercises. Training methods based on bilateral transfer are mainly used in unilateral (asymmetric) sports [1,2]. Ruddy and Carson [3] demonstrated that physical training with one arm improves performance with the opposite (untrained) arm. This phenomenon is called inter-manual transfer [3]. Similar effects have also been shown in many other motor tasks [4–12]. Interhemispheric interactions are often called interlimb interactions [10,12], inter manual interactions [16,17], contralateral interactions [18,19], and bilateral transfer [20]; henceforth, we will use the term bilateral transfer. Various aspects of motor control are asymmetrically distributed in both hemispheres of the brain [21,22]. The left hemisphere [23] is responsible for subtle and synchronous movements that require sequential and dynamic motor control, while the right hemisphere is for complex and intuitive movements, thus specializing in visual and spatial motion control [24]. Ruddy and Carson [3] showed that the unilateral execution of a movement task gave rise to a bilateral increase in corticospinal excitability. During unilateral practice, such distributed activity (the cross-activation) leads to simultaneous adaptations in neural circuits that project to the muscles of the untrained limb, thus facilitating the subsequent performance of the task. As Ruddy and Carson [3] explained, “alternatively, bilateral access models entail that motor engrams formed during unilateral practice, may subsequently be utilized bilaterally—that is, by the neural circuitry that constitutes the control centers for movements of both limbs.” [22]

Previous an array of researchers did a lot about Transfer Training [24] in Fencing and the Effects of specific muscle imbalance improvement training on the balance ability; To the best of our knowledge, this has been the only study on transfer training by combining the way of doing aerobics choreography with the motion of fencing. AeroFencing choreography exercise is a routine that is a combination of movements set to a specific count on both sides of the body. AeroFencing practices are based on music counts. Exercises are performed in counts of two. A good illustration, two advanced to the right. Change this into a four-count exercise by adding two advances on the left side. Combine your exercises to fill 16 counts by adding various basic footwork with aerobic dance exercises the same as Mambo or V-Step. A 16-count pattern fits with music rhythms. When you repeat this pattern, you have a 32-count routine that will flow with the current music style.

Strengthening the core stabilizing muscles has become one of the new topics in medical sports today. Central stability has many benefits, including improving sports performance, preventing injuries, and reducing musculoskeletal disorders and their treatment. Core stability is defined as the ability to control the position of the torso on the pelvis in order to produce and effectively transfer force to the extremities of the body during sports activities. The core stabilizing muscles of the body include some muscles of the torso and thighs, which are responsible for maintaining the stability of the spine and pelvis and are very important for transferring energy from the torso to the upper and lower limbs during sports activities [25]. It has been shown that AeroFencing activates the core muscles of the body before moving the limbs and the central part of the body by providing stability and plays an important role in creating a stable support surface for performing lower limb movements. Current evidence states that reducing the stability of the core muscles can set the stage for injury, and proper training can reduce it. Isometric, isokinetic, and is inertial methods can evaluate core muscle stability. The appropriate intervention will reduce the amount of injury to the torso and lower limbs. One of the essential items in fencing is changes of direction (COD) (mainly back and forth displacements and lunges) that need a high balance in the body.

2. Materials and Methods

In this semi-experimental study, The participants were randomly divided into two groups: (A) experimental (n = 13) and (B) control (n = 12).The group studied consisted of twenty-five foilists and saberist aged 10–14, both boys and girls, all being at least intermediate-level fencers age range of 13.3 ± 2.12, athletes from Columbus fencing & fitness gym in the USA, with an average height of 0.5 146±3.8 and average body mass index 19.2±3.32. After selection and division, a consent form was obtained from the sample subjects' parents. After the necessary investigations and based on the information from the completed questionnaires, the participants were randomly divided into two experimental and control groups. In this research, samples were tried to be equal in terms of gender, age, height, weight, monthly period, and food regime so that the effect of interfering variables is as low as possible. The measurements in the pre-test and post-test were done the same way, and to minimize the acute impact of training and fatigue in the post-test, it was done two days after the end of the training period. At the beginning of the work, a briefing session was held, including introducing the research conditions, possible benefits and risks, and the necessary recommendations for the subjects. Before the pre-test and implementation of the sports program, preliminary evaluations based on determining the age, height, weight, and physical fitness factors were carried out in experimental conditions. Then, the experimental group did three training sessions for 30 minutes a week for four weeks, and the control group was not affected by the exercise program. In the end, both groups did the desired tests again to collect data after the test. AeroFencing aims to address these issues by training those in an asymmetric sport (fencing) to be more symmetrical, strong, and stable.

2.1. Exercise Protocol

AeroFencing is a choreographed, repetitive basic movement of fencing and aerobic dance routine set to music. A typical AeroFencing program begins with 5 to 10 minutes of warm-up. The general goals of the warm-up include gradually increasing the body temperature, HR, and blood flow to active muscles. This prepares the body physiologically for performing an activity that will demand energy expenditure above resting levels. The second step uses choreographed AeroFencing routines through the performance of short combinations of different basic fencing motions mixed with aerobic dance, the development of a full choreography to a final song, or dancing to other songs independently. Participants must pay attention to the angle of the foot, and most of the exercises have to be designed to be done in the same choreography on both sides of the body equally. The last step is 5 minutes of working in a group of 2 people as opponents, using both sides of their bodies and coordinated to the rhythm of the music. The amount of energy expended during a class session of AeroFencing can vary dramatically according to the intensity of the exercise. 'Low intensity' dance exercise is usually characterized by less large muscle activity and less low extremity impact and music of slower tempo; however, 'high intensity' AeroFencing entails using large muscle groups. Choreography was designed using: Running backward, fencing step touch, fencing mambo, fencing grape vine, fencing pivot, fencing step side, fencing twist, fencing cross step, fencing lunge, fencing double attack, fencing advance and retreat, fencing fleche, fencing jump forward and backward, fencing parry, and fitness squat and lunge.

2.2. Intervention

The experiment aimed to compare the anaerobic power and speed of the dominant and non-dominant sides of the body before and after the AeroFencing training. For each participant, three experiments are considered below. The specialized training program was implemented in the experimental group for four weeks, 30 minutes, 3 times a week. All exercise was practiced equivalently on the dominant and non-dominant sides.

2.3. Measurements

2.3.1. Vertical jump test

Sargent's jump measured anaerobic power before and after the exercise protocol. In this test, the person performed a vertical jump (centimeter used for measuring).
Procedure: the athlete stands side to a wall and reaches up with the hand closest to the wall. Keeping the feet flat on the ground, the point of the fingertips is marked or recorded. This is called the standing reach height. The athlete then stands away from the wall and leaps vertically as high as possible, using both arms and legs to assist in projecting the body upwards. The jumping technique can or cannot use a countermovement. Attempt to touch the wall at the highest point of the jump. The difference in distance between the standing reach height and the jump height is the score.[26] The best of three attempts is recorded. And in the final results of Sargent's vertical jump test, calculated through the following formula:

Power-peak (W) = 78.6 · VJ (cm) + 60.3 · mass (kg) - 15.3 · height (cm) - 1,308

2.3.2. Straight thrust speed

counting the straight thrust for the foil and cut the mask for the saber in 30 second for comparison powerfully and balancing in 2 hands.

2.3.3. Leg speed

Leg speed is measured by passing a 14-meter strip with two sides of the body.

2.4. Statistical Analysis

The Shapiro-Wilk test uses correlated and independent tests for the normal data distribution in the pre-test and post-test. All statistical operations were performed using software (SPSS/22), and the tests were performed at the $\alpha \geq 0.05$ level.

3. Results

The specifications and characteristics of the subjects are presented in Table No. 1.

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Table1. Summary statistics specifications of participants

Group	**Variables**			
	Age	**Height(cm)**	**Weight (kg)**	**BMI (kg/m2)**
EXP (13)	13/3±2/12	161/3±8/05	43/35±9/32	19/3±4/5
CON (12)	14/5±3/76	158/4±7/27	45/63±8/57	20/1±3/3

The results of the Shapiro Wilk test showed that the research variables have a normal distribution, so parametric tests were used for statistical calculations. The results of independent and correlated t-tests are presented in Table No. 2**.**

Table 2. The mean and standard deviation of the variables in two groups

Variables	**Group**	**Pre**	**Post**	**t-Correlate**	**significance level**	independent t	**significance level**
Anaerobic power(watt)	EXP	33/3±4/3	39/2±5/2	* 6/6	P<0/001	** 5/5	P<0/001
	CON	32/1±4/5	33/5±5/7	1/5	P<0/157		
Speed of trust hand (number)	EXP	55/4±7/3	2/2 64/4±	* 7/5	P<0/001	** 7/3	P<0/001
	CON	6/4 54/2±	56/3±6/7	1/7	P<0/245		
Leg speed (second)	EXP	8/2±1/4	6/1±1/5	* 7/2	P<0/001	** 6/4	P<0/001
	CON	8/5±1/2	8/7±1/2	-	P<0/351		

(P ≤ 0/05) significance level
(*)sign indicates intragroup difference
(**) sign indicates intergroup difference

Due to the results of the independent t-test in Table No. 2, assuming equal variances between the post-test results of the experimental and control groups in anaerobic power (watts), Straight thrust speed (number), and speed feet (seconds), there is a significant difference.

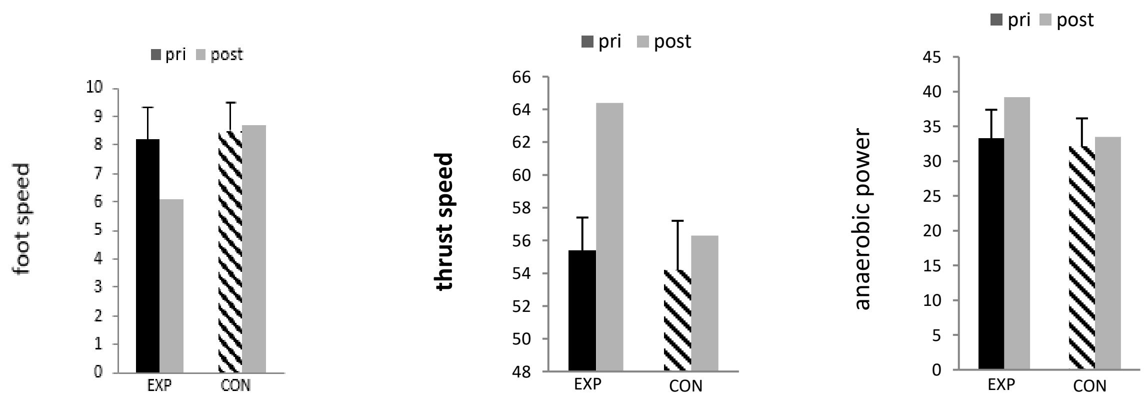

Figure 3. Scales in research groups

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The results of the correlation t-test between the pre-test and post-test to demonstrate how AeroFencing training affected the individuals' increases in anaerobic power, attack speed, and leg speed revealed a significant difference. Additionally, according to the results of the independent t-test, which was used to compare the two groups, there is a significant difference between the experimental and control groups in all three variables, indicating that beginner fencers' variables have changed significantly as a result of their four weeks of AeroFencing training. Unequal pressure on the body's side muscles may result from biomechanical alterations during AeroFencing training. Muscle fiber contraction occurs due to muscle activation by the central nervous system or depolarization of the outer surface of the muscle fiber membrane. Depolarization waves move from the point where the nerve cord enters the muscle to its two ends along the length of the muscle cord. The depolarized region of the fibers of each excited movement unit produces a large electrical effect on the electrode near them because the tissue surrounding the muscle fibers is a conductor of electricity. As a result, maintaining balance in a closed movement chain requires coordinated movement strategies across the thigh, knee, and ankle, which might throw off balance by weakening each joint's mechanical stability or afferent feedback. Instability in the vertebral column results in incorrect movement decreased muscle-nerve coordination and a higher risk of vertebral injury. As a result, increasing the simultaneous contraction of the muscles surrounding the lumbar vertebrae, such as the abdominal obliques, transversus abdominis, multifidus, and spinal straightener, can strengthen the stability of the vertebrae. The following can be mentioned as some of the reasons why AeroFencing exercises can increase factors related to coordination and balance that can increase muscle speed and strength: facilitating and synchronizing large and fast contraction movement units, stimulating muscle spindles, reducing the self-inhibitory effect of the Golgi tendon organs, and also increasing the coordination of the muscles involved in co-contraction activities. Muscle contraction activates the gamma efferent nerves in the spindles, increasing their activity. This sensitivity in the spindles enhances the sensation of joint position, which significantly impacts joint control [27]. Additionally, a change in the mega receptors' feedback, which results in a remodeling of the central nervous system and a shift in sensorimotor integration, is one of the potential explanations for the rise in speed and the frequency of hits following AeroFencing training.[28] It is also possible to mention the activation of deep sensory receptors, the priming of motor neurons in a group of muscles and joints for movement, the improvement of motor unit coordination and integration, the co-contraction of cooperative muscles, and increasing the inhibition of opposing muscles [29]. The physiological explanation is that AeroFencing activities accelerate the transition from the extroverted to the introverted stage, and more movement units are involved at the beginning of the introverted activity. More power will consequently be generated. It may be argued that AeroFencing exercises boost the explosive power of the leg muscles since jumping, leaping, and strength exercises significantly alter the anaerobic performance of muscles and athletes' explosive power. When the muscles are stretched and then immediately contract, these reflexes take place. The coordination and efficiency of the neurological and muscular systems can be improved by various activities, including explosive workouts that are used to build strength. There are different viewpoints regarding the sorts of physical exercises and how they affect the quantity and growth of strength and power in this context, leading to various physical exercise methods. The mechanisms responsible for strengthening anaerobic performance due to speed training may be related to increase force production and neural adaptation. The usage of glycolytic pathways, which results in a rise in the concentration of phosphofructokinase or phosphorylase enzymes and a consequent relative increase in force generation and brain adaptation, are among the mechanisms that may be responsible for enhancing anaerobic power [30]. The time interval between the extroverted and introverted contraction phase is decreased by increasing and strengthening these two phases because jumping exercises in the contraction stretch cycle create a change in speed in the extroverted and introverted contraction phase. Jumping exercises for AeroFencing hence boost and enhance speed. Several studies have also noted that jumping exercises considerably impact running speed. But the nature of the dependent variables and the content and combination of movements in the executive programs can be used to explain why these differences exist. Research has shown that muscle glycogen stores increase after speed training as an important fuel in activities with speed repetitions. his phenomenon speeds up ATP reloading, which enhances aerobic power. Various investigations have noted that this form of training is unsuccessful at the cross-sectional level or the composition of the type of muscle fibers. It has also been demonstrated that after speed or resistance exercises, the activity of glycolytic pathway enzymes such lactate dehydrogenase, myokines, creatine phosphokinase, and phosphofructokinase increases. Further enhancements in explosive power at the outset of running races have also been brought about by speed training. According to what can be concluded, after performing extroverted and intense muscular exercises, the body's physiological indicators change depending on the type of index measured. For the duration of the extroverted/intense activity, various outcomes can be anticipated. Additionally, since speed training puts the most pressure on the muscles, it alters and simultaneously activates the movement units' mobilization pattern due to neuro-muscular adaptation. When describing the physiological basis for this claim, it can be said that the increase in speed following exercise may be brought on by cellular-molecular changes in the motor units' central nervous systems, the nerve-muscle connection plate, and the systems involved in the mitochondria's sarcoplasmic network, or it may occur in the contractile proteins themselves. Therefore, the primary position of the alterations can be determined by various inputs, including hormone changes, type, duration, and intensity of training. Therefore, the researchers suggest that the adaptation following speed training is brought on by several hormonal changes and intense muscular stretching during exercise, both of which reduce the H reflex [31]. In this instance, more movement units are called for a particular activity, facilitating contraction and enhancing the muscle's capacity to generate power. Stopping or lowering the inhibitory impulses (muscle spindle) that allow more motor units to be activated simultaneously can increase the recall pattern of motor units. The higher the intensity of the resistance training or the faster it is performed, the greater the increase in anaerobic power. because a high-intensity movement can further increase the usage of motor units, the synchronization of discharge, and muscle activation levels [32]. Additionally, the correlated t-test revealed that after four weeks of AeroFencing training, there is a significant difference between the pre-test and post-test of the fencers' anaerobic power, attack speed, and foot speed, and these changes are not statistically significant in the control group [33]. The variables of muscular endurance of the trunk flexors, trunk extensors, lateral trunk flexors, and anaerobic speed and power have been demonstrated to be significantly associated. It refers to the ability to control the trunk in response to internal forces and external disturbances. These forces include forces generated from distal parts of the body as well as expected and unexpected disturbances. Some muscles contract before the agonist muscles of the limb to make up for the disruption effect on the stature when reaction forces brought on by limb movement challenge the stability of the torso. Because several central stabilizing muscles, including the transversus abdominis, multiceps, rectus abdominis, and abdominal obliques, are permanently contracted before lower limb movements, the weakness of these muscles may cause a delay in the activation of the muscles of the upper and lower limbs.[34] The findings above support that motor control and stability develop in a proximal-to-distal pattern. Hence, the possibility for adequate muscle activation patterns in response to joint load may be diminished by an asymmetry in proximal muscle activation and decreased activation of trunk and thigh muscle structures. It has been demonstrated that proximal muscle exhaustion affects stature control more than distal muscle fatigue. One likely reason is that proximal muscles, like the muscles in the thighs, cross the body at more points and have a bigger cross-sectional area than distal muscles, like the muscles in the ankles.

Conclusions

Research found that AeroFencing Training could significantly affect anaerobic power and speed and power of the dominant and non-dominant sides. The present training protocol, offered for the first time in the world by the first researcher of this article, can improve the required factors and overall development in these athletes and can be used as a complementary exercise along with specialized fencing exercises used in the training centers. the researcher hopes that presenting this type of warmup will assist in having symmetrical muscles and fewer injuries in the long term. Coaches can use all kinds of exercise in different routines

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