

# Designing an electronic vest to evaluate movement abilities in foil fencers

Ishraq Ghaleb Oudah<sup>1</sup>, Reza Rajabi<sup>2</sup>

<sup>1</sup> Faculty of Physical Education and Sport Sciences, University of Baghdad, Iraq.

<sup>2</sup> Faculty of Physical Education and Sport Science, Tehran University, Islamic Republic of Iran

\* Correspondence: Ishraq Ghaleb Oudah; [ghalebio@gmail.com](mailto:ghalebio@gmail.com)

## ABSTRACT

Fencing sport coaches seek fencers who have high velocity and work hard to develop it through training. The research problem lies on when measuring movement abilities through some tests. Manual measurement does not give reasonable impartiality of timing because there is a time-frame between the movement of the fencer and the speed of the movement of the human time setter. Therefore, the authors sought to design an electronic vest to evaluate movement abilities in foil fencers. The study design was experimental, with 12 Iranian foil fencers of the national team, who were divided into two equal groups of 6 fencers. Moreover, there were 12 students from Physical Education and Sport Sciences that worked on the scientific foundations to design the electronic vest. After conducting 4 exploration tests, the electronic vest proved its efficacy to evaluate movement abilities in foil fencers. In conclusion, the electronic vest designed in this study has high quality and accuracy to evaluate movement abilities in foil fencers.

## KEYWORDS

Electronic vest; Movement abilities; Foil fencers

## 1. INTRODUCTION

Scientific studies try to find innovate new methods and ways of learning and training, using many equipment and innovative learning and training means in order to develop and treat the problems in sport fields trough scientific research (Abd Aljaleel & Malih, 2022). Modern theories in physical education and sport sciences are used to develop everything linked to the process of learning and training of skills in all sport games (Al-khoury et al., 2022). Fencing sport is one of the games which has an increased interest on due to innovate and manufacturing learning and training tools and

equipment which helps the fencer to mastering and developing skills and performance accuracy through acquiring physical, skillful and kinetics abilities (Marib, 2017). In fencing sport, the correct skillful performance of fencing fencers is linked to the speed in motor performance, emotions and fencer responses through competitions (Fatimah & Thafir, 2015).

Therefore, to train any skill in fencing requires formation of quick movement abilities, so many exercises should be conducted according to different formations by using a variety of equipment to develop the movement abilities of fencers, who have a certain target for once or many times in the shortest possible time or maximum number of duplicates and for a short and specific period of time (Abass et al., 2022). These are what the trainer needs while using miscellaneous forms of motor skills in fencing sport. From here came the importance of this research design of an electronic vest to measure and develop movement abilities in foil fencers (Hussein & Salih, 2022).

Fencing sport coaches seek fencers who have high velocity and work hard to develop it through training. The research problem lies on when measuring movement abilities through some tests. Manual measurement does not give reasonable impartiality of timing because there is a time-frame between the movement of the fencer and the speed of the movement of the human time setter.

Therefore, the authors sought to design an electronic vest to evaluate movement abilities in foil fencers, which are the basic parameters to avoid the competitor's touches and gaining a touch in the shortest time on the competitor's target (Abou El Fotouh, 2018). The hypothesis of the research was that the electronic vest would be suitable to evaluate movement abilities in foil fencers.

## **2. METHODS**

### **2.1. Participants and design**

The study design was experimental, with 12 Iranian foil fencers of the national team, who were divided into two equal groups of 6 fencers. Moreover, there were 12 students of Physical Education and Sport Sciences from Tehran University that worked on the scientific foundations to design the electronic vest.

### **2.2. Steps of vest design**

Before designing the vest, the authors had discussed the idea with members of the Scientific Commission and some of the experts in the sport fields and training in order to get their scientific notes about the scientific benefits of designing and manufacturing the vest. To be sure about the truthiness of the idea and manufacturing the vest, the authors had designed the first sample of the vest by computer using 3DAMX program, which is a developed simulation program continuing of most

of tools which converts the nature into three dimensional pictures and used by most of references and designs. After that the method was decided to manufacture the vest in its final shape. According to the experimental tests the vest was made on a fixed dummy for the first time to state the suitability of the used tools materials and quality of installation. Also to determine the measurements of the proposed device (the electronic vest) the authors had designed the vest according to the official certified measurement by the International Fencing Federation and after collecting all basic materials the vest was made in its final form.

### **2.3. Components of the electronic vest**

The electronic vest consists of these parts: 1) An official electrical foil vest: the vest has been modified from inside to sensors, electrical circuit, and a battery installed safely and scientifically. 2) A transmitter device for the coach: it is a small device carried by hand consists of a small screen with three buttons. The first button is for alarm or direction its job to give a signal to the vest to light up a light after pressing by the coach. The second button is a reset button to reset the device when it is needed. The third button is the delete button which deletes all the trials appearing on the terminal. 3) A receiver device: Carried by the attacker in a small bag prepared for this reason and linked to the belt of the fencer. This device is connected directly to the electrical weapon which is hold by the attacker. 4) Signals transmitter and transceiver device: this device carried by the defender fencer in a small bag designed for this purpose connected to the designed electronic vest which the defender wears. 5) Electronic sensors and lights: the vest consists of internal electronic sensors connected with four special gelatin bulbs in variant colors (Red-Green-Yellow-Blue) installed on key areas (Area 6, Area 4, Area 8 and Area 7). The connection among these devices is non-wired (without Wi-Fi, Bluetooth or Wireless) rather the connection is made by special electronic system, which is used by some airplanes and could receive and transmit a signal within 1 km range. 6) Electrical control panel: it is an electrical circuit powered by a small dry battery which put inside the vest that consists of an internal system works sequentially to make the gelatin bulbs lights up in special and random format after receiving the signal from the coach device. 7) Metal connection cord: it is a cord that transmits data to the terminal of the coach device and then to a computer in order to save and use later.

### **2.4. The way of working of the electronic vest**

After preparing the fencers (the attacker and the defender) the coach carries his/her device to give the signal to start the work and each fencer carries his/her device. The coach presses the button

to send a signal and straight away on of the lamps on the electronic vest starts to light up to thrill the attacker fencer to extend his/her arm at full speed to touch the light and record a touch. The time here calculated since the thrill light appears until the weapon touches to the turn off the lamp directly. The attempt appears on the coach device with its number (time in seconds), so the power of the strike was (500 gram) it appears on the screen and if it's less than (500 gram) it doesn't appear on the coach screen. Knowing that turning on or how to run the gelatin lamps is works randomly not on appointment, it perhaps opens as a circle, with the counterclockwise or against counterclockwise and so on, to test the tempo of motor feedback.

Rather, the rapport tests start since the coach presses on to the thrill or signal button. One of the lights light up randomly for example: if the Red light turns on the attacker fencer starts to guidance his weapon towards the light next to it which is the Green light so he rolls his arm on the same drawn tracks on the surface of designed suit to move on to passes the arm of the defender fencer to reach quickly the intended light (Red) then he touches it and the light turns off. The touch recorded and also appears on the coach device screen with its number (time in seconds). Knowing that the drawn tracks on the suit in this test was to improve the motor rapport for the attacker so it was drawn opposite the intended area and this means circular paths in Green was drawn on red light and vice versa too for other lamps for example circular paths in Yellow was drawn on Blue light and vice versa.

## **2.5. Scientific benefits of manufacturing the electronic vest**

The main benefit is the possibility of measuring two abilities in one device at the same time (the tempo of motor feedback and motor rapport) in fencing sport scientifically, accurately and objectively which ensures saving in time, money and effort. Also, to train and develop two abilities in one device at the same time (the tempo of motor feedback and motor rapport) in fencing sport with a vest easy to worn, not heavy, and safe. It gives high excitation and stimulation when it is used for measurement and training, stimulating the fencer to touch at maximum tempo and correctly with a not fixed target as in the real competitions. It also guides the armed arm in a consistent and orderly manner with time control. It gives feedback about the performance to the coach and the fencer at the same time, and it provides the fencer with the course of the movement. It is easy to manufacture and has low cost. Furthermore, it is easy to store and carry in daily use for training, and can store the data for each fencer on the computer or USB and be used it statistically any time to know the level of fencers' development.

## **2.6. Exploration tests**

The following four exploration tests were conducted:

The First Exploration Test: this test was conducted to be ensured about the efficiency of approved materials used in manufacturing the electronic vest, which are electrical cords, the lamps, sensors, stopwatch and the start button, which they have been installed on the electrical foil weapon vest and then installed on a timber dummy to illustrate the efficiency of raw materials for manufacturing. This test showed:

1. The lamps should be of gelatin type with different colors and high sensitivity towards vibrations and touches.
2. Reducing the number of using cords to reduce the weight on the electrical vest.
3. Looking for the best location on the vest to install the sensors away from the touching target area.

The Second Exploration Test: after searching on the internet about the factories who manufacture the gelatin lamps, it was imported from the Canadian Electronic Industries Company, and then connected to the vest. This test showed:

1. The gelatin lamps approved its efficiency for the manufactured work.
2. A stopwatch connected with stimulates lights in order to measure the feedback time and coordination work between the arms and eyes.

The Third Exploration Test: it was confirmed of the harmonic action programming between the eye and arm by putting progressive and multiple color lighting once on the right and once on the left, in which the movement of the wrist relies on while defending and change the attack movement of the armed arm. This test showed:

1. The efficiency of electronic and electrical programming of the light signals used in tempo feedback and motor rapport.
2. The device (the electronic vest) has approved its soundness to measure the tempo of motor feedback and motor rapport of fencing fencers.

The Fourth Exploration Test: the purpose of this test was to conduct the scientific foundation of the electronic vest:

1. Content Validation: After designing and manufacturing the electronic suit the ratification was done through presenting it to a group of experts and specialists on tests and measurement fields in fencing sport, and they confirmed its validity to measure rapport and the tempo of motor feedback for upper limbs in fencing, with a 100% ratio of agreement.
2. Discriminatory Power: It is the ability of the electronic vest to distinguish individuals with high rapport and feedback tempo from individuals with low rapport and feedback tempo. A total of 30 students from the Physical Education Faculty at Tehran University were tested randomly in fencing lesson. After collecting the results and organize them in descending order from the highest to the lowest degree, 27% of the highest degree in rapport and tempo of motor feedback and 27% of the lowest degree were chosen, thus, the number of each group was 8 students, so 16 students in total were subjected to analysis. The T-test was used to separate samples to find out the differences between the average of upper and lower of the two groups in the rapport and tempo of motor feedback. The calculated value of the T-test according the individual mistake was counted to distinguish the test, by comparing the level of significance as 0.05, and turned out that the two test of rapport and feedback tempo were distinctive. The level of mistake was lower than level of significance (0.05), as shown on Table 1.

**Table 1.** Discriminatory power for motor rapport and tempo of motor feedback of the electronic vest

Tests	SD	T Value	Mistake Level	Sig.
Tempo of motor feedback	0.11 0.27	11	Influence	+
Motor rapport	0.2 0.6	7	Influence	+

## 2.7. Stability

The tempo of motor feedback and motor rapport was evaluated in 12 fencers from the Iranian National Team and the test was conducted again after 7 days. After calculating the stability coefficient between the two tests, it is showed that the stability coefficient value is too high, which means the manufactured vest has high resolution, objectivity and quality to measure the rapport and tempo of motor feedback for upper limbs in fencing (Table 2).

**Table 2.** Stability of the electronic vest for tempo of motor feedback and motor rapport

Tests	Correlation (R)	Mistake Level	Sig.
Tempo of motor feedback	0.95	Influence	+
Motor rapport	0.93	Influence	+

## 2.8. Objectivity

It means that the arbitrators do not differ in estimation of something, since the method of recording results of motor rapport and motor feedback is self-executed by the device relying on the movement of the tester on the electronic vest. Therefore, the timing starts from the beginning of the fencer movement and finishes at the end of his/her movement, and there are no subjective factors affecting the method of recording. This means that the two tests that are conducted on the electronic vest have a high objectivity, and this has been proven by experts on the suitability of the designed suit to measure the motor rapport and the motor feedback for upper limbs.

## 2.9. The Main Experiment

*Preliminary tests:* The authors conducted the preliminary tests onto the two samples of the research, the control and experimental groups, to test the tempo of motor feedback and motor rapport and taking in account the tight control of the tests as much as possible. The research samples were found to be homogeneous and equal for the purpose of starting from one point. Table 3 explains this.

**Table 3.** Relationship between the two research groups in preliminary test for the purpose of homogeneity and equivalence

Variables	Dimensions	Mean	SD	Sig.	T-test
Tempo of motor feedback	Experimental	4.45	0.1	0.68	0.237
	Control	4.46	0.1		
Motor rapport	Experimental	5.20	0.2	0.74	0.488
	Control	5.25	0.2		

*Exercises using the electronic vest:* The authors prepared exercises conducted by the experimental group to improve the rapport and tempo of motor feedback through its implementation on the electronic suit worn by one of the fencers, while the control group conducted the regular exercises followed by the team coach without the electronic vest. It took 8 weeks to implement the exercises by 3 training units per week and each unit about 90 minutes. The main exercise time wearing the electronic suit was ranged between 20-25 minutes. The high frequency training method

was used, as it was the time of performance from 10-15 seconds for each exercise, and the number of repetitions from 5 to 10, with resting time between repetitions (Yahya, 2002).

*Subsequent tests:* The authors conducted the subsequent tests onto the two research samples, experimental and control groups, in tempo of motor feedback and motor rapport, considering the time and place conditions that were used on the preliminary tests.

### 3. RESULTS

The Table 4 explains that there are significant differences between the values of arithmetic means and standard deviations for the preliminary and subsequent tests for both experimental and control groups in tempo of motor feedback and motor rapport test for foil weapons. The error level values for all the tests were less than the level of significance 0.05. This means that both research samples, the experimental and control groups, developed in tempo response and motor rapport for foil weapons as a result of regular and continuous training. The authors believe that regular, continuous and modified training has a positive impact on the level of motor performance and motor skills, and this is what the two groups achieved. In general, the electronic vest exercises and training curriculum “are a set of physical and motor situations and movements that aim at different physical and motor abilities to reach the individual to the highest possible level of skill, motor and functional performance in the sport of fencing, based on the educational and scientific foundations and the correct motor paths of movement art” (Selim, 2021). It can provide the individual who exercises an important amount of motor, physical and skill abilities to meet the requirements of athletic performance.

**Table 4.** Statistical milestones between the preliminary and subsequent tests for research groups

Tests		Mean	SD	Mean	T-test	Sig.	
Experimental	Tempo of motor feedback	Preliminary	4.4	0.10	1.7	19.85	0.000
		Subsequent	2.8	0.18			
	Motor rapport	Preliminary	5.2	0.16	2.13	43.14	0.000
		Subsequent	3.1	0.08			
Control	Tempo of motor feedback	Preliminary	4.5	0.13	0.98	10.39	0.000
		Subsequent	3.48	0.14			
	Motor rapport	Preliminary	5.25	0.18	1.18	9.9	0.000
		Subsequent	4.06	0.13			



It turns out from Table 5 that there are significant differences between the experimental and control groups in the values of the computational averages and in the values of the standard deviations in tempo feedback and motor rapport test for foil weapon. The error level values were less than the significance level, which is 0.05, and this means that the experimental group sample developed in tempo feedback and motor rapport in foil weapon better than the control group because of the use of the electronic vest in training.

**Table 5.** Statistical Parameters

<b>Tests</b>	<b>Groups</b>	<b>Mean</b>	<b>SD</b>	<b>T-Test</b>	<b>Sig.</b>
Tempo of motor feedback	Experimental	2.6	0.19	7.5	0.000
	Control	3.5	0.15		
Motor rapport	Experimental	3.1	0.09	15.3	0.000
	control	4.1	0.12		

The movement of fencing sport requires a high tempo and expects to respond from the defender to the attacker's movement in as little time as possible. Also, it requires high reflection and analysis of the attacker's movements, attacking and then responding. It is necessary to identify the precise motor path within the central nervous system, which is reflected positively on the ability to harmonize and streamline performance and the implementation of new motor duties in the best and least time (Kadhim & Malih, 2022).

The exercises carried out on the electronic vest have promoted the improvement of neuromuscular compatibility, which leads to the improvement of the components of some of the various motor elements such as tempo feedback, reaction, excellence, and compatibility (Liemohn, 1990). The authors refer the development of the experimental group better than the control group to the effectiveness of the implemented exercises on the electronic vest, which the authors prepared and implemented on the experimental group, because its similar in composition to the basic movements and at similar tempos or approximate to the direction and tempo skills of the sport of fencing, and therefore, it improved the tempo of response and motor rapport within the experimental sample.

#### 4. CONCLUSION

In conclusion, the electronic vest designed in this study has high quality and accuracy to evaluate movement abilities in foil fencers. It works in two different ways, the first is to measure the

tempo of motor feedback for upper limbs and the second is to measure the motor rapport. It is a mean of measurement and also useful for training to develop the abilities at the same time. The electronic vest influenced positively in developing the tempo of motor feedback and motor rapport when it was used by foil weapon fencers. The method of manufacturing is easy, not expensive, and quick, with available materials at local markets with high quality. It is also easy to carry and move from one place to another. Moreover, it is easy to use and provide security and safety to its users, and it stimulates excitement during its use. Therefore, the authors highly recommend the use of this electronic vest.

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The authors declare no conflict of interest.

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