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## Aspects of body balance characteristics of novice fencers

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### Abstract

The subject of balance in fencing does not benefit from vast research, due to complexity of the movements that are involved. The aims of our paper were to evaluate the static balance in 11-13 years old fencers and to find out if physical fitness or anthropometric variables can be correlated with postural balance. Our study comprised 13 healthy subjects; they were tested for balance on standing position and fencing position, with eyes both closed and open, and for physical fitness characteristics on agility, flexibility and strength. The data were statistically analyzed using the paired samples t-test and Pearson correlation in the SPSS version 20.0 for Windows. The differences were considered significant if the p value was below 0.05. The comparison of the results indicated a better stability with open eyes and statistical difference between keeping the eyes open and closed in the mediolateral movement of the centre of pressure. Correlation analysis showed that anthropometric variables, such as weight and body mass index, influence balance as speed, leg strength and abdominal strength. These relationships may influence the training program in order to develop the body balance at this level.

Keywords: Balance; movement; coordination; athletes.

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## 1. Introduction

The analysis of posture and movement in general has allowed a better understanding of the physiology of posture and movement in athletes by establishing a connection between motor learning and training. Previous studies indicate that balance is one of the basic physical qualities of the athlete's execution of any sports movement, and if the athlete is to lose his balance abilities, he consequently loses his accuracy of performing the skill (Fong & Fong, 2012; Zemkova, 2011).

Literature reviews show that are some sports that requiring fine postural control such as: gymnastics (Boso & Golias, 2012; Shigaki et al., 2013; Vuillerme, 2001), dance (Hatzitaki et al., 2002; Schmit, Regis & Riley, 2005) judo (Paillard et al., 2002; Perrin et al., 2002), fencing and shooting (Zemkova, 2011; Herpin et al, 2010), soccer (Jakobsen et al., 2011, Paillard et al., 2006), ice skating (Alpini et al., 2008), tai chi (Fong & Ng, 2006), and other sports (Schmit, Regis & Riley, 2005). Most of these studies were based on a kinetic analysis of the pressure exerted on different surfaces such as normal surface or foam surface, with sway support or reduced support on one or both legs, in different conditions, such as with eyes open and eyes closed.

Fencing is characterized by asymmetric and unnatural movements to be performed with great speed and precision, within a limited space and time frame. The asymmetric specific patterns of the lower extremities in unilateral sports like fencing are characterized by the continuous, repeated and intensive extension movements, which require excessive muscular force, speed and neural-muscular coordination (Tsolakis & Tsiganos, 2008). Fencing requires intense visual monitoring and high-speed motor skills, while retaining efficient balance control (Herpin et al., 2010). In order to educate the sense of balance and orientation of body movements through space, we need to take into account the entire complex of proprioceptive and exteroceptive sensations, as well as the internal mechanisms which command, control and execute the movement (Cronin, McNoir & Marshall, 2003).

Dedicated literature unfortunately still has many unanswered questions on this subject, including whether anthropometric characteristics interfere with postural balance in novice fencers, or whether there is any relationship between motor skills and postural balance. No studies were found regarding the connection between balance and anthropometric and physical fitness characteristics of fencers of different ages, or comparisons with other athletes in the age group 11-13 years old.

The purposes of present study were: 1) to evaluate the oscillations of center of pressure in medial-lateral and anterior-posterior direction, as frequencies of the oscillations, in both direction, with and without visual control performed with Global Postural System 400 stabilometric platform in 11-13 year-old fencers; 2) to find out if physical fitness characteristics or anthropometric variables are correlated with postural balance in novice fencer players in standing and guard position with the eyes open or closed. The results would allow coaches to design training programs able to increase equilibrium and specific adaptations required by fencing.

## 2. Material and Method

### 2.1. Subjects

A number of 13 healthy fencers (mean±SD age, 12.00±0.81 years) participated to this study. The study included five boys and eight girls. The anthropometric characteristics measured were height (1.58±0.07 cm), weight (46.82±8.16 kg) and BMI (18.57±2.53). The subjects were involved in at least 3 weekly training sessions, of about 1 hour and 30 minutes each. They have been practicing this sport for one to three years already, and each of them competed at least once in the national championships. As additional notices, we would like to state that we obtained the consent form from the subjects' parents

and that the study was approved by the Ethic Commission within the Faculty of Physical Education and Sport under the number 04/17.07.2016.

## **2.2. Procedures**

### **2.2.1. Balance Tests**

The balance test was carried out using the Global Postural System (GPS) 400 stabilometric platform. The stabilometric platform, based on software version GPS 5.0 is able to find and analyze an individual's balance and to find out the oscillations and frequencies of the center of pressure (CoP). The following parameters were recorded to measure the balance of the subjects with their eyes open and closed: the oscillation of CoP in medial-lateral (ML) and anterior-posterior (AP) direction (measured in units) and ML and AP frequency (F) of oscillations in ML and AP direction (measured in Hz). The balance was measured, on two situations (with eyes open and eyes closed) on the fixed support surface, as:

*Standing position.* During this test, the subject was asked to maintain the orthostatic posture with palms facing the body and legs straight, with eyes open.

*Fencing position* ("en garde" position – preparatory for a match). The subject adopted the basic sabre fencing position by placing the dominant foot 30 cm behind the non-dominant one, with the handle near the upper part of the abdomen and the head rotation near to 90°.

For both positions, the subjects were asked to hold the position as still as possible, but not less than 30 seconds. If the subjects maintained position less than 30 seconds, they could take the test again (but no more than 3 attempts overall) and the best result was recorded by the computer.

*Sit up Test:* from lying position with the knee bent, feet flat on the floor (held by a partner) and the arms folded across the chest. The subjects were asked to lift the upper body to a 90 degree position and then return to lying on the floor. We assessed abdominal strength (AS) and recorded the number of sits up in 30 seconds (numbers).

### **2.2.2. Physical fitness test**

A set of four physical fitness tests were measured to assess the level of speed and agility, flexibility, leg strength and abdominal strength. The measurements were made in accordance with literature (MacKenzie, 2001; Turner et al., 2013), as follows:

*2-4-2 Shuttle Run Test* to assess agility. Subjects began the test in the fencing position with the leading foot placed on the start line. They were asked to move forward and back each time 2m, 4m and 2 m with fencing footwork. Athletes performed three trials with three minutes break between them and the best result was recorded (seconds).

*The Sit and Reach Test* was used to evaluate the lower back and hamstring flexibility. The starting position of the subjects was: sitting on the floor without shoes, with feet flat against the box and legs straight. They reached forward and pushed the fingers along the table as far as possible. The score was the distance between finger tips and to the edge of the table (centimeters).

*Standing Long Jump Test.* The objective of this test was to investigate the development of the elastic leg strength (SLJ). The test was performed from standing position behind a line and jumping horizontally as far as possible, taking momentum by swinging arms forward (meters).

## **2.3. Analysis**

The data were stored and statistically analyzed using the SPSS version 20.0 software for Windows (IBM, Chicago, USA).

## **3. Results**

The comparisons between the positions in our two different situations showed: (1) for standing position (Table 1), a significant difference for oscillation of CoP-ML direction ( $p=0.004$ ); and (2) for

fencing position (Table 2), some differences between the means were registered, but not enough to be statistically significant.

**Table 1. Variables of balance in standing position**

Parameters	X±SD (OE)	X±SD (CE)	p-values
CoP-ML	4.68±6.49	14.50±10.11	.004*
CoP-AP	3.33±21.98	7.84±14.63	.314
F-ML	0.26±0.14	0.34±0.17	.254
F-AP	0.19±0.05	0.27±0.14	.122

\*p<.005 (OE=open eyes; CE=closed eyes)

**Table 2. Variables of balance in fencing position**

Parameters	X±SD (OE)	X±SD (CE)	p-values
CoP-ML	4.68±6.49	14.50±10.11	.004*
CoP-AP	3.33±21.98	7.84±14.63	.314
F-ML	0.26±0.14	0.34±0.17	.254
F-AP	0.19±0.05	0.27±0.14	.122

\*p<.005 (OE=open eyes; CE=closed eyes)

The correlation analysis between the variables of standing balance with eyes closed and the anthropometric and physical fitness characteristics is described in Table 3.

**Table 3. Standing position with eyes open - correlation**

Variables	CoP-ML	CoP-AP	F-ML	F-AP
Weight	-.042	.317	.417	-.264
Height	.105	.109	.366	.272
BMI	-.120	-.305	.279	-.497
2-4-2 SRT	-.253	-.729*	-.262	.245
SLJ	.325	.402	.231	-.048
Sit and Reach	.325	.039	.101	.552
Sit-up	-.150	.659*	.062	-.393

\*Correlation is significant at the 0.05 level

Only two variables from the physical fitness type that could be correlated with one of the balance variables, respectively CoP-ML. In the case of fencing position (Table 4), there was a high correlation between height and CoP-ML, and between weight and BMI with CoP-AP.

In the situation of closed eyes, variables of balance, in standing position, were correlated with weight, BMI and abdominal strength (Table 5).

**Table 4. Standing position with eyes closed - correlation**

Variables	CoP-ML	CoP-AP	F-ML	F-AP
Weight	.266	.755*	-.163	-.249
Height	.077*	.144	.299	.196
BMI	.185	.843*	.007	-.409
2-4-2 SRT	.292	-.199	-.057	-.034
SLJ	-.356	.308	-.122	.004
Sit and Reach	-.051	.268	-.005	-.065
Sit-up	-.372	.254	-.049	-.266

\*Correlation is significant at the 0.05 level

**Table 5. Fencing position with eyes open - correlation**

Parameters	CoP-ML	CoP-AP	F-ML	F-AP
Weight	.642*	.640*	-.064	.691
Height	.321	.118	.084	.373
BMI	.617*	.369	-.085	.606*
2-4-2 SRT	-.053	-.272	.608	-.155
SLJ	-.016	-.024	-.341	-.011
Sit and Reach	.319	.121	.281	.093
Sit-up	-.123	-.019	-.698*	.371

\*Correlation is significant at the 0.05 level

In the fencing position with eyes closed, none of the anthropometric variables were correlated with the balance variables (Table 6). From physical fitness variables, only the abdominal strength was correlated with one of the balance variables, respectively position of CoP-ML.

#### 4. Discussion

This study has shown that the postural response depended on the motor experience. The motor experience was reflected by the fencing position tests: no statistically significant differences were found between the open eyes and closed eyes tests in oscillations and frequencies of CoP, as a positive effect of the fencing training program. Previous studies have shown that physical activities are involved in the development of proprioception in teenagers (Abernethy & Bleakley, 2007; Rota et al., 2010). The best stage for the development of the equilibrium ability, in order to reach a balanced position, is considered to be at 10-12 years old and should be included as part of athletic training. In fencing, vision is not the primary information source for equilibrium control, but it is essential for specific fencing actions (Fong & Ng, 2006). The research of Cavanagh and Alvarez (2005) suggests that the extensive training increases visual attention abilities. Hatzitaki et al. (2002) pinpoint that 11 to 14 year old children are capable of applying strategies for maintaining balance in static and dynamic conditions, and Elfateh (2016) suggests that balance correlates with motor skills in fencing basics.

If the subjects had their eyes open, the oscillations of CoP-ML were relatively similar to the AP ones in the standing position (Table 1). When the eyes were closed, the oscillations double their values (CoP-ML=14.5 compared to the average value of CoP-AP=7.84). The difference is much more important in the fencing position (Table 2): CoP-ML it is double if the eyes are open, and four times more left-right oscillations are noted when the eyes are closed – this is because the fencing position is a more recently acquired posture (from the point of view of muscular education), which means that at the moment the muscles aren't yet fully educated to assume this position. The guard position in fencing increases muscular tone and generates high stress on the somatic-kinesthetic receptors to maintain balance (Herpin et al, 2010). As was expected, the oscillations of the CoP-AP are not very different, whether having the eyes open or closed: these are the normal oscillations of the body, explained by the fact that the muscles are constantly involved in maintaining our orthostatic. The AP oscillations are characteristic of walking, running, jumping, or any other movements that humans make. As the subject grows older, the ML oscillations reduce their amplitude as equilibrium and the capacity for muscular coordination become more developed.

An interesting find that was obtained from data analysis: the CoP-AP oscillations have been more obvious in girls than in boys, especially in the fencing position with eyes closed, which can also be connected to a lower degree of safety or self-confidence – this aspect will be further researched in a subsequent stage of the study. We did not observe correlations between the AP or ML oscillations and the weight of the analyzed athletes.

The analysis of Table 1 and Table 2 that shows the frequencies at which the body oscillates confirm the biomechanics reality: the F-ML oscillations is greater than that of the F-AP ones – the muscles of the iliopsoas and the back abdominal area have as their main function the realignment of the pelvic area from an anterior-posterior position. It should also be noted that in the fencing position, the values of

the F-ML and F-AP are very similar to each-other when the eyes are closed (0.41 and 0.39 respectively). If the eyes are open, the difference between the F-ML and F-AP in the fencing position is more significant: 0.31 (ML) versus 0.21 (AP) – a difference which could be explained by the intervention of the visual apparatus that helps to maintain the position. This leads us to note that it would be important, as a method of athletic training in fencing, to give special attention to balance exercises with closed eyes.

Anthropometric variables are directly related to equilibrium. Some studies have reported evaluation of different groups - such as athletes, adolescents or elderly people - with normal body mass or overweight, and have shown that when body mass increases, balance worsens (Prado, Stoffregen & Duarte, 2007; McGraw et al., 2008). With a normal-to-low BMI, but having a greater mean height at a mean age of 12 years old, our subjects obtained a high positive correlation of BMI with, CoP-AP oscillation (fencing position with eyes open) and CoP-ML oscillation (fencing position with eyes closed). There were no correlations between body height and static equilibrium. In the scientific literature regarding the influence of anthropometric variables' measurements on balance, there are different opinions about this topic. This lack of consensus impedes the use of such results in athletic practice, where each sport requires different anthropometric characteristics.

Identifying factors of physical fitness that influence balance can help to improve the training programs and specific exercises. The speed variable is very important in fencing during offensive and counter-offensive actions and has a crucial role in athletes' success (Cronin, McNoir & Marshall, 2003). There was a higher negative correlation with CoP-AP oscillation for the case of the standing position with eyes open. In the same position the abdominal strength (AS) was high positively correlated to CoP-AP (Table 3). However, in the situation of eyes closed the AS was negatively correlated with F-ML. Those findings were not consistent with other studies (Table 5). In the fencing position with eyes open does not exist any correlation between variables of balance and physical fitness characteristics (Table 4), but we could find a correlation between the AS and the CoP-ML in situation of eyes closed (Table 6).

Some limitations could be considered for our study: the number of subjects is too small to give a general characteristic for the general populations of novice fencers, and in the same time the study is not longitudinal, therefore it does not allow to find how athletic training influences the evolution of balance; our group was composed by girls and boys and could not find any statistical differences in balance at this age between the genders; regarding the experience in this sport (between one and three years) our attempt to find differences in postural balance and correlations between these lead to no statistical results.

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