International Journal of Applied Sports Sciences
2014, Vol. 26, No. 1, 11-17.

ISSN 2233-7946 (Online)
ISSN 1598-2939 (Print)
http://www.sports.re.kr/eng/05publication/Callforpaper.jsp

Comparison of Anthropometric and Functional Characteristics of Elite Male Iranian Fencers in Three Weapons

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Abstract

Purpose: Recognizing the characteristics of elite athletes has a valuable significance in any sport for two reasons: 1) It leads to a high-level performance; and 2) this recognition helps us to determine the weaknesses and strengths of athletes. The present study was designed to compare the anthropometric characteristics, aerobic and anaerobic capacities of elite male Iranian fencers in three different categories (epee, foil and sabre).

Materials and methods: For this purpose, 24 fencers of Iran national senior fencing team were chosen and their anthropometric characteristics, somatotype, grip power, aerobic and anaerobic capacity of leg and hand, were measured.

Results: Statistical analyses of data showed significant differences ($p<0.05$) between lean body mass, weight and efficient hand length (EHL) of sabre and foil fencers. In addition, significant differences ($p<0.05$) were found between EHL and the difference between the length of two opened arms and height of epee and foil fencers. The amount of these variables were higher in epee than foil fencers. Aerobic capacities of epee and foil fencers were higher than sabre ones ($p<0.05$). The dominant somatotype for three categories was endomorphic mesomorph.

Conclusion: Based on the physiological and some anthropometric differences among the three fencing categories found in the present study, it could be concluded that the training programs and athlete selection criteria should be different among the fencing categories.

Key words: Fencing, Anthropometric Characteristics, Aerobic Capacity, Anaerobic Capacity, Somatotype

Introduction

With the improvement of the scientific view on different kinds of sports, the investigation of all aspects of any sport seems essential, especially for distinguishing the points that can define sports characteristics. Fencing is one of the primary Olympic sports which has been in the games since the 1st modern Olympic event(1896, Athens)(Koutedakis et al., 1993) and based on its medal counts in competitions, it can be valuable for any country to participate in this event. It consists of three weapons with each having special rules and structures (Roi & Bianchedi, 2008), as well as many differences that often lead athletes to specializing in only one weapon. Part of this limitation is due to their rules and structural discrepancies, but the main difference lies in their physiological differences, which may

Submitted : 26 January 2014, revised : 17 May 2014,
accepted : 4 June 2014.
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hamper performance.

In epee category, the whole body is the target and strikes are made by the tip of the weapon with specified amount of force (> 7.36 N). In foil category, the acceptable target is the trunk and similar to epee strikes are made by the tip of the weapon but the amount of force needed for detecting the hit is >4.90 N. However, in sabre category, the valuable targets are the trunk, head, and upper arms, and both tip and blade hits are acceptable. Meanwhile, based on the action to rest ratio and heart rate of activity the physiological strain in foil and saber is higher than epee (Roi & Bianchedi, 2008).

Athletes in different sports need special types of requirements to succeed. The peak point of these requirements can be seen in elite athletes who need the highest level of adaptations and abilities for performing in the top level. The two main determinants for elite athletes' performances are genetic and environmental characteristics. Genetic characteristics are sometimes told to be responsible for more than 50 percent of the athletes' success (Smith, 2003). In addition, their abilities and adaptations are highly affected by training. Therefore, the complete analysis of elite athletes' abilities can provide information on both genetic and environmental characteristics and, according to the principle of adaptations (Hawley, 2009).

Fencing is one of the rare sports which can be both aerobic and anaerobic (Anna & Valery, 2006). Thus, the examination of both of these capacities seems necessary for designing the physical fitness of these athletes. In addition, because of the fact that they use weapons, the fencers' ability for taking a grip can affect their performance. Furthermore, the length of arm (absolute or relative) which is determined by the efficient length of the dominant hand (EHL) and the difference between opened arms' length and the athletes' height; is presumed to be valuable for the fencers' performance.

Previous studies have suggested the different roles of anthropometric characteristics in various sports (Alcaraz et al., 2012; Chaouachi et al., 2009; Katic et al., 2005) as well as fencing (Sterkowicz-Przybycieñ, 2009). Sterkowicz-Przybycieñ, (2009) investigated body composition and somatotype of elite polish fencers and revealed that sabre fencers' weight, fat free mass, BMI and fat free mass index were higher than two other categories (epee and foil). In addition, the dominant somatotype for saber (somatotype=3.4‐5.4‐1.8) and epee fencers (3.6‐4.9‐2.5) was the endomorphic mesomorph, while, for foil fencers (2.9‐4.2‐2.8) was balanced mesomorph.

Since physical and physiological characteristics of elite athletes play a major role in high quality performance and are the main determinants in winning the competition by athlete, the present study was designed to compare the anthropometrical characteristics, as well as aerobic and anaerobic capacities of Iranian male national senior fencing team members based on their weapons.

Materials and methods

Participants

Twenty-four national fencers (24.08±3.47 years) participated in this study (eight fencers in each weapon). The participants were invited to the national team for the Asian fencing championships (China & Shanghai, 2013). All subjects were the winners of at least two medals in previous Asian championships; in addition, all three groups were among the five best Asian teams.

All tests were performed for each participant in one day, and at the last training camp before Asian fencing championship. The same order of tests for all fencers was used as follow: Anthropometric characteristics, somatotype measurements, hand grip power, aerobic capacity, leg anaerobic power and hand anaerobic power. After each test the subjects were allowed to have a rest equal to 3 times of the test duration. All athletes were asked to not engage in any physical activity or training 48 hours prior to the test day. In addition, they consumed their breakfast 2 hours before the tests and all tests were performed at 09:00.

Anthropometry and body composition evaluation

Body composition analyzer (BIA X-Plus, Neomyth Medical- South Korea) was used to determine all body composition variables. Body height, sitting height, EHL and arm length was measured using Seca meter (Germany) to the nearest 0.1cm, their Subjects' body weight was measured with minimum clothes by using a balanced scale (Seca-Germany) to the nearest 0.1 kg.

Because of using the weapon in fencing, the phrase "efficient hand length" was used to describe for the part of hand that directly affects the distance of the fencers' body to his opponent, which means the length from the shoulder acromion process to the wrist of the dominant hand (styloid process) of fencers (Figure 1). The distance between wrist to finger tips has been deleted in this calculation because it is used for taking a grip, and therefore it does not affect the EHL.

Arm's length was measured from the tip of the longest finger of one hand to the tip of the same finger of other hand, while participants opened their arms horizontally as much as possible.

Somatotype evaluation

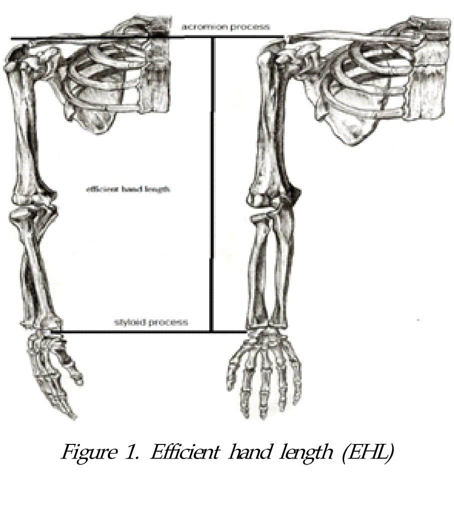

Figure 1. Efficient hand length (EHL)

Somatotype of all athletes was determined by using Heath-carter method (J. L. Carter & Heath, 1990) which is carried out by taking 10 measurements, consisted of: height, weight, two girths (arm flexed and tensed), four skinfold thicknesses (triceps, subscapular, supraspinale and medial calf) and bi-epicondyle breadth of humerus and femur (J. L. Carter & Heath, 1990). To take girths, the Seca scale (Germany) was utilized in defined positions, and Slim Guide (USA) was used for the evaluation of skinfolds and breadth. In addition, all measurements were performed accurately by researcher, and according to the guidelines in the heath-carter manual (J. Carter, 2002).

Hand grip power evaluation

Maximal isometric force was determined twice, by using a mechanical handgrip (Yagami, YDM-110D, 5-110kg) and the highest reading, was recorded as the participant's record. For the adequate provision for the fingers, prior to test the adjustable rod of dynamometer was adjusted according to the subjects' hand size. In addition, 3-minute rest was allowed between the tests. The test was performed when the subject's hand was in anatomical position, and without flexion in elbow joint. Because of the asymmetric nature of fencing (Margonato et al., 1994), this test was performed on the dominant hand of the subjects.

Aerobic capacity evaluation

Although all subjects were recreationally trained subjects, one familiarization session was designed. In this session, participants familiarized with the laboratory environment and the testing protocol. They also had the opportunity to practice walking and running on treadmill. Thereafter, they had 5-min rest and performed a VO_{2max} test without mask and measuring oxygen uptake. Continuous incremental treadmill test to the point of voluntary exhaustion was used for the evaluation of aerobic capacity. During the test, the computerized gas analyzer(cortex-Metalyzer 3B) and treadmill ergometer(Technogym-Italy) were used. After participants performed a 5-min warm up on a treadmill, and stretching on their own choice, a proper facemask was fitted on their faces prior to the commencement of the protocol. The test started at 6 km/h without any incline for 2 minutes; after this, for each 2 minutes, the speed increased by 2 km/h each 2 minutes until the speed reached 16 km/h. After this speed, the gradient increased by 2% every 2 minutes while the speed did not increase anymore. During the test, the heart rate was controlled continuously via heart rate monitoring system (PE3000, Polar Electro, Kemple, Finland). In addition, the participants' perceived exertion was determined continuously during the test by means of Borg's 6-20 category scale. The VO_{2max} was confirmed by following criteria:1) plateau in VO_2, 2) respiratory exchange ratio above 1.15, 3) heart rate reaching age predicted value and 4) rating of perceived exertion of 20(Ahmadizad & Bassami, 2010).

Anaerobic capacity evaluation

Anaerobic capacity of leg and foot muscles were determined by means of Wingate 30's anaerobic test (Ergomedic Monark 894 Eand 891E, Sweden). The load was setat 0.075 of participant body weight. Prior to the test, pedals height had been adjusted according to the participants' heights. In addition, participants performed a two-minute warm up on a cycle ergometer without load.

Statistical analysis

All statistical analyses were performed using SPSS software version 19. Between group comparisons were made using one way ANOVA, and in the case of the presence of significant difference, Bonferoni's post-hoc test was used. The data are presented as mean ± SD, and significance level was set at $p<0.05$.

Results

The data for all measured variables are presented in Table 1. Statistical analysis of the data showed, significant differences ($p<0.05$) between weight ($F_{2,\ 23}$

Table 1. Anthropometrical characteristics (Mean ± SD), aerobic and anaerobic capacities of athletes.

Variables	Epee (n=8)	Foil (n=8)	Sabre (n=8)	Overall (n=24)
Age (year)	23±3	24±4	24±3	24±4
Height (cm)	181± 6	178±5	183±7	181±6
Weight (kg)	78±8	71±4*	83±4*	78±8
Sitting height (cm)	93±5	94±2	97±3	95±4
Body mass index (kg/m^2)	24±2.0	22.5±1.8	25.1±2.0	23.9±2.1
Opened arms with height difference (cm)	9.0±4.6*	3.8±3.2*	5.6±3.7	6.1±4.3
Efficient hand length (cm)	59.0 ± 2.1#	56.6±1.7*#	59.1±1.6*	58.2±2.1
Body fat percent (percent)	19.4±3.6	16.9±4.2	19.9±1.6	18.7±4.7
Lean body mass (kg)	63.1±5.4	59.8±3.9*	66.7±4.3*	62.8±5.4
Skeletal muscle mass	28.38±3.83	26.5±5.24	30.88±2.75	28.54±4.20
Endomorph	3.18±0.88	3.45±0.82	3.83±0.98	3.45±0.91
Mesomorph	4.28±1.18	4.30±1.43	5.01±0.72	4.53±1.15
Ectomorph	2.25±0.98	2.78±1.03	2.14±1.01	2.39±1.00
VO2max(ml/kg.min)	50.9±3.9#	46.0±4.8*	41.5±3.3#*	47.0±5.3
Max leg anaerobic power (w/kg)	12.8±1.6	13.1±1.3	12.3±1.4	12.7±1.4
Mean leg anaerobic power (w/kg)	8.7±0.6	8.4±1.1	8.2±0.9	8.5±0.8
Hand grip power (N)	59.2±9.3	52.3±4.9	61.4±7.5	57.7±8.1
Triceps skinfold(mm)	10.97±4.80	11.37±3.13	11.03±2.71	11.12±3.44
Supraspinale skinfold(mm)	9.83±4.33	10.67±2.67	14.93±5.60	11.81±4.70

** and #significant difference sbetween groups.*

= 8.63, $p<0.01$), lean body mass (LBM) ($F_{2, 23} = 4.37$, $p<0.05$) and EHL ($F_{2, 23} = 4.74$, $p<0.05$) of foil and sabre fencers, in which sabre fencers had higher weight, LBM and EHL than foil fencers. In addition, the differences between the length of two opened arms and height ($F_{2, 23} = 3.72$, $p<0.05$) as well as EHL ($F_{2, 23} = 4.74$, $p<0.05$) were higher in epee fencers than foil fencers, while the difference between body mass index (BMI) of foil and sabre fencers was nearly significant ($F_{2, 23} = 3.3$, $p = 0.057$). Moreover, a significant difference was found between aerobic capacity (VO_{2max}) of epee and sabre ($F_{2, 23} = 14.74$, $p<0.001$), and between foil and sabre fencers ($F_{2, 23} = 14.74$, $p<0.01$), where both epees and foils had a greater aerobic capacity than sabre fencers. However, for other anthropometric characteristics, somatotype, and anaerobic capacity of fencers, the differences were non-significant ($p>0.05$).

In addition, the common somatotype profile among all groups of fencers was endomorphic mesomorph (mesomorphy is dominant and endomorphy is greater than ectomorphy), but this type of somatotype was more common among epee athletes (6 fencers against 4 in each sabre and foil). The other epee fencers were ectomorphic mesomorph (mesomorphy is dominant and ectomorphy is greater than endomorphy), whereas, in foil the 4 remaining fencers were balanced mesomorph (n = 2, mesomorphy is dominant and endomorphy and ectomorphy are equal) and ectomorphic mesomorph (n = 2). In sabre, the somatotype of the 4 remaining athletes were balanced mesomorph (n=1), mesomorph ectomorph (n=2, mesomorphy and ectomorphy are equal, and endomorphy is smaller) and mesomorph endomorph (n=1). Mean somatotypes of the three weapons are presented in Figure 2.

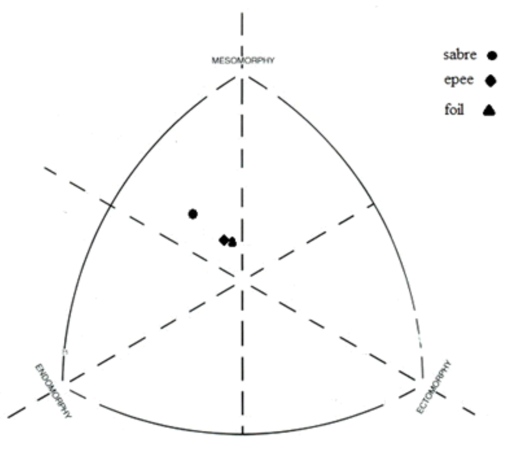

Figure 2. Mean somatotypes of the three weapons

Discussion

The main aim of this study was to compare and define the distinguishing points of elite fencers according to their fencing weapons. Most of previous studies have not categorized the fencers based on their weapon (Anna & Valery, 2006; Koutedakis et al., 1993; Tsolakis & Vagenas, 2010). Our results showed that among all fencers, sabre fencers had more EHL, body weight and lean body mass compared to foil fencers. Although the results for epee fencers compared to the other two groups was non-significant, the differences between foil and sabre fencer support those of Sterkowicz-Przybycieñ, (2009) who investigated the polish fencers. In general, the important fact is that sabre fencers have the most lean body mass and weight, and foil fencers have the least. This might be because of the delicate movements of foil fencers that impose a limitation on their muscle volume. In other words, sabre fencers need high speed and power and because of the direct relationship between muscle mass and power output, having a large muscle mass is an advantage in sabre fencers. Lack of significant differences for other variables in three groups, might be due to small number of subjects recruited in each group, which is the nature of such studies. However, power output is essential for all groups of fencers because it can impair their range of motion, which, in turn, might affect the performance of foil fencers.

In addition, compared with foil fencers, epee fencers had larger EHL and larger differences between two opened arms and height. This can be one of the most important characteristics for epee fencers, which is partly because of the non-priority rule in epee (Roi & Bianchedi, 2008). This advantage will help them contact their opponent faster while keeping their bodies at further distance from their rivals. Furthermore, foil fencers had the least differences between two opened arms and height and EHL among all groups of fencers, which might be attributed to their lowest playing distance. Usually during the match, they come closer to each other more than other fencers, thus they need more range of motion for their movements, which can be impaired by extra muscle mass.

In the present study, the typical somatotype was endomorphic mesomorph in all groups of fencers. The somatotype for epee and sabre fencers in the study by Sterkiwicz and Przybycieñ, (2009) on polish fencers were similar to ours, whereas, in foil fencers the balance mesomorph somatotype was the common type (Sterkowicz-Przybycieñ, 2009).

One of the findings of the present study was that both epee and foil fencers had higher aerobic capacity than sabre fencers, whereas, epee and foil fencers had similar aerobic capacity. In fact, this can be due to more aerobic nature of epee and foil weapons compared with sabre. This is supported by the findings of previous studies (Aquili et al., 2013; Lavoie et al., 1985; Roi & pittaluga, 1997) regarding the ratio of their actions to interruptions (activity to rest) (i.e. 1:1 for epee, 1:3.5 for foil, and 1:6.5 for sabre). The aerobic capacity for epee fencers, in the present study was close to Britain and Italian epee fencers (Iglesias & Cano, 1990; Koutedakis et al., 1993) but not to Swedish fencers, in which their aerobic capacity was much higher (Nyström et al., 1990). The latter finding might be attributed either to the training quality or to the differences in measurement method for aerobic capacity.

Lack of differences among other functional factors including anaerobic capacity and handgrip strength might be due to the similar concentration of fencers in three categories on these variables and their importance in all categories.

Conclusion

In general, the result of the present study showed valuable anthropometric and physiological as well as functional differences among three groups of fencers, which is an indicator of different requirements for achieving success in these categories. It seems that longer EHL can be a valuable factor in epee and sabre fencers. Nevertheless, as predicted, epee and foil fencers had more aerobic capacity than sabre ones, and this should be noted both in designing the training and choosing the athletes for competitions. Therefore, for having the highest level of performance, it is suggested that fencers design their training protocols based on the characteristics of their category.

References

Ahmadizad, S., & Bassami, M. (2010). Interaction effects of time of day and sub-maximal treadmill exercise on the main determinants of blood fluidity. *Clinical hemorheology and microcirculation,* **45**(2), 177-184.

Alcaraz, P. E., Abraldes, J. A., Ferragut, C., Vila, H., Rodríguez, N., & Argudo, F. M. (2012). Relationship between characteristics of water polo players and efficacy indices. *The Journal of Strength & Conditioning Research,* **26**(7), 1852-1857.

Anna, S., & Valery, S. (2006). Aerobic and Anaerobic Capacities of Different Age and Performance Female Fencers. *The official journal of the Polish Neuropsychological Society,* 12(2), 214.

Aquili, A., Tancredi, V., Triossi, T., De Sanctis, D., Padua, E., D'Arcangelo, G., & Melchiorri, G. (2013). Performance Analysis in Saber. *The Journal of Strength & Conditioning Research,* **27**(3), 624-630.

Carter, J. (2002). The heath-carter anthropometric somatotype-instruction manual. *San Diego, USA.*

Carter, J. L., & Heath, B. H. (1990). *Somatotyping: development and applications* (Vol. 5). Cambridge University Press.

Chaouachi, A., Brughelli, M., Levin, G., Boudhina, N. B., Cronin, J., & Chamari, K. (2009). Anthropometric, physiological and performance characteristics of elite team-handball players.

Journal of Sport Sciences, **27**(2), 151-157.

Hawley, J. A. (2009). Molecular responses to strength and endurance training: are they incompatible? *Applied Physiology Nutrition and Metabolism-Physiologie Applique Nutrition ET Metabolisme,* **34**(3), 355-361.

Iglesias, X., & Cano, D. (1990). El perfil de l'esgrimista a Catalunya. *Apunts: Educació Física i Esports,* 19, 45-54.

Katic, R., Blazevic, S., Krstulovic, S., & Mulic, R. (2005). Morphological structures of elite Karateka and their impact on technical and fighting efficiency. *Collegium antropologicum,* **29**(1), 79-84.

Koutedakis, Y., Ridgeon, A., Sharp, N., & Boreham, C. (1993). Seasonal variation of selected performance parameters in épée fencers. *British Journal of Sports Medicine,* **27**(3), 171-174.

Lavoie, J., Léger, L., Pitre, R., & Marini, J. (1985). Compétitions d'escrime. Épée. Analyse des durées et distances de déplacement. *Medicine du Sport,* **5**(59), 279-283.

Margonato, V., Roi, G., Cerizza, C., & Galdabino, G. (1994). Maximal isometric force and muscle cross sectional area of the forearm in fencers. *Journal of sports sciences,* **12**(6), 567-572.

Nyström, J., Lindwall, O., Ceci, R., Harmenberg, J., Swedenhag, J., & Ekblom, B. (1990). Physiological and morphological characteristics of world class fencers. *International journal of sports medicine,* **11**(02), 136-139.

Roi, G. S., & Bianchedi, D. (2008). The science of fencing: implications for performance and injury prevention. *Sports Medicine,* **38**(6), 465-481.

Roi, G. S., & pittaluga, I. (1997). time-motion analysis in womens sword fencing. *sport sciences,* **66**, 22-25.

Smith, D. J. (2003). A framework for understanding the training process leading to elite performance. *Sports Medicine,* **33**(15), 1103-1126.

Sterkowicz, K., & Przybycieñ. (2009). body composition and somatotype of elite of polish fencers. *Collegium antropologicum.* **33**(3), 765-772.

Tsolakis, C., & Vagenas, G. (2010). Anthropometric, physiological and performance characteristics of elite and sub-elite fencers. *Journal of Human Kinetics,* **23**(1), 89-95.