

Original Article

Anthropometric, physiological and performance aspects that differentiate male athletes from females and practical consequences

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Abstract

The article provides a concise analysis of the meaningful and comprehensive aspects of the incidence of gender differences in sport performance, in particular analyzes some aspects (physiological, quantitative and qualitative) that determine the performance of the sport and influence the organization of training in elite sports. The results of different scientific papers will allow to better understand and motivate more accurately the methodological choices and the procedural attentions, in the respect physical, physiological, technical, psychic and gender characteristics in the various sports activities. The objective of the study is theoretical argument for the part relating to the revision of the scientific literature of the theory of training and interpretative for the theoretical and documentary results.

Key Words: differences of gender, performance factors, motor skills, training, sport d'elitè.

Introduction

In elite sports, the differences in performance between men and women diminish more and more. The field of investigation of many research is to know the differences of strength in order to demonstrate the reasons for the different levels of sports performance, but there is not only this conditional capacity to affect performance but even others quantitative and qualitative (Tiziana et al, 2017, Raiola, D'Isanto 2016, Cirillo et al, 2016, Gaetano, 2012ab, Raiola 2011ab). Among the most robust examples of differences between men and women is the better throwing accuracy shown by men (Hall et al, 1995), together with a better spatial ability (Watson & Kimura, 1989); the throwing accuracy male advantage has been shown to be independent of different paper-and-pencil spatial tasks (Watson & Kimura, 1991). There is some evidence in which golfers are much more accurate than others in estimating distances on grass (Durgin et al, 2011). A study of spatial navigation differences in female athletes and non-athletes showed that the elite athletes, such as soccer, field hockey, and basketball, had faster walking times during the navigation of all obstructed environments by processing visuo-spatial information faster and navigating through complex, novel environments at greater speeds (Gérin-Lajoie et al, 2007).

Sex differences in physiology and anatomy can have some profound differences on the body's response to performance fatigability. Fatigability not only limits athletic performance and daily tasks in some populations but is also the foundation for neuromuscular adaptation needed for effective training and rehabilitation (Hunter, 2016). Among the main physiological differences affecting sports performance there are several aspects to consider. From the anthropometric point of view, the woman is definitely disadvantaged; their stature, in fact, is lower on average than that of men. Women have a greater sense of balance, while males gain a mechanical and structural advantage that allows them greater strength and speed. The body weight in women is on average lower than men, but what differentiates them is mostly the body composition (women's fat mass is 25%, while in men it is about 15%). The highest percentage of fat in women penalizes their sports performance, however, there is a discipline in which this characteristic is an advantage them, swimming over long distances. As far as muscle tissue is concerned, predominance is male; Referring to body mass, muscular tissue of men is in fact about 45%, while in women it is about 36%.

Differences of muscle strength are related to the greater development of muscle mass, which is favored in men from higher testosterone production, whose levels are clearly different between the sexes. Consequently, men benefit of this in all those disciplines that require considerable levels of strength, speed, and power. With training, woman's strength increases, but the gain obtain is lower than that of man. In adult women, the VO₂max value is on average less, is of about of 15-20% for trained athletes, while rising to 15-30% for untrained subjects. One reason of this difference, in relation to maximum oxygen consumption, is the highest concentration of hemoglobin (10-14% more) in men, because in men's circulatory system there is greater oxygen transport capacity and, consequently, has a greater aerobic capacity, to which the VO₂max value is related. At the level of the cardiovascular system, the main differences between men and women are related to the size of the cardiac chambers, the blood hemoglobin concentration and the volume of circulating blood; in women all these parameters are lower. This penalizes women especially in aerobic disciplines. Men have greater joint flexibility

than women in the shoulders and trunk areas, while female subjects, on the other hand, have greater flexibility in lower limbs, particularly with regard to abduction. This article aims to highlight gender differences, taking particular account of the various motor skills in the various sports disciplines and their influence on sporting workouts and performance.

Results

Starting in the 1980s, by analyzing male and female records, after an initial reduction in differences, a substantial stability is being achieved. This analysis, however, is not correct because it does not take into account doping (doping practices are more efficient in women than men, because increased of the power and diminution body fat are more easily achievable in women). There are numerous studies that compare the muscular performance of the two genres, most of these comparisons involve samples of untrained or otherwise trained subjects. In this article, attention will be focused on comparing the high performance performance of the two genres. A first particular analysis is represented by the comparison of the two genres in the racing disciplines, which have a huge variety in relation to the length and duration of the competition. This extensive field of investigation allows to study the contribution of the various metabolic areas.

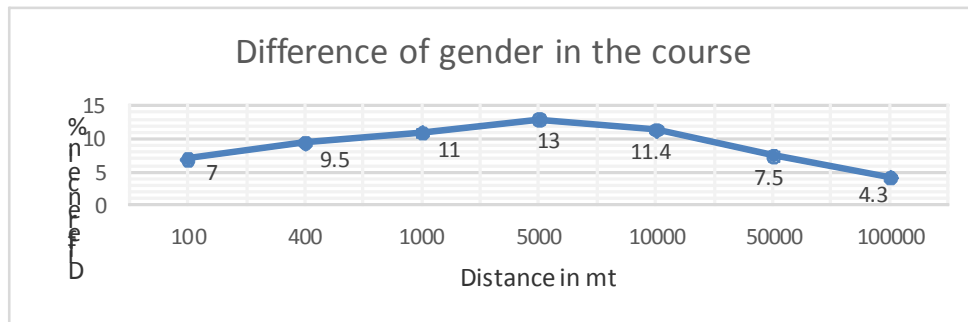


Fig. 1 – Gender differences and world records in racing disciplines, data obtained from the official IAAF website (2006).

Observing fig. 1 it can be deduced that the greatest difference between the sexes in the 5000 m is due to the great gender difference existing in the metabolic sources responsible for the transformation of energy. If we compare the differences between the sexes in the sports disciplines that depend on the explosive force, it can be established that there are almost identical conditions of performance. This is the case of the long jump, the jump up and the triple jump in the light athletics. This allows to compare performance differences between the two sexes in typical explosive exercises (light athletic jumps) fig. 2.

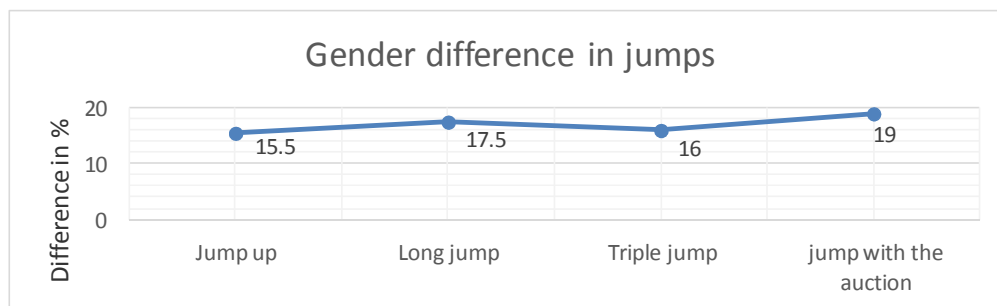


Fig. 2 – Gender differences and world records in jump disciplines, data from official IAAF websites (2006)

If gender differences are compared in the aforementioned disciplines, it can be seen that in those of explosive force and rapid force we find a superiority of men over much larger women than in the disciplines of maximum speed and resistance. It is evident that the distinct difference between the genres in high-performance sports is determined by specific physiological factors of each sex that determine the training program of athletes and athletes.

The advantages of men are based primarily on anthropometric factors and higher concentration of male sexual hormone, testosterone, which, thanks to its anabolic action, causes greater muscular hypertrophy. In relation to this, gender differences can be better understood and explained in terms of motor skills and sports performance. The coordinative aspects are often considered a sector in which women are at an advantage. This is a difference that is particularly accentuated in the age group ranging from eighteen to thirty (Tittel 1988). Several researchers have mentioned the best spatial orientation, the sense of rhythm, balance, and the best coordination in the endurance of athletes. The hypothesis that has been advanced is that sex hormones can affect motor skills (Bayer & Hausmann, 2012). In table 1 shows a summary of gender differences with regard to motor

skills and their causes.

Table 1. Gender differences in the field of the motor skills

Gender differences	Causes	Source
The maximum strength in trained women is 30-40% lower than men.	The greater muscular mass of the men than women.	Issurin, Sharobajko, 1985
Men have remarkable advantages, especially in explosive strength exercises.	FFT hypertrophy in men.	Drinkwater, 1988
As far as maximum speed is concerned, men and women get average and maximum similar values.	There is no difference between men and women for the phosphate reserves and for alactacid anaerobic metabolism.	Weber et al, 2006
The aerobic capacity of the trained women is 10-25% lower than men.	Women have a lower hemoglobin content and a lower systolic heart flow.	Drinkwater, 1988
Women present more articular mobility than men.	Women have a high elasticity of tendons, ligaments and connective tissue.	Kibler et al, 1989
Women's coordination skills, after the 18th year, are 10% better than men.	Women have better balance and spatial orientation in fine-motion tasks.	Tittel, 1988

There is no evidence, however, that the result of the processes of motor learning differs between men and women (Mittleman, Zacger 2000). Sex differences in physical prowess extend also at the psychomotor abilities, which abilities refer to skills that arise from brain-body coordination (D'Isanto, 2016, D'Isanto, Di Tore, 2016, Di Tore et al, 2016). These are generally classified into two categories: gross motor skills and fine motor skills. Gross motor skills refer to large movements using large muscle groups like running, jumping and related secondary power components. The magnitude of differences in gross motor skills are as large as sex differences in physique. For example, in terms of hand-grip strength, 95% of males produce more force than 90% of females, with 75% of untrained males producing more force than 90% of heavily trained females (Leyk et al, 2007).

Fine motor skills refer to small movements using small muscle groups like the manipulation of objects and making quick, accurate movements (Thorley & McDaniel, 2013), in which a certain type of movements are involved, of hand, arm, leg, or foot movement, manipulating real objects. Scientific literature highlighted that women use analytical strategies while men tend to use holistic strategies. According to classical studies, males show a net advantage at least in the two categories of mental rotation and spatial perception. There are several studies investigating sex differences in visuo-motor tracking and hand-eye coordination. There is a large sex difference favouring males in pursuit precision (Wilmer & Nakayama, 2010). The motor activities are the foundation of all learning and accompany the individual development in all its phases (Raiola, Di Tore, 2017, Altavilla, Raiola, 2015, Altavilla et al, 2015).

Discussion and conclusions

A first consideration is that the absolute values of maximum strength in men are much higher, therefore men have a significant advantage as far as strength exercises fast and explosive strength. This superiority, however, is not as obvious as that concerning the maximum strength, because the speed of female muscle contraction is similar to that of male muscle (Trappe et al. 2003). The maximum speed is determined by factors, which do not benefit neither the one nor the other sex, from muscle contractility, which is almost similar between men and women, by metabolic factors, for which the superiority of men is produced by major muscle mass (Weber, Chia, Inbar, 2006). In trained men the blood lactate accumulation is significantly higher than in women trained in a similar way (Issurin et al. 2001). Aerobic capacity is considered to be an indicator of the athlete resistance, a clear superiority caused by greater muscular mass and a better supplying of oxygen to the muscles. If we talk about aerobic resistance in long-lasting resistance disciplines, we find a scarce gender difference, which can be explained by the greater ability to withstand the fatigue and burn fat from women, gaining benefits with increasing duration of load. In addition to the anthropometric and biomechanical factors that undergo significant gender differences - the attention of researchers has been particularly attracted by the physiological determinants of maximum sports performance (Cheuvront et al. 2005). For the researchers and the coaches is of great interest the gender difference with regard to the cumulative effect of training. Male athletes are advantaged, with regard to hormonal stimulation of anabolism, this means that their training regarding to strength, aimed at an increase in muscle mass (Rago et al, 2017, 2016, Gaetano, Rago, 2014), is better.

While on the one hand male athletes have the advantage of higher hypertrophy, which results in a better training response to fast strength exercises. On the other hand there is no gender difference in muscle contractility and nervous adaptation, provoked from the training of the speed (Issurin, 2004). This type of training in untrained subjects causes similar effects. Thus, for example, a training with tiresome intervals, of the

duration of 8 weeks in untrained women and men, resulted in a similar increase in maximum aerobic capacity, of about 19 to 21% higher than the pre-training level (Weber, Schneider, 2002).

Aerobic training is an industry in which women can normally achieve significant improvements. Despite being disadvantaged with regard to oxygen supply, trained women can increase their aerobic capacity from 10 to 30%. This is very similar to that of men (Wilmore, Costill 1993). Experiences with high-level athletes in sports such as art gymnastics, ice figure skating, show that men and women do not show any difference in the skillfulness of technically very difficult skills. According to the general view, however, women are more prepared for technical skills that require a high degree of flexibility, balance and only moderate strength commitments, while men would be superior in motor skills that require a lot of strength or rapid strength. In general, high-level athletes, regardless of their gender, have the same level of training as regards the coordinately exercises and ability very challenging. The highest gender differences are marked in those sports disciplines that require maximum strength (from 22.6 to 30%), explosive strength (from 15.9% to 17.4%), and a combination of maximum aerobic capacity and capacity glycolytic-anaerobic (from 11.6 to 13.2%).

Minor gender differences are typical of maximum speed disciplines (7.1%) and those requiring aerobic endurance of long-lasting (from 8.1 to 5.1%). It should be stressed that female athletes have several advantages: better fatigue resistance in low and medium intensity loads, improved fat utilization in strength loads, and faster recovery capability. Despite their inferiority in various motor skills, women, thanks to the use of specific mechanisms of adapting to the maximum strength and to challenging aerobic loads and coordination, have positive reactions to loads that are often close to those of men.

The females choose their own ways to develop their technical expertise (Raiola et al, 2013ab), they are more constant and react more sensitively to technical details and also have a better ability to adapt to technical skills that require good balance and medium strength skills (Raiola, 2014). Finally, also the differences in learning and memory between men and women are commonly recognized by general population as well as scientists. A better understanding the biology of sex differences in cognitive function will not only provide insight into healthy life style, promoting gender-specific exercise or sports, but also is integral to the development of personalized, gender-specific medicine (Li, 2014).

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