

## SPECIFICITY OF SPORTS TRAINING WITH WOMEN

### Abstract

An increasing number of new physical activities, the emergence of new disciplines and female participation in disciplines that, until recently, were only male, has become a daily practice. Female participants is growing in number and is more evident, so the question of whether women's sports training has certain peculiarities, has been naturally imposed. Despite an increased number of researches on a female sample, the male samples are still dominant. Mechanical identification of men and women can cause more harm than good, especially in professional sport. Based on previous research, it can be said that the overall maximum ability of an adult woman is 70 - 90% of the overall maximum capacity of an adult male, which primarily stems from the morpho-functional characteristics. The woman has a lower maximal speed, strength, speed – power component, endurance, much better flexibility and agility, greater accuracy and precision of movement, compared to the average man. The strength of any muscle group in women is on average less than men the same age. Although women have lower power, adaptation to strength training in women is not different, so there is no reason why female athletes would not apply the same methods as men. Sports training increases maximal oxygen consumption among women in the same way as in men. Today sports training enables women to run and achieve results in the long and the longest distance, as well as men. In fact, the last two decades of research have pointed to similar training methods, training responses, physiological requirements, both men and women.

**Key words:** WOMEN / STRENGTH / ENDURANCE / FLEXIBILITY / ENVIRONMENTAL

### INTRODUCTION

In the area of scientific observation and study of differences between women and men in sport, certainly one of the central places involves the following questions: Is there specific sport training for women, or whether there are specific reactions of some sports activities? Mechanical identification of men and women can cause more harm than good, especially in professional sport. Today there are growing number of new methods of physical activity, the emergence of new disciplines, and increasing female participation in them. Application of different methods of pharmacological and medical procedures and interventions, particularly in professional sport, allows greater access to all what was not available in women's sports. Female participants are growing in number and are more evident.

However, women's body is sensitive biological – psychophysical organism. Physical exercise or sports activity of women has to be based on knowledge of the diversity and specificity - anatomical, physiological, psychological (Juhas, 2003; Bacanac & Juhas, 2006). Characteristics of women are featured by a group of female sex hormone estrogen, which plays a major role in life of women.

Morphological characteristics of the female body contribute greatly to the ultimate sports opportunities. An adult female is generally lighter and shorter than a man, of relatively greater trunk length and lower leg length, absolutely and relatively with narrower shoulders, and relatively higher bicristal and bitrochanter width. Almost all female circumferences are smaller except for thigh circumference. The

female skeleton consists of bones that are slightly shorter, thinner, more porous and brittle. Some skeletal areas have specific characteristics, such as the pelvic. Pelvic sockets are remoter and relatively short femur converges more toward the middle or toward the knees, making physiological x - legs. This axis ratio leads to a special transfer of muscles power in the pelvis and lower extremities area.

High flexibility of joints due to lower strength of ligaments is characteristic in development of female children under the influence of female sex hormones. Previously it is manifested particularly in the extension movements, displaying also hyperextension of knuckles, hands, elbows, feet and knees, which prevents a woman to properly execute certain movements. Muscle cells of women are less in number, muscle tissue is softer and more elastic. These properties cause that women's muscle tissue contraction exhibits lower speed, lower power, and endurance as well as a reduced ability to hypertrophy under the influence of physical strain. A characteristic of the female body is also greater amount of fat. This »surplus« at the same time reduce the amount of so-called active tissue, thus reducing the specific weight of the female body.

Heart of a woman is both absolutely and relatively smaller than the male. Blood of women has a different concentration of salt, content of plasma, the number of blood elements, and the total amount of blood is also lower. This generally reduces women to perform more intense and longer work. The higher frequency of breathing and rapid movement of blood under slightly lower blood pressure, the body compensates not only the reduced content of the blood elements, but also lower systolic blood volume. In this way, women provides blood minute volume, approximately the same as men and a sufficient transport of oxygen and carbon dioxide. Women need to invest more work in order to achieve the same performance as a man.

Therefore, women, due to their morpho-functional characteristics, pay more energy for equal work or the same work for a woman can be a work of greater intensity.

The percentage lower bone mass, greater bone porosity and greater amounts of adipose tissue contribute that the centre of gravity of some body parts have a different position relative to the body of a man. Longer torso, shorter arms and legs, wider and lower pelvis, condition lower centre of gravity position of

the body. A different arrangement of certain segments of the body centre of gravity, lower overall centre of gravity of the body, along with the fact of greater energy payment of the work done, further disable the maximum speed while moving, and raising the body, like in long jump and high jump. Anatomy of pelvic - hip area allows greater oscillation of pelvis, which is not desirable to achieve high-speed walking and running.

On the other hand, such functional characteristics of motor apparatus enable women soft and merged movements with expressive flexibility, that drives women to sports activities, such as rhythmic gymnastics, dance, synchronized swimming, etc.

Answers to questions about specificity of female sports training will be sought by considering previous research in the area of development of strength, cardiovascular endurance, flexibility, and in the field of training in certain specific environmental conditions, such as, for example, training at high and low temperature or low air pressure.

### **WOMEN'S SPECIFIC SPORTS TRAINING OF STRENGTH AND POWER, CARDIOVASCULAR ENDURANCE, FLEXIBILITY**

Power of any muscle group in women is on average lower than in males of the same age, and the differences go up to 25% in absolute values, and 20% in relative units in relation to body mass. The average strength of women in the upper body is 25-55% of the average strength of the average man. For lower-body strength the percentage is higher, 70-75% (Fleck & Kraemer, 2004; Wilmore, Costill, & Kenney, 2008). Due to increased demands for power, speed and explosiveness at all levels of women's sports, there is a need to strengthen and improve overall power and endurance.

Even in the 90-ies of the last century, research has shown that women have similar adaptation and muscle hypertrophy in response to strength training (Hickson, Hidaka, & Foster, 1994; Staron et al., 1994). Under the influence of sports training women can, thanks to the light skeleton, develop their skeletal muscles, while at the same time still maintaining a relatively small body mass. This good feature is expressed in sports such as rhythmic and artistic gymnastics (Djordjevic-Nikic & Moskovljevic, 2009).

On the other hand, such an apparatus represents a risk factor in terms of injuries due to overload, which, in particular, occurs in sports dominated by explosive power. Sports activities and sports in where this motor skill is dominant could be considered »undesirable« for a woman. Lower muscle strength contributes to a significant delay for men, in, for example, athletic jumps, which require great body acceleration in a short period. On the other hand, training can strengthen ligaments.

Although women exhibit less power than men, adaptation to strength training in women is no different than in men, so there is no reason why female athletes would not apply the same methods of training as men. There are some myths related to power exercise in women which experts tried to break (Ebben & Jensen, 1998; Zaciorski & Kramer, 2009). One is that muscle mass shall increase too much and women by refusing to implement certain methods or training intensity, limit their own advancement. The lack of heavy loads (3-5 RM  $\geq$  90%) can significantly reduce the effects of training to increase maximum power.

With the implementation of strength training for women one should pay attention to several effects. A possible problem that may occur are menstrual irregularities that may occur due to training, and should reduce the load or suspend the training process until they stop. Due to the increased risk of anterior cruciate ligament injuries, women should apply strength training even in the preseason, and later maintain the resulting physiological adaptation to reduce the possibility of injury. Caution should be exercised when using complex power exercises that engage upper and lower body, for example weightlifting. It is known that women have less muscle mass and strength in the upper body than men, and complex exercises can be performed adequately with lower part of the body, while in the top injuries can occur due to lack of preparedness. It is therefore necessary to develop and strengthen the upper body first, so that the body is proportionally strong to perform complex exercises. For women, the development of the upper body is a limiting factor, for example in basketball shot or in volleyball spike.

Women have fewer muscle fibres than men, and a cross section of muscle fibres is smaller. During strength training is necessary to activate all available muscle fibres, which require higher intensity, the use of certain bodybuilding techniques, to develop hypertrophy necessary for specific muscle groups and

to stimulate physical development of the entire muscular system. Fleck & Kraemer (2004) explain the increase in muscle mass and volume in some women, as the influence of several factors:

- higher concentrations of testosterone and growth hormone at rest,
- stronger hormonal response to resistance training than usual,
- minor differences in the concentration of oestrogen and testosterone,
- a genetic predisposition to develop greater muscle mass and
- the ability to perform more intensive strength training.

Hewett, Stoupe, Nance, & Noyes (1996) initiated research of the effect plyometric training on the prevention of knee injury (anterior cruciate ligament), which is thought to be most common in women. This study observed the effects of neuromuscular training on the incidents of knee injuries of female athletes. The results showed that the athlete, who used a specific plyometric training program, reduce the number of incidents. Hewett's investigations continued, and among others, Meyer joined, and in 2005 considered the effects of plyometric training, strength, balance and „core stability“ training in injury prevention in women (Hewett, Myer & Ford, 2005). The same authors (Hewett, Myer & Ford, 2006; Hewett, Ford & Myer, 2006; Myer, Ford, Brent, & Hewett, 2006) continue to study neuromuscular training (including plyometric exercises) to reduce the potential risk factors of knee injuries in female athletes, measuring the degree of neuromuscular changes and the mechanics of movement of the lower extremities, the impact of plyometric training and training of balance, on the force, strength, balance and landing force in women. The results of these studies support the hypothesis that the combination of different methods of training can maximally improve the efficiency of training for women in the prevention of injury, improve measured performance and mechanics of movement. Under the auspices of the International Olympic Committee a group of doctors and sports scientists was invited to pool their research experience (Renstrom et al., 2008) in creating a successful prevention program in preventing anterior cruciate ligament injuries in female athletes. This call resulted in a proposal to implement adequate programs neuromuscular and

proprioceptive training that involved the proper landing or adequately establish contact when landing.

Each sport requires a certain kind of manifestation of power, and accordingly should be conveyed load. There is no evidence that women more frequently get hurt during strength training than men.

Zatsiorsky and Kraemer (2009) concluded, on the grounds that women have more slow than fast muscle fibres, that strength training are more needed, especially in maintaining the achieved form. They also observed a slight increase in levels of testosterone, which is responsible for adaptation to strength training. Women who have higher levels of adrenal androgens have an advantage in the susceptibility to strength training. Only at the maximal and almost maximal intensities the largest and fastest fibres in the muscle are triggered, and this principle is important to understand and apply, especially in training female athletes. Most women are afraid to train with heavy weights, but only if we use much resistance it is possible to stimulate and activate the motor units that contain more and faster muscle fibres. Women's muscle fibres are smaller and fewer than the male. Nevertheless, these differences in muscle fibre can affect the strength program, in the sense that women can see a dramatic increase of strength training after stagnation, in which muscle fibres with fast contraction need additional time to catch up and overtake the size slow contracting fibres. It is important to use larger load to stimulate the growth of this type of fibres. Moreover, if slow contracting fibres become dominant, it will require more training, especially during the periods of maintenance (e.g. twice a week instead of once).

Generally, when strength training is applied to female athletes one should keep in mind (Simek, 2008): to use less total load, that the strength of upper body is lower, that women are susceptible to certain types of injuries, that all varieties of strength training and force are applicable to the athletes, and their selection will depend primarily on the goal of training, competition calendar and the available equipment.

Physical exercises of endurance type for women are determined by already mentioned morpho-functional characteristics of the female body. The smaller oxygen capacity, decreased red blood cell count, haemoglobin content, smaller content of iron in the blood, have certain functional realignment. Woman compensate for the difference in the amount

of iron by increased distribution of body iron, in the form of functional iron that can be mobilized immediately to transport oxygen, compared to the reservation, as dysfunctional iron (ferritin). This ratio is less favourable in men.

Women have lower maximal oxygen consumption by about 25 - 30% than men. The average for women aged 20 - 40 years is 28-37 ml / kg / min. Girls have the highest value at the age of 9-10 years, and after that it declines to an average annual value of 0.5 ml / kg / min, until the age of 15, when it is stabilized, unlike the men who in the period of 9-15 years have a constant progression. The reason for this is found in a marked weight gain, but not at the expense of skeletal muscle, but at the expense of the skeleton and body fat. Average values of maximal oxygen uptake in women athletes were about 55 ml/kg/min (Drinkwater, 1984), while Daniels and Daniels (1992) and Bank and Heller (1993) for elite runners in the long distance found values of 67-68 ml/kg min. Increasing the body fat is usually the cause of lower aerobic power (Drinkwater, 1984; Pate, Sparling, Wilson, Cureton, & Miller, 1987). Standard factors affecting the oxygen consumption, haemoglobin concentration and blood volume, as well as factors that indicate the differences, were also explored. Telford and Cunningham (1991) have found on a sample of 190 categorized athletes in eight sports the average value of haemoglobin of 144 g/L, which was 10% lower than men (159 g/L in 249 men). Weight, Alexander, Elliot, & Jacobs (1992) found in 34 men and 16 women long distance runners the difference in concentration of 2,3-diphosphoglycerate which the author considers as compensation for low values of haemoglobin. In the same study no differences were found between men and women in erythropoietin, a hormone that forms red blood cells.

Sports training increases maximal oxygen consumption among women in the same manner as in men. This growth rate can go up to 30% depending on age and training. Today sports training enables women to run and achieve results in the long and the longest distance, as well as men. By breaking the myth of the physiological differences to the submission of long-term physical activity occurred in 1984, when was held the first official women's marathon at the Olympics. In the following fifteen years, the evidence was sought that women were capable of long-term activity. Research by Bam, Noakes, Juritz, & Dennis (1997) has shown that differences are negli-



gible in men and women who equally trained for distances over 42.2 km, and for over 70km women have a slight advantage. Previously confirmed by Speechly, Taylor, & Roger (1996) by comparing the results at 90 km, and Sparling, O'Donnel, & Snow (1998) by observing the world's best results in running for the period 1980-1996. Coast, Blevins & Wilson (2004) have confirmed that the differences decrease with the distance lengthening, especially for longer than a marathon, which is based on energy utilization, increased metabolism of fat and the relative progress of women training at longer distances.

According to Beneke, Leithauser and Doppelmayr (2005), women are superior in running the ultra distances, as shown by the results on one of the most challenging ultra marathons »Badwater Ultra marathon Race« length 216 km, which since 2002 is increasingly more dominated by women.

Bam et al. (1997) explained better results in women's running at longer than distance of 42.2 km with greater glycogen savings based on increased fat oxidation. During 90-100 min of exercise on the treadmill at 65%  $VO_2$  max Tarnopolsky, MacDougall, Atkinson, Tarnopolsky and Sutton (1990) found a higher utilization of lipids in women, which was confirmed at 75%  $VO_2$  max (Tarnopolsky, Atkinson, Phillips, & MacDougall, 1995). Riddell et al. (2003) also found a receipt for a better aerobic capacity at 60%  $VO_2$  max and the use of stored glycogen. Greater utilization of lipid was confirmed by Perreault, Lavelly, Kittelson and Horton (2004), and. Sartorio et al. (2004) confirm the important influence of growth hormone.

Because of blood loss during menstruation women are more sensitive to loss of iron. During physical exertion leads to intensification of the process of erythropoiesis so that the iron content decreases during the training and up to 25% of the value before the training. It is therefore necessary to replace iron lost during intense training.

In relation to the research area of endurance and strength, much less of them deal with differences in other abilities such as flexibility, coordination ... In terms of flexibility, studies show greater flexibility in women than in men. The large sample in this area has been covered by Kibler, Chandler, Uhi and Maddus (1989). They have studied the flexibility of 629 women and 1478 men and found the women are more flexible in all measurements (11 tests) than men.

McHugh, Magnusson, Gleim and Nicholas (1992) also found a greater flexibility of the hip in women. Due to differences in locomotor's apparatus there are differences in the incidence of injury. Unfavourable amount of muscle mass and body weight, lower ligaments and unfavourable axis relationships contribute to more frequent injuring. Knapik, Bauman, Jones, Harris and Vaughan (1991) during a three-year study of 138 women concluded that the imbalance between the specific strength and flexibility is a first indication of injury of the lower extremities.

In general, research shows that ankle distortion, patellar dislocation, distortions and contusions shoulder, elbow, fingers and knee and injuries of hamstring muscles thigh are most common at women. It is believed that the laxity of the joints cause of injury in 40% of cases. The abovementioned should be borne in mind when it comes to physical exercise or sports activity of women.

### **FEMALE SPORTS TRAINING WITH REGARD TO SPECIFIC ENVIRONMENT CONDITIONS**

Competitions can be held in different environmental conditions, from high to low temperatures, different humidity, air pressure, which also applies to training conditions.

Adjustment of skeletal-muscle capillary blood vessels of the physical effort is worse in women than in men. In terms of physical effort capillary blood vessels in women expand less, capillary blood flow to the muscles is lower and muscle fibres are supplied by smaller amount of oxygen. Poor capillary circulation in skeletal muscle may partly explain inadequate thermoregulatory adaptation to physical exertion at high ambient temperature. Additional load represents an increase in body temperature due to energy released during muscular work. Increased subcutaneous fat in women hinders heat loss. Women have fewer sweat glands, sweating occurs later, with a small amount of sweat secreted. Since, during the continuous work, sweat secretion occurs later in women than in men, highly intense and long-term work at heat poses a risk to the woman, and regular physical activity contributes to the adaptation of the organism.

That is why every major physical effort under conditions of high ambient temperature is a further

strain on their bodies, with possible adverse consequences. As the temperature increases neurons from the thermoregulatory centre stimulate blood vessels in the skin to expand and to secrete sweat. As the temperature rises in warm conditions, the difference between the skin and the air is reduced, leading to a dry heat loss from the skin. In hot humid conditions the possibility of sweating is decreased because the air is saturated with water vapour. When the air temperature is above skin temperature, about 35 °C, the body receives heat from the environment. At this temperature athletes fail to regulate the temperature due to lack of sweating. Repeated exposure to heat conditions leads to adaptation. If women and men lose the same level of fluids by sweating, woman is more dehydrated because she loses proportionately greater amount of water and plasma. Therefore it is suggested that women take more fluid than men. In humid warm climate conditions women are more flexible than men. And after ten days of acclimation, women continue to have advantage. Millard-Stafford et al. (1995) found in the long distance runners a lower level of sweating in women and minor changes in plasma volume during the 40km run. Similarly as shown in the example of tennis (Bergeron et al., 1995).

In endurance sports heat regulation plays an important role. About 75% of energy released when muscle work is converted into heat. The value of the maximum temperature tolerance of the body in both sexes is about the same, but women have already reached this limit at lower temperatures. In men, the body temperature at a marathon race, may increase to 41 °C, while such high temperatures of women's body are not measured. Women initially adjusted higher heat production with stronger vasomotor reaction. Research shows a relationship between maximum oxygen consumption, sugar metabolism, menstrual phase and tolerance to high temperature (Cheuvront & Haymes, 2001). Thus, trained long runners show greater tolerance to heat than the average, untrained women. Generally, care should be taken of the possibility of heat stroke in women, especially in long-term activities.

Exercising at cold temperatures is lower challenge for the thermoregulatory system. Decrease in body temperature stimulates vasoconstriction and delivery of more blood in blood vessels. Research

shows that women are better able to work in cold conditions than men. Women, on average, have more subcutaneous fat than the average man. This indicator is highly correlated with the maximum effect of working in conditions of low temperature (Hong, Park & Rennie, 1986). Additionally, the relationship of the body surface and body mass determines the heat loss from the body. This ratio is higher in women. When men and women are equally trained in the conditions of temperatures from -5 to +5 °C, higher body temperature was found in women (Graham & Loughheed, 1985). During exercise in cold water (20 °C), in men who had 9% and 17% body fat, metabolic rate have increased, while for women with 18.5% fat level remained the same (McArdle, Magel, Gergley, Spina & Toner, 1984). The decline in temperature during one hour of exercise was greater in lean men, and average men, slim women, and finally the average women (25% body fat). Generally, care should be taken of the possibility of hypothermia, which can be avoided with adequate clothes and preparation for exposing these conditions.

Training and competing at altitude, lower atmospheric pressure, represent a challenge to organism. During his stay in these conditions leads to different problems and varying degrees. Accelerated heart rate, shortness of breath, fatigue, intoxication, irritability, headache, nausea, vomiting, and finally loss of consciousness. Miles, Wagner, Horvath and Reyburn (1980) showed a reduction in women VO<sub>2</sub> max by 10% stay at an altitude of 2130 m 13% to 3050 m. Drinkwater et al. (1979) showed the maximum intensity of exercise at 4100 m were significantly lower VO<sub>2</sub> max, heart rate and time of fatigue, compared with values at sea level. Research of Drinkwater, Kramar, Bedi and Folinsbee (1982) have shown that women climbers show the same decrease in oxygen consumption opportunities as men. Women are more tolerant of staying at a height, rarely suffer from altitude sickness, show less change in heart rate at rest, a small change in body weight, volume and chemical composition of the blood of men. Repeated exposure to diluted air conditions leads to adaptation (Chapman, Stray-Gundersen & Levine, 1998).

## CONCLUSION

Although an increase of research on a sample of women has been reported, the ones on a male population are still dominant. Based on earlier results, the general maximum adult woman is 70 - 90% of overall maximum capacity of an adult male. So, women have lower maximal speed, strength, speed - strength component, endurance, much better flexibility and agility, greater accuracy and precision of movement, compared to an average man.

No matter that women go in for all existing sports today, the long, exhausting physical strain for a woman is not desirable (in terms of functions of women), as well as the efforts of great strength, such as weightlifting. Excessive lifting, intra-abdominal pressure with strength training exercises with heavy loads and loads of muscle-tendon appliances can lead to permanent physiological changes in the position of

the uterus in the pelvic cavity, followed by a series of functional changes.

In fact, the last two decades of research have pointed to similar training responses for men and for women. Physiological demands in most sports activities are the same for both men and women. The training methods that are applied are also the same. Most research points to the answers to basic training and physiological adaptation, and much less is known about more subtle changes and adaptations, which leaves room for further research in this field.

The pure type of woman or man is more rarely found. There are usually expressed male traits in women and vice versa. A woman can be high, with long lower limbs, more compact structure of the skeleton, broad shoulders and narrow pelvis, more developed musculature and atypical fat distribution. Women actually experience morpho-functional transformation and as such become physically capable of achieving better and more top sports results.

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