



# IAAF @-Letter

## for CECS Level II Coaches

April 2008

No. 1

SPECIFIC THEME: Strength training guidelines for women

GENERAL THEME: Basics of strength training for women

### Specific Theme

#### STRENGTH TRAINING GUIDELINES FOR WOMEN

##### 1 Introduction

Although women first began strength training for sports in the 1950s to improve their performance in athletics, they have traditionally participated in strength training less than men. Such exercise has not been considered feminine, and lack of research and information regarding the effects of strength training on women has made it a predominantly male activity.

Although since the 1970s strength training has grown in popularity among female athletes, the lack of accurate information persists and feeds misconceptions that keep women away from strength training or prevents them from training in optimal ways.

Though gender differences regarding absolute strength exist, women are as able as men to develop strength relative to total muscle mass. Conse-

quently, women should strength train in the same ways as men, using the same programme design, exercises, intensities, and volumes, relative to their body size and level of strength, so they can achieve the maximum physiological and psychological benefits (Ebben & Jensen, 1998, pp. 86, 88).

##### 2 Trainable characteristics of muscle

###### 2.1 *Development of lean tissue mass*

Development of lean tissue mass in women is extremely important, especially in the upper body. In order for muscle tissue to be developed, it must be stimulated by the workout protocol. Stimulation of muscle is a function of the activation of motor units (alpha motor neuron and its associated muscle fibres). According to the so-called size principle, motor units are activated from smallest to largest in a sequential pattern to meet the external demands of the exercise (i. e., to lift the amount of weight on the barbell).

Although most women are afraid to lift heavy weights, it is only with the use of heavy resistance that motor units containing the larger muscle fibres are stimulated or trained (Zatsiorsky & Kraemer, 2006, p. 177).

A number of programme design factors must be considered when trying to maximally stimulate the optimal number of motor units in a muscle. Each time, an athlete changes the angle, whether it is the joint angle or the angle at which the force is exerted, the exercise is changed to the extent that different motor units are used.

When trying to develop optimal muscle mass it is important to use a set of exercises that stimulates different biomechanical angles in order to make sure that the entire muscle is stimulated. Heavier resistances are also required to stimulate higher threshold motor units. This is especially important for power development in women. The use of higher training volumes (e. g., multiple set training) is also important to develop lean tissue mass, as multiple-set training programmes have been shown to be superior to single-set circuit training for women (Zatsiorsky & Kraemer, 2006, p. 177).

## 2.2 *Strength development*

Although many women shy away from heavy loading schemes, it has been well established that women need heavy resistances in order to develop maximal 1RM (one repetition maximum) strength. While some sports may not require massive strength (e. g., cross-country running), heavy re-

sistances are needed for the optimal development of connective tissues such as ligaments, tendons, and bones.

The most effective presentation for such heavy and very heavy loads is the use of a periodised training schedule (i. e., classical linear or non-linear programmes). This allows for recovery from heavy workouts and is needed in an optimal programme (see the example of a non-linear periodised training programme on p. 5 of this IAAF @-Letter).

## 2.3 *Muscular power development*

Muscular power is becoming a prominent performance characteristic in almost all women's sports.  $P = Fd / t$  is the base equation that conditioning programmes affect. High force training or heavy weight affects the force part of the equation, and mechanical power training along with body mass and high speed movements affect the velocity component of the equation. Thus, both heavy resistance training and explosive power training are essential in any strength training programme for women. Many programmes focus solely on the force component of the power equation, but just as important is the use of loads and exercises that address the velocity component.

Maximal mechanical power typically takes place somewhere between 30 and 45% of 1RM in exercises like the squat jump, but can be higher in such lifts as the hang clean, pull, etc. (e. g., 60 and 70% of 1RM).

Of dramatic importance when training for power is to choose exercises in which a limited amount of deceleration occurs over the range of motion. This typically requires an exercise that allows for continuous acceleration of the mass or a machine, or pneumatics, that allows for high velocity movements to occur. If the mass cannot be released, the body will attempt to protect the joint by activating antagonist muscles and limiting the firing of the agonists, making the exercise ineffective for power development (Zatsiorsky & Kraemer, 2006, pp. 179-180).

Muscular power can also be developed with supplemental training of the stretch-shortening cycle using plyometric muscle actions prior to rapid shortening. Such drills can help in power development by emphasizing the velocity component of the power equation.

It is imperative that one does not compromise the development of maximal strength. A lack of heavy loading with a concentration on purely mechanical power loads along with lighter resistance can result in a plateau of power and a decrease in strength over a training period. Thus, heavy resistances must be included in workouts or training cycles, using resistance of 90-100% of 1RM. Strength and power development will interact and need to be addressed over an entire training programme. Programmes that focus on one component alone, either strength or power, will diminish development of the other component (Zatsiorsky & Kraemer, 2006, p. 180).

#### 2.4 *Local muscular endurance development*

Local muscular endurance, i. e. the ability to produce multiple muscular contractions at different percentages of maximum, can also be an important and trainable feature in women's strength training.

Muscular endurance can be differentiated into higher and lower intensity muscular endurance. Higher intensity muscular endurance training, which has also been called power endurance or strength endurance training, is characterised by using heavier loads (60-80% of 1RM) and incorporates short rest periods and multiple sets. Higher intensity muscular endurance is especially important in sports that require repeated bursts of high intensity efforts. Conversely, lower intensity muscular endurance can be developed with high numbers of repetitions. Using sets with resistances from 40-60% or 1RM or above 20RM loads will enhance local muscular endurance with little or no carryover to 1RM strength. Such training can include both isolated exercises as well as whole-body multi-joint exercises.

Another method of improving local muscular endurance is to use shorter rest periods between sets, with loading allowing only 8-10 repetitions.

Care needs to be taken that to see that exercise technique and format are monitored at the end of local muscular endurance sets as fatigue becomes detrimental to motor performance (Zatsiorsky & Kraemer, 2006, p. 181).

### 3 Essential features of women's strength training

The following features might be considered as essential in a strength training programme for women:

1. Well-designed strength training programmes for women include exercises with free weights and dumbbells and exercises that use body weight resistance. Women should train at the same intensities as men.
2. The use of strength training machines and abdominal exercises need not be discontinued, but emphasis should be placed on the use of free weight exercises, including foot-based lower-body exercises such as the lunge, diagonal lunge, walking lunge, step-up, lateral step-up, and squat.
3. Women should also include upper-body exercises that employ multiple muscle groups such as the bench press, incline press, latissimus dorsi pull-down, pull-up, and back extension.
4. Women who have developed a strength base should consider using total-body exercises such as the push press, hang clean, power clean, clean and jerk, and snatch.

5. A training programme should stress multiplanar, multijoint, functional exercises because they develop intermuscular coordination, proprioception, and balance and result in strength that transfers to sports and daily activities. For example, the step-up is superior to the leg extension machine because it offers functional strength for walking up a flight of stairs while carrying bags of groceries.
6. For athletes who play foot-based sports the squat is superior to using the leg press machine, since the squat is functionally more similar to the sport and requires greater balance, weight, and body control in all three planes of motion (Ebben & Jensen, 1998, p. 97).

Workout protocols for women have been found to be effective if they have

- varied training demands (periodised training),
- multiple sets, and
- a varied loading scheme that includes heavier resistances for strength development.

(Zatsiorsky & Kraemer, 2006, p. 184).

## Periodised programme for development of strength and power in women athletes

(based on Zatsiorsky & Kraemer, 2006, p. 179)

### Exercises

Monday	Wednesday (moderate)	Friday (light)
Barbell squat	Hang clean	Jump squat (loaded 30% 1 RM)
Bench press	Leg extension	Dumbbell shoulder press
Leg press (sled)	Stiff-leg deadlift	High pull
Cable seated row	Pectoral dec fly	Bench press
Wide-grip lat pull	Dumbbell incline press	Seated row
Shoulder press	EZ arm curl	Dumbbell arm curl
Sit-ups	Triceps push-down	Sit-ups
Leg curl	Hyperextension	Stiff-leg deadlift
Dumbbell upright row	Split squat	Lunge

### Rest periods between sets and exercises:

Monday: 3-4 min

Wednesday: 1-2 min

Friday: 2-3 min; jump squats, 3-4 min

### Resistance and set ranges:

Monday: 3-5RM zone, 3-5 sets

Wednesday: 6-8RM zone, 2-4 sets

Friday: 12-14RM zone, 1-3 sets; jump squats, 3-5RM zone, 6 sets of 3

## General Theme

### BASICS OF STRENGTH TRAINING FOR WOMEN

#### 1 The female athlete's need for strength training

With the greater demands for power, speed, and intensity in women's sports on all levels there is a definitive need for increased upper-body strength along with increased total-body power.

One of the main differences between men and women is a dramatic difference in upper-body size and strength, and in many sports it is the physical capabilities of the upper body that limit performance outcomes (e. g., in throwing events in track and field). In addition, the integration of power into whole-body movements (e. g., sprint speed, jumping) is also needed for successful performance (Zatsiorsky & Kraemer, 2006, p. 174).

##### 1.1 Upper-body size and strength demands

The need for development of the upper-body musculature is the primary challenge faced by the majority of women. A continuum exists as to the upper body's importance and function, from the development of postural local musculature endurance in an elite distance runner to the strength and power needed in the upper body for shot putting. Training programmes for women need to emphasize the upper-body musculature due to the role it plays in performing sport skills from sprinting to the javelin throw. It has been shown that

women have fewer muscle fibres and the cross-sectional areas of their muscle fibres are smaller than those of men's muscle fibres. In order to develop the upper-body musculature under these conditions, all available muscle fibres need to be activated, which requires heavier loading and the use of more exercise angles to stimulate overall physical development of the available musculature. This may require the use of body-building techniques to develop the hypertrophy needed for certain upper-body muscle groups. These techniques can then be integrated into a programme of total-body strength and power exercises.

##### 1.2 Power demands

Total-body power development with power cleans and other Olympic style weightlifting exercises is vital for sport performance gains. Total-body power is becoming an increasingly important training component for almost all women's sports and must be seriously addressed in a strength training programme.

Women have greater potential than men for upper-body strength and muscular development primarily due to a lack of aggressive training programmes for the upper body. In general this means the following:

1. Each upper-body muscle must be exercised at more angles.
2. Exercises should be integrated with closed kinetic-chain power exercises.
3. Heavier resistances must be used and integrated into a periodised strength training programme.

4. Multiple set training should be used.
5. A periodised training format should be developed.

## 2 Benefits and myths concerning strength training for women

### 2.1 Benefits

The benefits of strength training for women include the following:

- Enhanced bone modelling to increase bone strength and reduce the risk of osteoporosis.
- Stronger connective tissues to increase joint stability and help prevent injury.
- Increased lean body mass and decreased non-functional fat.
- Higher metabolic rate because of an increase in muscle and a decrease in fat.
- Improved self-esteem and confidence.
- Increased functional strength for sports and improved physical performance in sport-specific skills.

A number of factors may reduce or eliminate these benefits, including the exclusive use of weight training machines, as well as training with loads that are too light and not progressing in resistance or intensity (Ebben & Jensen, 1998, p. 92).

### 2.2 Myths

Certain misconceptions about women and strength training have limited the benefits about strength training for women due to the creation of inadequate training programmes.

- **Myth 1:** Strength training causes women to become larger and heavier.

**Truth:** Strength training helps reduce body fat and increase lean weight. These changes may result in a slight increase in overall weight, since lean body mass weighs more than fat.

- **Myth 2:** Women should use different training methods than men.

**Truth:** The fear that using free weights and explosive exercise will cause injury in women is unfounded. So there is no need for them to use weight machines and slow, controlled movements. Women, like men, should follow a programme that gradually increases the intensity and load. Furthermore, sport-specific exercises should closely mimic the biomechanics and velocity of the sport for which an athlete is training. For example, the push press – rather than triceps kickbacks – offers a superior arm extension training stimulus for improving the ability to put the shot in track and field.

- **Myth 3:** Women should avoid high-intensity or high-load training.

**Truth:** Women not only need to train at intensities high enough to

cause adaptation in bone, muscle, cartilage, ligaments, and tendons; to gain maximum benefit from strength training, they should occasionally perform their exercises at or near the repetition maximum for each exercise. (Ebben & Jensen, 1998, p. 91)

### 3 Physiological differences between women and men

The most common fear of many women athletes is that strength training will make them look like a man. However, without anabolic drugs there is little chance of women looking like men through strength training (Zatsiorsky & Kraemer, 2006, p. 181).

#### 3.1 Differences in muscle fibre

Women have not only fewer muscle fibres than men but their muscle fibres are also smaller than those of men.

Women have the same array of muscle fibre types as men, with both type I (slow twitch – ST) and type II (fast twitch – FT) and all of their subtypes. A gender difference does exist as to the ratio of muscle fibre sizes in untrained individuals. About 75% of untrained women have ST-fibres that are larger than the FT-fibres. It may be that untrained women who have greater potential for strength and power sports may be in the 25% of women that have such a profile of fibre size. It is still unclear whether these different starting points for untrained women are due to lesser strength and power demands in a

women's everyday activity profile or whether it is a true gender difference.

Nevertheless, these differences in muscle fibres can influence a strength training programme in that women see more dramatic increases from a strength training programme after a plateau in which FT-fibres need the extra time to catch up and surpass ST-fibre size. Important to this training phenomenon is the use of heavier resistances to stimulate faster growth of the FT-fibres found in the higher threshold motor units. In addition, if ST-fibres predominate, a more rapid detraining phenomenon may result, requiring more frequent maintenance workouts.

#### 3.2 Differences in strength and power

The average woman's maximal mean total-body strength is about 60% of the average man's maximal mean total-body strength. Average upper-body strength in women ranges from 25-55% of men's average upper-body strength. Lower-body strength has been shown to be a higher percentage at about 70-75% (Fleck & Kraemer, 2004).

Research on male and female strength potential reveals that women possess about two thirds of the strength of men. However, the measurement of strength in absolute terms fosters misconceptions about the strength of women, how women see themselves, and the way they exercise (Ebben & Jensen, 1998, p. 88).

The average woman has 54-73% of the maximal vertical jump and 75%

of the maximal standing long jump of the average man (Fleck & Kraemer, 2004). For the standing long jump this translates to the average woman generating approximately 63% of the power generated by the average man.

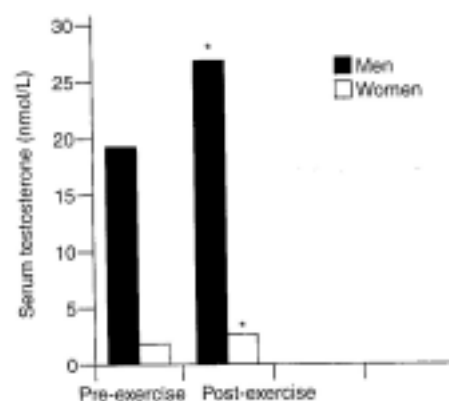
As far as the causes of these differences are concerned, one possibility is differences in the size ratio of muscle fibre type between men and women. About 70-75% of women have type I muscle fibres with a cross-sectional size that is larger than that of their type II FT-fibres. Power at faster velocities of movement could be affected if the force-velocity curve of women were different from that of men. However, it appears that the drop-off in force as the velocity of movement increases is similar in both genders and that peak velocity during knee extension is not different between genders. The rate of force development could affect power output.

Men also have greater pennation angles (i. e., the angle of the muscle fibre's direction of pull relative to the direction of pull needed to produce movement) in many muscles, and this would also affect the mechanics of muscle actions.

Since the skeletal muscle's rate of force development is slower for the average woman than for the average man, training for explosive strength is vital for female athletes in order to enhance rate of force development capabilities and improve power performances (Zatsiorsky & Kraemer, 2006, p. 183).

### 3.3 Differences in hormone concentrations

The most obvious difference underlying the fundamental mechanisms that mediates male versus female adaptations to resistance training is the male hormone testosterone. The resting concentrations of this hormone in women are 10-20 times lower than in men (see Fig. 1).



**Figure 1:** The relationship between young (20-25 years) trained men and trained women for serum total testosterone responses before and after a weight training workout. Although both genders demonstrated a significant increase after the workout with the change being greater in men than women, the concentrations for women are dramatically lower than for men (Zatsiorsky & Kraemer, 2006, p. 183).

The difference in testosterone concentrations is most dramatic when changes occur in adolescent boys and girls, as testosterone mediates the boys' larger muscle size, shoulder girth, and strength. With women producing most of this hormone from the adrenal glands and from the ovaries less so, some women have higher concentrations of adrenal androgens. This appears to give them

an advantage over other women in the trainability of muscle. Although the values are still 10-20 times lower than that of men, one can see small increases with the exercise stress as well as small increases over the training period.

Fleck and Kraemer (2004) have postulated that the following factors relate to the anabolic differences in women as they relate to training adaptations. Larger increases than normal in lean body mass and limb circumferences in some women are probably due to several factors, including:

- higher than normal resting testosterone, growth hormone, or other hormones,
- greater hormonal response than normal to resistance training,
- lower than normal estrogen-to-testosterone ratio,
- genetic disposition to develop large muscle mass, and
- the ability to perform more intense resistance training.

The responses of muscle fibres are more rapid in women than in men. It has been shown that within two workouts the isoforms of myosin ATPase change to the faster type, whereas it takes four workouts to stimulate the same changes in men. Thus, women have been found to be very responsive to the resistance training stimulus. The key is to optimally load and vary the programme so that a proper exercise stimulus is created that is capable of stimulating the needed physiological responses leading to adaptations.

Incorporation of training protocols that address the trainable characteristics of muscle in proportion to importance to the sport is vital to a successful strength training programme for women.

#### **4 Menstrual cycle and strength training**

It has been observed that a decrease in normal premenstrual symptoms (e. g., breast enlargement, appetite cravings, bloating, mood changes) occurs in trained women. This has led to a general concept that active women have fewer problems with premenstrual symptoms than sedentary women. Similar to premenstrual symptoms, dysmenorrhea (painful menstrual periods) occurs less frequently and is less severe in athletes than in the normal population.

On the other hand, exercise can cause menstrual cycle abnormalities. Other factors involved with menstrual abnormalities include inadequate caloric intake, which can interact with exercise training and competition and may help to mediate menstrual problems. Many sports in which lower body weight appears to enhance performance (e. g., cross-country running) may in fact promote problems with menstrual cycle normality. In addition, high volumes of intense training accompanied by low levels of caloric intake may exacerbate such problems.

For women proper nutritional intake of total calories and diet composition (i. e., protein intake) are essential in order to meet the demands for energy expenditure but also for the re-

pair and remodelling of muscle tissue. Many women do not eat enough protein to meet the demand for amino acids needed for protein synthesis after a strength training workout. Such dietary behaviour and other nutritional deficiencies (e. g., reduced calcium intake) can help limit optimal adaptation to a workout and training programme. In addition, they may well be a major contributing factor to menstrual cycle abnormalities.

Strength is not different over the normal menstrual cycle, but other investigations indicate that the best physical performance probably occurs between the immediate post-menstrual period and the 15<sup>th</sup> day of the menstrual cycle. However, the effect of the menstrual cycle on performance is still unclear and is probably highly individualistic.

Participation in conditioning programmes and athletic events should not be discouraged during menstruation; to date negative effects are highly individual and no detrimental effects on health have been observed (Zatsiorsky & Kraemer, 2006, p. 187).

## 5 Strength training and pregnancy

The risk of heavy lifting during pregnancy is not injury to the baby but injury to the mother. Pregnancy hormones cause the ligaments to soften, which helps the pelvis widen to make room for childbirth. As a result of softer ligaments, joints may be less stable than usual and injury may be more likely. Therefore, women

should not start a new or more aggressive strength training programme during pregnancy.

The following exercises can be performed by pregnant athletes:

- **Squats:** Range of motion should be decreased (knees should never be flexed beyond 90°). The squat workout can be increased by decreasing the pace (i. e., slow lowering to a count of three or four).
- **Leg presses:** Leg presses help keep the lower abdominals tight, which protects the back. However, this exercise should be limited to the first three months of pregnancy only.
- **Hip abductor machines:** Working out on a hip abductor machine will build strength in the hips, which counteracts postural changes. Lower abdominals should be kept tight to avoid hyperextending the back.
- **Ab work:** Concentration should be on gaining control of the lower abdominals by performing pelvic floor exercises. Traditional sit-ups should be deleted from the exercise routine.

## 6 Summary (as based on the NSCA's position on strength training for women)

- Both with men and women, proper strength exercise programmes may increase athletic performance, improve physiological function, and reduce the risk of injuries.

- Due to similar physiological responses, males and females should train for strength in the same basic way, employing similar methods, programmes, and types of exercise.
- In the lower body, the relative strength (strength to lean body mass) of untrained women appears to be approximately equal to that of men.
- Females can hypertrophy their muscles through resistance training relatively, but not absolutely, the same as men.
- Female athletes appear to have the same fibre-type distribution as men, although the female fibre appears to be smaller in cross-sectional area.
- There is little research evidence to suggest that the onset of a normal menstrual period affects athletic performance.
- Female athletes whose menstrual cycle has ceased have an increased likelihood of developing musculoskeletal injuries.
- Resistance training using multi-joint and structural exercises is recommended to induce sufficient stresses on the skeletal system and to enhance calcium storage in bone.
- Women may safely weight train during pregnancy; however, common sense must be employed when selecting training intensities and exercises.
- Due to the influx of the hormone relaxin, which softens tendons and ligaments in preparation for delivery, caution is warranted for pregnant women in performing heavy multijoint exercises (squats, deadlifts, snatches, and cleans) after the first trimester.
- It has been demonstrated that resistance training leads to favourable changes in body composition with minimal change in body weight.
- Because most women are weaker than males in the upper body, adult women should work especially hard on upper-body strength training (National Strength Coaches Association, 2005).

#### References:

EBBEN, W. P. & JENSEN, R. L. (1998). Strength training for women: Debunking myths that block opportunity. *The Physician and Sportsmedicine*, 26(5), pp. 86-97

FLECK, S. J. & KRAEMER, W. J. (2004). *Designing resistance training programs* (3<sup>rd</sup> ed.). Champaign, Ill.: Human Kinetics

NATIONAL STRENGTH COACHES ASSOCIATION (2005). "Strength training for female athletes," NSCA Position Statement. Colorado Springs, Co: National Strength and Conditioning Association. URL: [www.nscalift.org/Publications/posstatements.shtml](http://www.nscalift.org/Publications/posstatements.shtml)

ZATSIORSKY, V. M. & KRAEMER, W. J. (2006). *Science and practice of strength training* (2<sup>nd</sup> ed.). Champaign, Ill.: Human Kinetics

**Further useful literature:**

INCLEDON, L. (2005). *Strength training for women: Tailored programs and exercises for optimal results*. Champaign, Ill.: Human Kinetics

PETERSON, J. A., BRYANT, C. X. & PETERSON, S. L. (1995). *Strength training for women*. Champaign, Ill.: Human Kinetics

PETANICK, K. & BERG, K. (1997). The effects of weight training on bone density of premenopausal, postmenopausal, and elderly women: A review. *Journal of Strength and Conditioning Research*, 11(3), pp. 200-208