

## Resistance Training for Running Economy

### Introduction

If you want to be a good runner, you need to run. It's 100% the best form of training! But is there a place for resistance training?

### Measuring running performance

There are many ways to measure running performance. For the majority of people, running a local route in a set time, keeping track of parkrun results, or maybe even competing in a 10k running race is how they measure progress. Looking at running times are of course a great measure of this, but what they do not tell you, is, if you made an improvement, where that improvement came from – Was it a warmer day that led to a faster time? Running with a friend who pushed you on? A new pair of trainers? Or was it a physiological/biomechanical change made through training?

### VO<sub>2max</sub>

When we run, our body requires oxygen to create energy. One measure of your potential running performance is called VO<sub>2max</sub>. This is the maximal amount of oxygen uptake that your body can produce. More oxygen into the body means more going to muscles and higher performance levels. VO<sub>2max</sub> is measured in millilitres of oxygen, per kilogram of body mass, per minute (ml/kg/min). Typical values would be:

Athlete	Male	Female
Elite runner	75.4	66.2
Highly trained runner	70.8	61.7
Moderately trained runner	62.2	55.8
Recreational	54.2	49.7

VO<sub>2max</sub> is without doubt a great measure... but it does have its limitations. VO<sub>2max</sub> does not take account of a person's individual biomechanics and running technique. Perhaps the best way to demonstrate this is to consider other athletes who have huge VO<sub>2max</sub> measurements; rowers and cyclists both achieve phenomenal figures parable with runners, but ask a rower or cyclist to run a 10k race, and they would likely perform at a lower level than you would expect! For that reason, we need a

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measure that not only includes a physiological measure, but also takes into account biomechanics and running technique.

## Running economy

A great measure of running performance is termed 'Running Economy' (RE). Running economy can be defined as 'The oxygen uptake required for a given velocity of running'. Oxygen uptake is measured in millilitres of oxygen per kilogram bodyweight (as per  $VO_{2max}$ ). Velocity is measured in kilometres per hour (kph) or metres per second ( $ms^{-1}$ ). Typical values would be:

Athlete	Running speed (kph)	Male (ml/kg/min)	Female (ml/kg/min)
Elite runner	16	39 (East African Olympic runner)	44.0 (Paula Radcliffe)
Highly trained runner	16	50.6	54.5
Moderately trained runner	16	51.4	52.9
Recreational runner	14 (reduced speed)	47.4	47.3

## Factors affecting running economy

Running economy is affected by any factor that impedes or benefits running velocity. These may include:

1. Metabolic efficiency
  - Core temperature
  - Muscle fibre type
  - Substrate utilisation
2. Cardiorespiratory efficiency
  - $VO_{2max}$
  - Heart rate
  - Minute ventilation
3. Training
  - Training history
  - Training type
  - Training phase
  - Quality v quantity
  - Fatigue
  - Training surface
4. Biomechanical efficiency
  - Anthropometrics
  - Running style

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- Gait
  - Kinematics
  - Flexibility
5. Core strength
    - The ability to resist rotational force in the running movement
  6. Neuromuscular efficiency
    - Neural signalling
    - Motor programming
    - Force production
    - Stiffness

Therefore, any intervention that can improve these factors and thus running economy are sought after. This article looks specifically at the difference a programme of resistance training may be able to make.

## Resistance training modalities

Resistance training for running performance comes in 3 main forms:

### 1. Plyometric training

Very fast foot contacts with the ground that utilise the stretch-reflex (Stretch Shortening Cycle) to increase rate of force development of a muscle as well as muscle-tendon 'stiffness'.

### 2. Explosive weight training

Resistance training with barbells or other apparatus that adds a load to a movement. These exercises are performed with maximal intent to move quickly and may typically use loads of 40-80% 1RM.

### 3. Traditional weight training

Barbell or dumbbell exercises completed at a steady tempo to repetition maximum.

Studies have shown that all 3 methods of resistance training may have benefits to running economy:

Study	Resistance training	Running economy improvement
Spurrs et al (2003)	8 plyometric exercises 2 sets of 10 reps 2-3 sessions per week 6 weeks total duration	RE change at 3 different speeds: @12kph + 6.7% @14kph + 6.4% @16kph + 4.1%

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Turner et al (2003)	<p>6 plyometric exercises</p> <p>1 set of 5-25 reps</p> <p>3 sessions per week</p> <p>6 weeks total duration</p>	<p>Average change over 3 velocities (2.23, 2.68 3.13 ms<sup>-1</sup>):</p> <p>+ 2.3%</p>
Paavolainen et al (1999)	<p>Various sprints and jumping exercises (reps and sets not detailed)</p> <p>Plus explosive weight training:</p> <p>Leg press, knee-extensor/flexor exercises</p> <p>30-200 contractions</p> <p>5-20 reps per set</p> <p>40% 1RM</p> <p>2-3 sessions per week</p> <p>9 weeks total duration</p>	<p>RE change +8.1%</p>
Millet et al (2002)	<p>6 exercises</p> <p>3-5 reps</p> <p>3-5 sets</p> <p>2 sessions per week</p> <p>14 weeks total duration</p>	<p>+ 5.6-6.9%</p>
Johnston et al (1997)	<p>Both explosive and heavy weight (3-5 sets 90% 1RM) training were used for 2-group study</p>	<p>RE change +6.2% in the heavy weight training group only</p> <p>(no change in explosive resistance training group)</p>

## Resistance training mechanisms for running economy improvement

The exact way that resistance training may benefit RE are multi-factoral and may include:

- Increased activation of motor units with less hypertrophy than traditional weight training, meaning that more force can be produced with no offset from increased body mass.
- More efficient recruitment of motor units.
- Better motor unit synchronisation.

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- Faster rate of force development of a muscle
- Increased stiffness of muscle-tendon unit meaning better storage and utilisation of elastic energy.
- Conversion of muscle fibres from fast twitch glycolytic (Type IIb) to fast twitch oxidative (Type IIa).

If you want to read a full journal article on the 'Effects of Strength Training on Running Economy', follow this link:

[https://elitetrack.com/article\\_files/strength-training-running-economy.pdf](https://elitetrack.com/article_files/strength-training-running-economy.pdf)

## Exercises that may benefit running economy

### Plyometric exercises

- Hops
- Skips
- Bounds
- Jumps

### Explosive resistance training

- Olympic movements
  - Cleans
  - Snatch
  - Power cleans
  - Power snatch
  - Hang cleans
  - Hang snatch
- Med ball/slam ball throws
- Resisted jumps

### Traditional strength training

- Squats
- Lunges
- Split squats
- Leg press
- Leg extension
- Leg curl

For more information on some of these training methods, please see my other articles: [www.trainermaker.com/reading-room](http://www.trainermaker.com/reading-room)

You can also read a fantastic article by the co-writer of this article with example session on this link:

<https://www.fastrunning.com/fast-10/2020/paul-navesey/how-i-put-together-my-sc-plan/28904>