The Marathon Runner:
Periodized 12-Week (Resistance) Training Programme

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Factors that affect Distance Running Performance

The primary factors that affect distance running performance are: 1) Maximal oxygen consumption (VO_{2max}), 2) Lactate threshold (LT), and 3) Running economy (Bassett & Howley, 2000; Daniels, 1985; Jones & Carter, 2000). However, among top levels athletes with similar VO_{2max} values, LT, and running economy, it has been suggested that muscular factors that limit endurance performance may be better predictors of determining success than VO_{2max}, and that differences in anaerobic power may be a determining factor in performance for well-trained runners (Noakes, 1988, as cited in Jung, 2003).

Evidence in the literature suggests that resistance training (RT) may have a positive impact on distance running performance (Johnston, Quinn, Kertzer & Vroman, 1997; Paavolainen, Hakkinen, Hamalainen, Nummela, Rusko, 1999).

Resistance Training

The marathon runner has several goals for utilizing RT in their training programme:

- To increase muscular endurance and strength;
- To improve anaerobic power; and
- To promote neural adaptations, in turn improving running economy.

On page 2 is an example of a periodized 12-week resistance training programme for a marathon runner. (Note that the marathon runner would also be completing aerobic training on top of this – an example of aerobic training is included on page 7 of this article).

Resistance Training Programme

	Endurance	**Strength/ Strength Endurance**	**Strength / Anaerobic Power**	**Anaerobic Power**
Sessions/Week	2-3 (i.e. Mon/Wed/Sat)	2 (i.e. Mon/Wed)	1-2 (i.e. Mon/Thurs)	2 (i.e. Mon/Thurs)
Sets (working)	6-12	2-6	3-5	Plyometrics 1-3
Reps	12-15	4-6	2-5	Plyometrics
Intensity	Moderate	Moderate to High-Intensity	High-Intensity to Maximal	Maximal
Rest/Recovery Periods	30-60 sec	2-3 min	2-5 min	2-5 min
Change Progression	Weeks 1-6	Weeks 3-6	Week 6-9	Weeks 6-12

These are examples of resistance training sessions (and what kind of resistance training system was used) for each different phase of the marathon runner's macrocycle:

Endurance (Recovery is 60 seconds between exercises)

<u>Lower Body</u> (Single Set System)
Squat 1 x 12-15
Lying Leg Curl 1 x 12-15
Alternate Lunges (forward) 1 x 12-15 (per leg)
Hip Extensions 1 x 12-15 (per leg)
Calf Raises (double-legged) 1 x 12-15
Abs a. hanging knee raises 1 x 15
b. swissball crunches 1 x 15
Swissball Back Extensions 1 x 15

<u>Upper Body</u> (Single Set System)
Close-Grip Pull-Ups 1 x 10-12
Flat Dumbbell Bench Press 1 x 12
Wide-Grip Lat Pull-Down 1 x 12-15
Seated Dumbbell Shoulder Press 1 x 12
Dips 1 x 12-15
Abs a. hanging knee raises 1 x 15
b. swissball crunches 1 x 15

Full-Body (Single Set System)

Squat 1 x 12-15

Lying Leg Curl 1 x 12-15

Alternate Lunges (forward) 1 x 12-15 (per leg)

Hip Extensions 1 x 12-15 (per leg)

Calf Raises (double-legged) 1 x 12-15

Swissball Back Extensions 1 x 15

Flat Dumbbell Bench Press 1 x 12

Lat Pull-Down 1 x 12-15

Seated Dumbbell Shoulder Press 1 x 12

Dips 1 x 12-15

Abs a. hanging knee raises 1 x 15

b. swissball crunches 1 x 15

Strength (Recovery is 2-3 minutes between working sets)

Lower Body (Multi Set System)

Squat 2 x 12-15 (warm-up sets)
3 x 5-6 RM (working sets)

Lying Leg Curl 2 x 12-15 (warm-up sets)
3 x 5-6 RM (working sets)

Abs a. hanging knee raises 1 x 15

b. swissball crunches 1 x 15

Upper Body (Multi Set System)

Flat Barbell Bench Press 2 x 12-15 (warm-up sets)
3 x 5-6 RM (working sets)

Lat Pull-Down 2 x 12-15 (warm-up sets)
3 x 5-6 RM (working sets)

Anaerobic Power (Recovery is 2-5 minutes between sets)

A mixture of Strength (but at lower RM and recovery 2-5 minutes) and Plyometrics Training in a week.

Plyometrics (Recovery is 2-5 minutes between sets)

Lower Body

Alternate Split-Squat jump 2 x 10

Single Arm-Leg Alternate Bounding 2 x 40 metres

Side-to-Side Box Jumps 2 x 10 (per side)

Upper Body

Plyometric Push-Ups 3 x 10

Side-to-Side m/b Throw 2 x 20 total

Medicine Ball (m/b) Sit-Ups 2 x 15

Resistance Training Systems used in the Marathon Runner's Resistance Training Programme

Single-Set System

The single-set system for the athlete on an in-season training programme that has limited time to devote to RT and wants increases in strength, motor performance, and body composition (Fleck & Kraemer, 1997). It is to be performed 1-2 times per week, with 1 set for 8-12 reps per exercise.

Multi-Set System

The multi-set system is superior to single-set system for gains in [maximal] strength (Fleck & Kraemer, 1997). Johnston, et a. (1997) found that 9 weeks of 2-3 sets of 6-20 RM increased running economy in trained female distance runners. Even a Bulk system of 3 sets of 5-6 reps at 5-6 repetition maximum (RM) during the Strength/Strength Endurance Phase will increase isometric strength of the back and legs (Fleck & Kraemer, 1997).

Plyometrics

Plyometrics are explosive movements and include weighted and unweighted exercises, such as bounding, jumps, leaps, etc. Plyometrics improve use of stored elastic energy and motor unit synchronisation (Jung, 2003); therefore they are used to increase ability to store and recover elastic energy, decrease ground contact time, and improve running economy (Paavolainen, et al., 1999).

Benefits of Resistance Training for the Marathon Runner

Benefits of resistance training for the marathon runner include:

- Improve endurance performance in trained individuals (Johnston, et al., 1997).
- Long-term endurance (time to exhaustion @ 80% VO2max) improved in trained athletes (Jung, 2003).
- Combined resistance with endurance training attenuates strength gains (Hennessy & Watson, 1994).
- Muscle fibres capable of producing more absolute force; therefore able to work at lower % of maximum strength during endurance exercise (Jung, 2003), decrease in anaerobic energy production; decrease in blood lactate (Marcinik, et al., 1991).

- Increase glycogen content of trained muscle (Tanaka & Swensen, 1998).
- Improved anaerobic power (and strength), abilities needed for attacking, hill climbing, and the final sprinting (Tanaka & Swensen, 1998).
- Improvement in running economy (Johnston, et al., 1997; Paavolainen, 1999):
  - Combination of improved muscle mechanics and neuromuscular efficiency may result in decreased oxygen consumption – improved running economy;
  - Increase in strength from RT improves mechanical efficiency, muscle coordination, and motor recruitment patterns (Sale, 1988, as cited in Folland & Williams, 2007);
  - Improve stretch-shortening cycle (Paavolinen, et al., 1999);
  - Decreased joint stiffness, by improved co activation of the leg muscles surrounding joints = allow runners to run at increased speeds (Scingeour, et al, 1986, as cited in Folland & Williams, 2007);
  - Improvements in running economy made in 10 weeks or less (Jung, 2003).

Physiological Adaptations to Resistance Training in the Marathon Runner

Resistance training causes quite a few changes, both muscular and neurological.

Muscular Changes

Quite a few muscular changes occur as a result of RT. Type IIb muscle fibres are transformed into Type IIa fibres (Tanaka & Swensen, 1998). There is an increase in myofibre size and volume after 8- 12 weeks of training (Folland & Williams, 2007), which increases muscular force production (Fitz & Widrick, 1996, as cited in Tanaka & Swensen, 1998); but despite muscle hypertrophy capillary density remains unchanged (Tanaka & Swensen, 1998). Increases in angle of fibre pennation also contribute to increased strength and force production (Folland & Williams, 2007). Other positive effects of RT in the muscle include hyperplasmia (Tanaka & Swensen, 1998), increased activity of anaerobic enzymes (Tanaka & Swensen, 1998), and increased intracellular muscle glycogen (Tanaka & Swensen, 1998).

Neurological Changes

Paavolinen, et al. (1999) suggested that improvements in endurance performance are likely to be because of neural adaptations. Neural adaptations include improved motor recruitment and

synchronisation (Folland & Williams, 2007), enhanced rate of force development (Folland & Williams, 2007), improved reflex activity (Folland & Williams, 2007), and improvements in stretch-shortening cycle (Folland & Williams, 2007).

Dangers of Resistance Training

There are dangers as well as benefits to RT. Doing the wrong type of training (i.e. pre-season training in-season) can affect the marathon runner. Too high a frequency of RT in-season (i.e. overtraining, caused in conjunction with running mileage) is another danger. Lastly, lack of form during RT increases risk of injury.

Other Considerations

Other factors aside from training will affect the marathon runner's performance. Such factors include nutritional and psychological considerations.

Nutritional

Pre- and post RT/Plyometric training is important for performance and recovery. For example, simple sugars post-training are important to speed up recovery process and replenish muscle glycogen (Burke, 2006). The marathon runner also needs to ensure that they consume enough protein (1.2-1.6 g/kg/day) per day to maintain muscle protein and prevent protein catabolism (Tarnopolsky, 2006). Supplementation can also help the marathon runner in their training to achieve training and performance goals; for example, creatine (helps with strength gains), etc. (Burke, et al., 2006).

Psychological

Psychological skills training is as important to the marathon runner as physical training (Hardy, Jones & Gould, 1997; Hodge, 2007; Orlick, 2000; Weinberg & Gould, 1999). Psychological skills that the marathon runner would definitely benefit from are positive self-talk and mental imagery/visualization (i.e. visualizing the muscle/s that are being used, in contraction; movement of exercise, etc.)

Aerobic Training Programme for a Marathon Runner (Example)

Marathon distance running programme

Base I: (total km = 47)

	Training type	Training intensity	% of total week	hard/easy day
Mon	Day off			E
Tues	Run 4–6 km (20–30 min)	LO	12.8%	H
Wed	Day off			E
Thurs	Run 10–15 km (50 min–1 hr 15 min)	LO	31.9%	H
Fri	Day off			E
Sat	Run 4–6 km (20–30 min)	LO	12.8%	H
Sun	Run 10–20 km (50 min–1 hr 40 min)	LO	42.5%	H

Base II: (total km = 84)

Mon	Easy run 4–6 km (20–30 min)	LO	7.1%	E
Tues	Med 6–12 km (30–60 min)	LO	14.3%	H
Wed	Easy run 4–6 km (20–30 min)	LO	7.1%	E
Thurs	Med long 15–20 km (1 hr 15 min–1 hr 40 min)	LO	23.8%	H
Fri	Day off			E
Sat	Easy run 5–10 km (25–50 min)	LO	11.9%	H
Sun	Long run 30 km (2.5 hr)	LO	35.8%	H

Key: Med = medium; (LO) = low intensity; E = easy; H = hard.

Speed training

Speed: (total km = 78)

	Training type	Training intensity	% of total week	hard/easy day
Monday	Easy run 6 km (30 min)	LO	7.7%	E
Tues	INTS 4–6 × 6–8 min (SM) 4–1 min rest btwn = 10 km (50 min)	LO/SM	12.8%	H
Wed	Easy run 6 km (30 min)	LO	7.7%	E
Thurs	Med long 20 km (1 hr 40 min)	LO/UT	25.6%	H
Fri	Day off			E
Sat	INTS 2–4 × 10–15 min (RP); rest 10–2 min btwn = 6 km (30 min)	LO/RP	7.7%	H
Sun	Long 30 km (2.5 hrs)	LO	38.5%	H

Key: LO = low intensity; SM = submaximal intensity; UT = up-tempo; INTS = intervals; btwn = between; min = minutes; MED = medium; H = hard; E = easy.

(Ackland, 1996, p. 300).

REFERENCE LIST

Ackland, J. (1996). *The power to perform: A comprehensive guide to training and racing for endurance athletes* (Revised ed.). Auckland, New Zealand: Reed Books.

Bassett, D. R. & Howley, E. T. (2000). Limiting factors for maximum oxygen uptake and determinants of endurance performance. *Med Sci Sports Exerc, 32*(1). (p. 70-84).

Burke, L. (2006). Nutrition for recovery after training and competition. In L. Burke & V. Deakin (Eds.) *Clinical sports nutrition* (3rd ed.). (p. 415-453). NSW, Australia: McGraw-Hill.

Burke, L., Cort, M., Cox, G., Crawford, R., Desbrow, B., Farthing, l., Minehan, M., Shaw, N. & Warnes, O. (2006). Supplements and sports foods. In L. Burke & V. Deakin (Eds.) *Clinical sports nutrition* (3rd ed.). (p. 485-579). NSW, Australia: McGraw-Hill.

Daniels, J. T. (1985). A physiologist's view of running economy. *Med Sci Sports Exerc, 17*(3). (p. 332-338).

Fleck, S. J. & Kraemer, W. J. (1997). *Designing resistance training programmes.* Champaign, IL, USA: Human Kinetics.

Folland, J. P. & Williams, A. G. (2007). The adaptations to strength training: Morphological and neurological contributions to increased strength. *Sports Med, 37*(2). (p. 145-168).

Hennessy, L. C. & Watson, A. W. C. (1994). The interference effects of training for strength and endurance simultaneously. *J Strength Cond Res, 8*(1). (p. 12-19).

Johnston, R. e., Quinn, T. J., Kertzer, R. & Vroman, N. B. (1997). Strength training in female distance runners: Impact on running economy. *J Strength Cond Res, 11*(4). (p. 224-229).

Jones, A. M. & Carter, H. The effect of endurance training on parameters of aerobic fitness. *Sports Med, 29*(6). (p. 373-386).

Jung, A. P. (2003). The impact of resistance training on distance running performance. *Sports Med, 33*(7). (p. 539-552).

Marcinik, E. J., Potts, J., Schlabach, G., Will, S., Dawson, P. & Hurley, B. F. (1991). Effects of strength training on lactate threshold and endurance performance. *J Appl Physiol, 23*(6). (p. 739-743).

Paavolainen, l., Hakkinen, K., Hamalainen, I., Nummela, A. & Rusko, H. (1999). Explosive strength training improves 5km running time by improving running economy and muscle power. *J Appl Physiol, 86*(5). (p. 1527-1533).

Tanaka, H. & Swensen, T. (1998). Impact of resistance training on endurance performance: A new form of cross-training. *Sports Med, 25*(3). (p. 191-200).

Tarnopolsky, M. (2006). Protein and amino acid needs for training and bulking up. In L. Burke & V. Deakin (Eds.) *Clinical sports nutrition* (3rd ed.). (p. 73-111). NSW, Australia: McGraw-Hill.

BIBLIOGRAPHY

Ackland, J. (1998). *Precision training: Training programmes for 27 sports using heart rate monitors*. Auckland, New Zealand: Reed Books.

Bean, A. (2001). *The complete guide to strength training* (2nd ed.). London, GB: A & C Black.

Dawson, B. (1996). Periodisation of speed and endurance training. In P. Reaburn & D. Jenkins (Eds). *Training for speed and endurance.* (p. 76-96). NSW, Australia: Allen & Unwin Pty.

Fredericson, M. & Misra, A. K. (2007). Epidemiology and aetiology of marathon running injuries. *Sports Med, 37*(4-5). (p. 437-439).

Morgan, G. T. & Glywyn, G. H. (1997). *Cross-training for sports: Programs for 26 sports.* Champaign, IL, USA: Human Kinetics.

Potach, D. H. & Chu, D. A. (2000). Plyometric training. In T. R. Baechle & R. W. Earle (Eds.). *Essentials of strength training and conditioning* (2nd e.). (p. 427-470). Champaign, IL, USA: Human Kinetics.