CityU Briefing Session for Standard Chartered Hong Kong Marathon 2016-2017

Coach: Wong Tak Shing

About me...

Year	Coaching
1997-2002, 2006-2014	Lecturer of Level 1, 2, and 3 (Sports Psychology) Sports Coaching Courses of the Hong Kong Coaching Committee
2006-2010	Tutor/Coach of Joint Sports Centre* Running Classes
2007-2008	Tutor/Coach of CityU Quali-run for Wellness 2007
2007-now	Tutor/Coach of CityU Standard Chartered Hong Kong Marathon Running Classes
2009-2012	Tutor/Coach of BU Standard Chartered Hong Kong Marathon Running Classes

* Joint Sports Centre – BU, CityU, and PolyU

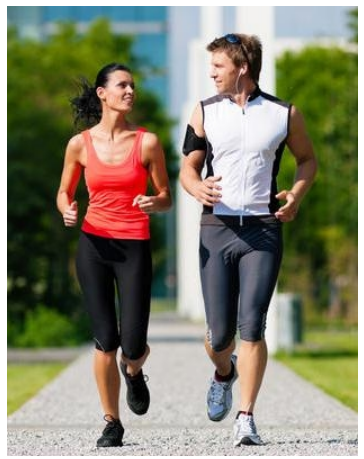
About me...

Year	Coaching
1984-1987	Coach (middle & long distance) of Colgate Women Athletics Training Course
1987-now	Teacher-in-charge of Athletics and Cross Country Team at school
1996-1998	Coach (middle & long distance) of HKAAA Athletics Junior Squad
1996-2001	Coach (middle & long distance) of TCAA Summer Athletics Training Course
1997-Feb	Team Manager of Hong Kong Junior Cross Country Team for the 4th Asian Cross Country Championships

Reasons for Running

Ng & Lonsdale (2010)

- Five main reasons for running:
  1. Physical health
  2. Mental health
  3. Social factors
  4. Achievements
  5. Fun



Reasons for Running

Curtis & McTeer (1981)

- For most marathon runners,
  - At the beginning
    - Physical and mental health
  - Eventually
    - Achievements and challenges

What is Training?

Klafs & Arnheim (1981)

- Training is a systematic process of repetitive and progressive exercise of work.
- Through systematic training and constant repetition, movements become more automatic and require less concentration by the higher nerve centers.
  - As a result, the amount of energy expended is reduced.

Goals for Running

- Just for health & fitness
- Just to finish the race
- To achieve personal best
- To obtain medals

Singer (1986, p. 31)

- "If you don't know where you're going, it is difficult to select a suitable means of getting there."

How to Train?

- What to train?
  - Running, cycling, swimming, weight training
- How much?
  - More is better?
  - Practice makes perfect?
- How hard?
  - No pain, no gain?

More is Better?

Grand, et al. (1984)

- Mileage↑ ⇒ Performance↑ (but, $r^2 = 0.1444$)
- 74% of runners who trained an average of 60 km/week claimed that they had different degrees of overuse injuries.

Fredericson, et al. (2007)

- Risks of running injuries significantly increase when the weekly mileage exceeds 40 miles (64 km).

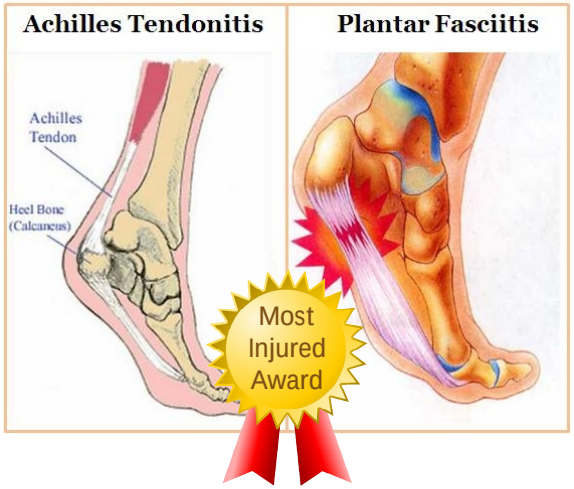
No Pain, No Gain?

Practice Makes Perfect?

Vernacchia, McGuire & Cook (1992, p. 105)

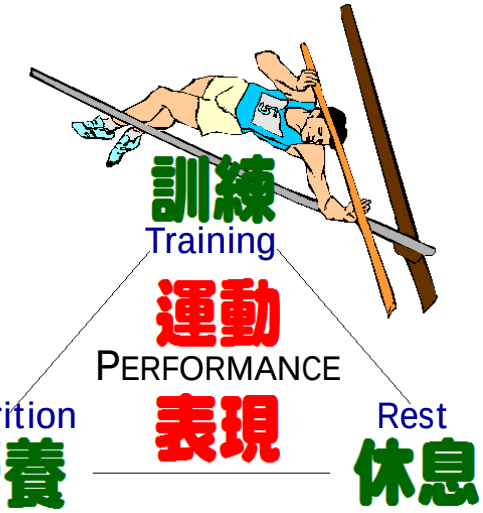
- "Practice does not make perfect; perfect, planned, purposeful practice makes perfect."

No Pain, No Gain?



The Scientific Basis of Training

- Rest and nutrition are too often neglected.
- The longer the race, the more important is nutrition.

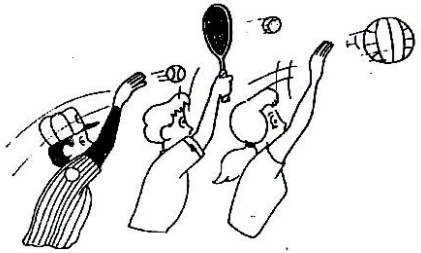


The Scientific Basis of Training

- Biomechanics
  - Analysis of running skills
  - Running economy
  - Wind resistance & equipment

The Scientific Basis of Training

- Sports Psychology
  - Psychological skills: goal setting, arousal management, concentration & relaxation, imagery, building up confidence, ...
  - Cognitive strategies: association and dissociation
- Motor Learning
  - Acquisition of skills
  - Transfer of learning

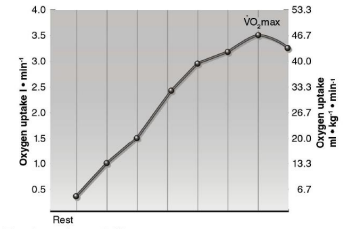


The Scientific Basis of Training

- Nutrition
  - Energy systems of the human body
  - Balanced diet & weight control
  - Water replacement and fuel supply during training and competition
  - Pregame meal & carbohydrate loading

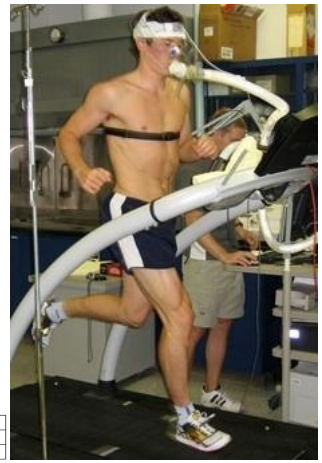
The Scientific Basis of Training

- Exercise Physiology
  - Principles of Training
  - Training Methods

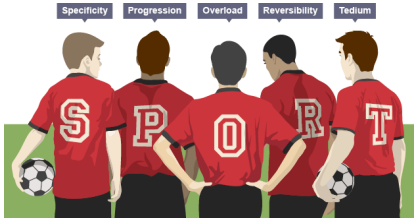


Exercise on the treadmill

Speed km/h	4.8	8.0	11.2	11.2	11.2	11.2	11.2
Treadmill grade, %	0	5.5	7.5	9.5	11.5	13.5	15.5
Time, min	0-2	2-4	4-6	6-8	8-10	10-12	12-14



Principles of Training



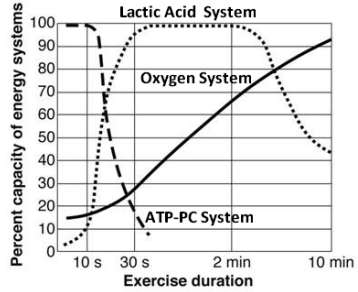
- Principle of Specificity
  1. Energy system
  2. Exercise mode
- Principle of Progressive Overload
- Principle of Hard and Easy Days
- Principle of Periodization

Wong-Sir's Comments on Running Skills

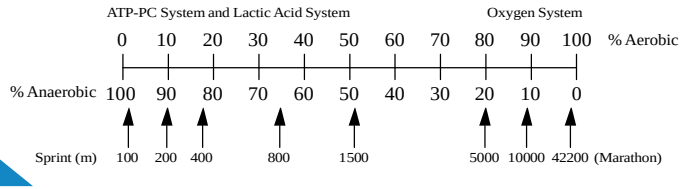
- Vertically aligned head and body.
- Look forward and further away.
- Arms bent at 90° or smaller at the elbow.
- Do not over stride.
- Use forefoot strike or mid-foot strike, avoid heel strike.
- Land within 30 cm in front of the projection of the C.G. on the ground.
- Run in a steady and relax manner.
- Do not overemphasis arms movement.

Principle of Specificity

1. Specificity of Energy System
   - ATP-PC system: Less than 10 s
   - Lactic acid system: 30 s to 2 min
   - Oxygen system: Over 3 min



The Energy Continuum for Selected Track Events

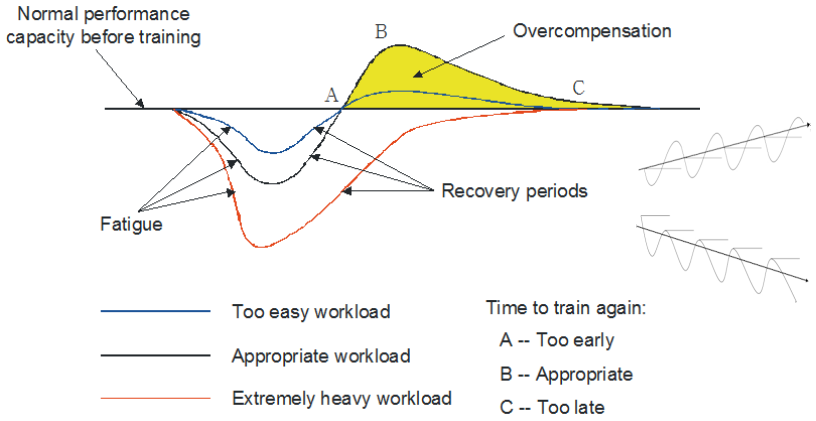


Principle of Specificity

2. Specificity of Exercise Mode

- Cyclists should pedal
- Swimmers should swim
- Runners should RUN

Principle of Progressive Overload



Principle of Progressive Overload

- Once the athlete has adapted to a workload of the training program, the workload should be increased.
- The workload should be increased progressively throughout the training program whenever the condition of the athlete has been improved so that the workload is always near to the maximal fitness capacity of the athlete.

Principle of Hard and Easy Days

Grobler, et al. (2004)

- Prolonged, exhaustive endurance exercise can induce skeletal muscle damage and temporary impairment of muscle function.

Knitter, et al. (2000)

- If the exercise involves a large eccentric component, such as downhill running, damage is generally more severe.

Principle of Hard and Easy Days

Gómez, et al. (2002)

- It took about 48 hours to recover from a 10-Km race.

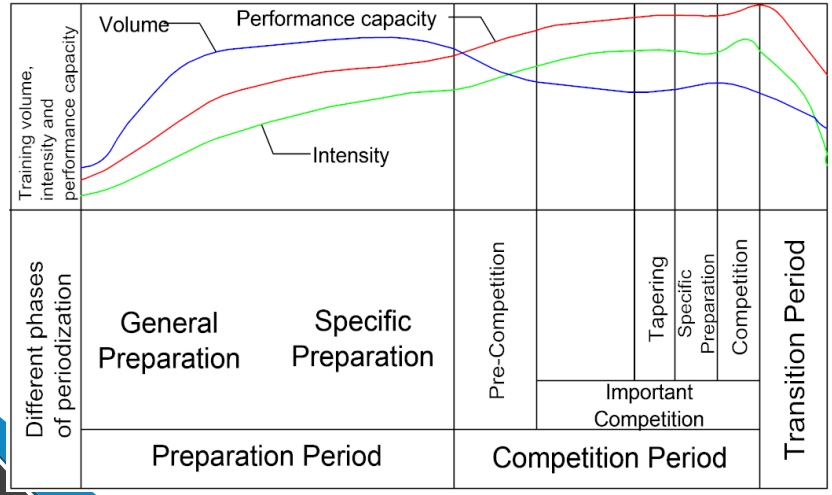
Grobler, et al. (2004)

- Evidence suggested that the repairing process after a 42.2 Km Marathon race might take 1 to 10 weeks to be completed.

Training Methods

- Continuous Running Training
- Interval Training
- Fartlek
- Hill running
- Time trial
- ...

Principle of Periodization



Continuous Running Training

Fox, Bowers, & Foss (1993)

1. Continuous Slow-Running Training
   - Generally, athletes should cover from 2 to 5 times of their race distance at a pace that can bring their heart rate to 80 to 85% of the HR_{max} (i.e., maximal heart rate).
   - Use as foundation training before moving up to continuous fast-running training, or as easy running sessions on recovery days.

$$HR_{max} = 220 - age$$

Continuous Running Training

Fox, Bowers, & Foss (1993)

2. Continuous Fast-Running Training
   - The intensity of the run should bring the athlete's heart rate to 85 to 95% of the HR_{max}.
   - Simulates the race situation better than continuous slow-running training.

Interval Running Training

Åstrand et al. (1960)

	Workload	Work	Rest	Total Time	Blood Lactate Concentration	Feeling of Subject
Continuously	350W	-	-	9 min	16.5 mM	Exhausted
Intermittently		3 min	3 min	30 min	13.2 mM	Exhausted
		30 s	30 s	30 min	2.2 mM	Not too tired

Interval Running Training

- Refers to a series of repeated bouts of runs alternated with periods of recovery.
  - e.g. 1, 20 x 200 m, 60 s each, jog 1 min between each.
  - e.g. 2, 8 x 1000 m, 5 min each, jog 3-4 min between each.
- The intensity or speed of the runs is usually greater or faster than that can be done continuously for the whole training session.
- The recovery periods are usually occupied by light or mild exercise (e.g., walking or jogging) rather than complete rest.
- Advantage: quantity of the runs can be increased while quality can be maintained.

Interval Running Training

Christensen et al. (1960)

- Running on a treadmill at a speed of 20 km/h (i.e., 2:06 marathon time)
  - The subject could only run continuously for 4 min (covering a distance of about 1300 m)
  - The blood lactic acid level at the end of the test was 16.5 mM.
- When the activity was conducted as alternating periods of 10-s run and 5-s rest
  - the subject completed 20 minutes of running at 20 Km/hr in a 30-min period (covering a distance of 6670 m) without undue fatigue.
  - The blood lactic acid level at the end of the test was only 4.8 mM.

Interval Running Training

Sharkey (1986)

- Approximately equal work and rest intervals between 2 to 5 min seemed to produce the greatest aerobic improvements.
- Shorter work intervals (e.g., 15 s) with a work-rest ratio of 1:1 are also effective in developing the aerobic system.
- For anaerobic training, the maximum duration for any work interval should not exceed 90 s, or the body might switch to the aerobic system to support the ongoing activity.

Training for Health and Fitness

USDHHS (2008) and WHO (2012)

- For Additional and More Extensive Health Benefits
  - Adults should increase their aerobic physical activity to 300 minutes (5 hours) a week of moderate-intensity, or 150 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity activity.
  - Additional health benefits are gained by engaging in physical activity beyond this amount.

Training for Health and Fitness

USDHHS (2008) and WHO (2012)

- For Health Benefits
  - Adults should do at least 150 minutes (2 hours and 30 minutes) a week of moderate-intensity, or 75 minutes (1 hour and 15 minutes) a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity.
  - Aerobic activity should be performed in episodes of at least 10 minutes, and preferably, it should be spread throughout the week.

Training for Health and Fitness

USDHHS (2008) and WHO (2012)

- Moderate-intensity
  - At 3 to 5.9 METs (i.e., 3 to 5.9 times the intensity of rest).
  - About 5 or 6 on a scale of 0 to 10 relative to an individual's personal capacity, where 0 is the level of effort of sitting, and 10 is maximal effort.
  - 2.5 mph or 4 km/h (3 METs) or faster (Ainsworth et al., 2011).

Training for Health and Fitness

USDHHS (2008) and WHO (2012)

- Vigorous-intensity
  - 6 METs or above (i.e., 6 or more times the intensity of rest).
  - About 7 or 8 on a scale of 0 to 10 relative to an individual's personal capacity.
  - 4 mph or 6.4 km/h (6 METs) or faster (Ainsworth et al., 2011).
  - 1 minute of vigorous-intensity activity counts the same as 2 minutes of moderate-intensity activity.

Ainsworth, Haskell, & Leon et al. (2011)

The compendium of physical activities（體力活動綱要）

Speed				Intensity
mph	min/mile	min/km	min/400 m	MET
7	8.5	5:17	2:07	11.0
7.5	8	4:58	1:59	11.5
8	7.5	4:40	1:52	11.8
8.6	7	4:21	1:44	12.3
9	6.5	4:02	1:37	12.8

Ainsworth, Haskell, & Leon et al. (2011)

The compendium of physical activities（體力活動綱要）

Speed				Intensity
mph	min/mile	min/km	min/400 m	MET
4	15	9:19	3:43	6.0
5	12	7:27	2:59	8.3
5.2	11.5	7:09	2:51	9.0
6	10	6:13	2:29	9.8
6.7	9	5:36	2:14	10.5

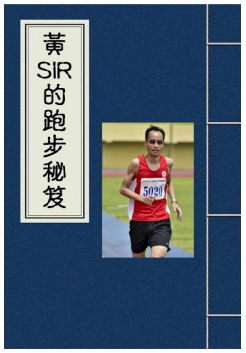
Ainsworth, Haskell, & Leon et al. (2011)

The compendium of physical activities（體力活動綱要）

Speed				Intensity
mph	min/mile	min/km	min/400 m	MET
10	6	3:44	1:29	14.5
11	5.5	3:25	1:22	16.0
12	5	3:06	1:15	19.0
13	4.6	2:52	1:09	19.8
14	4.3	2:40	1:04	23.0

Wong-Sir's Comments on Training for Race Performance

- No definite answer from authorities
- Take part in a race for the first time
  - Goal: Finish the race
- Take part in the race again
  - Goal: PB or medal
- Pace judgement is extremely important



Constant Speed Tables for Selected Distances

100 m	200 m	300 m	400 m	600 m	800 m	1000 m	1200 m	1500 m	1 Mile	2000 m	3000 m	4000 m	5000 m	10000 m	H-Mar	Marathon
0:00:15	0:00:30	0:00:45	0:01:00	0:01:30	0:02:00	0:02:30	0:03:00	0:03:45	0:04:01	0:05:00	0:07:30	0:10:00	0:12:30	0:25:00	0:52:45	1:45:29
0:00:16	0:00:32	0:00:48	0:01:04	0:01:36	0:02:08	0:02:40	0:03:12	0:04:00	0:04:17	0:05:20	0:08:00	0:10:40	0:13:20	0:26:40	0:56:16	1:52:31
0:00:17	0:00:34	0:00:51	0:01:08	0:01:42	0:02:16	0:02:50	0:03:24	0:04:15	0:04:34	0:05:40	0:08:30	0:11:20	0:14:10	0:28:20	0:59:47	1:59:33
0:00:18	0:00:36	0:00:54	0:01:12	0:01:48	0:02:24	0:03:00	0:03:36	0:04:30	0:04:50	0:06:00	0:09:00	0:12:00	0:15:00	0:30:00	1:03:18	2:06:35
0:00:19	0:00:38	0:00:57	0:01:16	0:01:54	0:02:32	0:03:10	0:03:48	0:04:45	0:05:06	0:06:20	0:09:30	0:12:40	0:15:50	0:31:40	1:06:49	2:13:37
0:00:20	0:00:40	0:01:00	0:01:20	0:02:00	0:02:40	0:03:20	0:04:00	0:05:00	0:05:22	0:06:40	0:10:00	0:13:20	0:16:40	0:33:20	1:10:19	2:20:39
0:00:21	0:00:42	0:01:03	0:01:24	0:02:06	0:02:48	0:03:30	0:04:12	0:05:15	0:05:38	0:07:00	0:10:30	0:14:00	0:17:30	0:35:00	1:13:50	2:27:41
0:00:22	0:00:44	0:01:06	0:01:28	0:02:12	0:02:56	0:03:40	0:04:24	0:05:30	0:05:54	0:07:20	0:11:00	0:14:40	0:18:20	0:36:40	1:17:21	2:34:43
0:00:23	0:00:46	0:01:09	0:01:32	0:02:18	0:03:04	0:03:50	0:04:36	0:05:45	0:06:10	0:07:40	0:11:30	0:15:20	0:19:10	0:38:20	1:20:52	2:41:45
0:00:24	0:00:48	0:01:12	0:01:36	0:02:24	0:03:12	0:04:00	0:04:48	0:06:00	0:06:26	0:08:00	0:12:00	0:16:00	0:20:00	0:40:00	1:24:23	2:48:47
0:00:25	0:00:50	0:01:15	0:01:40	0:02:30	0:03:20	0:04:10	0:05:00	0:06:15	0:06:42	0:08:20	0:12:30	0:16:40	0:20:50	0:41:40	1:27:54	2:55:49
0:00:26	0:00:52	0:01:18	0:01:44	0:02:36	0:03:28	0:04:20	0:05:12	0:06:30	0:06:58	0:08:40	0:13:00	0:17:20	0:21:40	0:43:20	1:31:25	3:02:51
0:00:27	0:00:54	0:01:21	0:01:48	0:02:42	0:03:36	0:04:30	0:05:24	0:06:45	0:07:14	0:09:00	0:13:30	0:18:00	0:22:30	0:45:00	1:34:56	3:09:53
0:00:28	0:00:56	0:01:24	0:01:52	0:02:48	0:03:44	0:04:40	0:05:36	0:07:00	0:07:31	0:09:20	0:14:00	0:18:40	0:23:20	0:46:40	1:38:27	3:16:55
0:00:29	0:00:58	0:01:27	0:01:56	0:02:54	0:03:52	0:04:50	0:05:48	0:07:15	0:07:47	0:09:40	0:14:30	0:19:20	0:24:10	0:48:20	1:41:58	3:23:57
0:00:30	0:01:00	0:01:30	0:02:00	0:03:00	0:04:00	0:05:00	0:06:00	0:07:30	0:08:03	0:10:00	0:15:00	0:20:00	0:25:00	0:50:00	1:45:29	3:30:59
0:00:31	0:01:02	0:01:33	0:02:04	0:03:06	0:04:08	0:05:10	0:06:12	0:07:45	0:08:19	0:10:20	0:15:30	0:20:40	0:25:50	0:51:40	1:49:00	3:38:00
0:00:32	0:01:04	0:01:36	0:02:08	0:03:12	0:04:16	0:05:20	0:06:24	0:08:00	0:08:35	0:10:40	0:16:00	0:21:20	0:26:40	0:53:20	1:52:31	3:45:02
0:00:33	0:01:06	0:01:39	0:02:12	0:03:18	0:04:24	0:05:30	0:06:36	0:08:15	0:08:51	0:11:00	0:16:30	0:22:00	0:27:30	0:55:00	1:56:02	3:52:04
0:00:34	0:01:08	0:01:42	0:02:16	0:03:24	0:04:32	0:05:40	0:06:48	0:08:30	0:09:07	0:11:20	0:17:00	0:22:40	0:28:20	0:56:40	1:59:33	3:59:06
0:00:35	0:01:10	0:01:45	0:02:20	0:03:30	0:04:40	0:05:50	0:07:00	0:08:45	0:09:23	0:11:40	0:17:30	0:23:20	0:29:10	0:58:20	2:03:04	4:06:08
0:00:36	0:01:12	0:01:48	0:02:24	0:03:36	0:04:48	0:06:00	0:07:12	0:09:00	0:09:39	0:12:00	0:18:00	0:24:00	0:30:00	1:00:00	2:06:35	4:13:10
0:00:37	0:01:14	0:01:51	0:02:28	0:03:42	0:04:56	0:06:10	0:07:24	0:09:15	0:09:55	0:12:20	0:18:30	0:24:40	0:30:50	1:01:40	2:10:06	4:20:12
0:00:38	0:01:16	0:01:54	0:02:32	0:03:48	0:05:04	0:06:20	0:07:36	0:09:30	0:10:11	0:12:40	0:19:00	0:25:20	0:31:40	1:03:20	2:13:37	4:27:14
0:00:39	0:01:18	0:01:57	0:02:36	0:03:54	0:05:12	0:06:30	0:07:48	0:09:45	0:10:28	0:13:00	0:19:30	0:26:00	0:32:30	1:05:00	2:17:08	4:34:16
0:00:40	0:01:20	0:02:00	0:02:40	0:04:00	0:05:20	0:06:40	0:08:00	0:10:00	0:10:44	0:13:20	0:20:00	0:26:40	0:33:20	1:06:40	2:20:39	4:41:18
0:00:41	0:01:22	0:02:03	0:02:44	0:04:06	0:05:28	0:06:50	0:08:12	0:10:15	0:11:00	0:13:40	0:20:30	0:27:20	0:34:10	1:08:20	2:24:10	4:48:20
0:00:42	0:01:24	0:02:06	0:02:48	0:04:12	0:05:36	0:07:00	0:08:24	0:10:30	0:11:16	0:14:00	0:21:00	0:28:00	0:35:00	1:10:00	2:27:41	4:55:22
0:00:43	0:01:26	0:02:09	0:02:52	0:04:18	0:05:44	0:07:10	0:08:36	0:10:45	0:11:32	0:14:20	0:21:30	0:28:40	0:35:50	1:11:40	2:31:12	5:02:24
0:00:44	0:01:28	0:02:12	0:02:56	0:04:24	0:05:52	0:07:20	0:08:48	0:11:00	0:11:48	0:14:40	0:22:00	0:29:20	0:36:40	1:13:20	2:34:43	5:09:26
0:00:45	0:01:30	0:02:15	0:03:00	0:04:30	0:06:00	0:07:30	0:09:00	0:11:15	0:12:04	0:15:00	0:22:30	0:30:00	0:37:30	1:15:00	2:38:14	5:16:28
0:00:46	0:01:32	0:02:18	0:03:04	0:04:36	0:06:08	0:07:40	0:09:12	0:11:30	0:12:20	0:15:20	0:23:00	0:30:40	0:38:20	1:16:40	2:41:45	5:23:30
0:00:47	0:01:34	0:02:21	0:03:08	0:04:42	0:06:16	0:07:50	0:09:24	0:11:45	0:12:36	0:15:40	0:23:30	0:31:20	0:39:10	1:18:20	2:45:16	5:30:32
0:00:48	0:01:36	0:02:24	0:03:12	0:04:48	0:06:24	0:08:00	0:09:36	0:12:00	0:12:52	0:16:00	0:24:00	0:32:00	0:40:00	1:20:00	2:48:47	5:37:34
0:00:49	0:01:38	0:02:27	0:03:16	0:04:54	0:06:32	0:08:10	0:09:48	0:12:15	0:13:08	0:16:20	0:24:30	0:32:40	0:40:50	1:21:40	2:52:18	5:44:36
0:00:50	0:01:40	0:02:30	0:03:20	0:05:00	0:06:40	0:08:20	0:10:00	0:12:30	0:13:25	0:16:40	0:25:00	0:33:20	0:41:40	1:23:20	2:55:49	5:51:38
0:00:51	0:01:42	0:02:33	0:03:24	0:05:06	0:06:48	0:08:30	0:10:12	0:12:45	0:13:41	0:17:00	0:25:30	0:34:00	0:42:30	1:25:00	2:59:20	5:58:39
0:00:52	0:01:44	0:02:36	0:03:28	0:05:12	0:06:56	0:08:40	0:10:24	0:13:00	0:13:57	0:17:20	0:26:00	0:34:40	0:43:20	1:26:40	3:02:51	6:05:41
0:00:53	0:01:46	0:02:39	0:03:32	0:05:18	0:07:04	0:08:50	0:10:36	0:13:15	0:14:13	0:17:40	0:26:30	0:35:20	0:44:10	1:28:20	3:06:22	6:12:43
0:00:54	0:01:48	0:02:42	0:03:36	0:05:24	0:07:12	0:09:00	0:10:48	0:13:30	0:14:29	0:18:00	0:27:00	0:36:00	0:45:00	1:30:00	3:09:53	6:19:45
0:00:55	0:01:50	0:02:45	0:03:40	0:05:30	0:07:20	0:09:10	0:11:00	0:13:45	0:14:45	0:18:20	0:27:30	0:36:40	0:45:50	1:31:40	3:13:24	6:26:47
0:00:56	0:01:52	0:02:48	0:03:44	0:05:36	0:07:28	0:09:20	0:11:12	0:14:00	0:15:01	0:18:40	0:28:00	0:37:20	0:46:40	1:33:20	3:16:55	6:33:49
0:00:57	0:01:54	0:02:51	0:03:48	0:05:42	0:07:36	0:09:30	0:11:24	0:14:15	0:15:17	0:19:00	0:28:30	0:38:00	0:47:30	1:35:00	3:20:26	6:40:51
0:00:58	0:01:56	0:02:54	0:03:52	0:05:48	0:07:44	0:09:40	0:11:36	0:14:30	0:15:33	0:19:20	0:29:00	0:38:40	0:48:20	1:36:40	3:23:57	6:47:53
0:00:59	0:01:58	0:02:57	0:03:56	0:05:54	0:07:52	0:09:50	0:11:48	0:14:45	0:15:49	0:19:40	0:29:30	0:39:20	0:49:10	1:38:20	3:27:28	6:54:55
0:01:00	0:02:00	0:03:00	0:04:00	0:06:00	0:08:00	0:10:00	0:12:00	0:15:00	0:16:05	0:20:00	0:30:00	0:40:00	0:50:00	1:40:00	3:30:59	7:01:57

Published by Wong-Sir from http://www.tswongsir-runners.guide/

Wong-Sir's Comments on Training for Race Performance

Pace Running

- Run at a steady pace as much as possible.
  - Newton's 1st and 2nd laws of motion
- Most of the runs should be conducted at race pace or slightly faster than race pace.
  - To facilitate Transfer of Learning

Determinants of Aerobic Performances

Joyner & Coyle (2008)

- Maximal oxygen consumption ($\dot{V}O_2max$), anaerobic threshold (AT) and running economy (RE) are the three main factors appear to play key roles in endurance performance.

Midgley, et al. (2007)

- These three determinants explain > 70% of the between-subject variance in long distance running performance.

Determinants of Aerobic Performances

Helgerud et al. (2007)

- Among these three, $\dot{V}O_2max$ is probably the single most important factor determining success in aerobic endurance sport.

$\dot{V}O_2max$

The Fick Equation

Subjects	SV_{rest} (ml/beat)	SV_{max} (ml/beat)
Untrained	50-70	80-110
Trained	70-90	110-150
Highly trained	90-110	150-220+

- $\dot{V}O_2 = \dot{Q} \times (a - \bar{v})O_2$ difference

  $= HR \times SV \times (a - \bar{v})O_2$ difference

Bassett & Howley (2000)

- In the exercising human, $\dot{V}O_2max$ is limited primarily by the rate of oxygen delivery (70-85% linked to maximal cardiac output), not the ability of the muscle to take up oxygen from the blood

$\dot{V}O_2max$

$\dot{V}O_2max$

- Known as maximum oxygen consumption, maximal oxygen uptake, or maximal aerobic power.
- The dot over the letter V (i.e., $\dot{V}$) simply means per minute.

Bassett & Howley (2000)

- Defined as the highest rate at which oxygen can be taken up and utilized by the body during severe exercise.

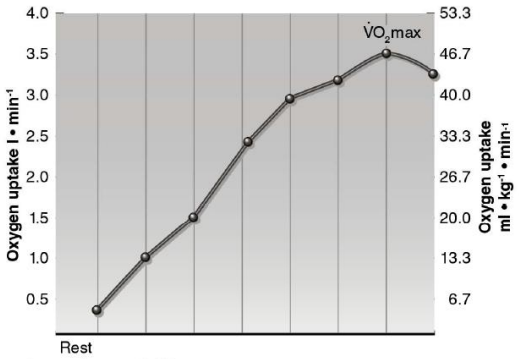
$\dot{V}O_2max$

Joyner & Coyle (2008)

- Champion endurance athletes have $\dot{V}O_2max$ values of between 70 and 85 ml/kg/min, which may be 50-100% greater than those seen in normally active healthy young subjects.
- Values in women are typically averaging about 10% lower due to lower hemoglobin concentrations and higher levels of body fat.

$\dot{V}O_2max$

- $\dot{V}O_2$ increases as the intensity of exercise increases, until a plateau (i.e., $\dot{V}O_2max$) is reached.



Exercise on the treadmill

Speed km/h	4.8	8.0	11.2	11.2	11.2	11.2	11.2
Treadmill grade, %	0	5.5	7.5	9.5	11.5	13.5	15.5
Time, min	0-2	2-4	4-6	6-8	8-10	10-12	12-14

$\dot{V}O_2max$

- Energy cost to run 5000 m in different speeds according to

$\dot{V}O_2$ (ml/kg/min) = 3.5 × Speed (Km/h)

Time	Speed (Km/h)	$\dot{V}O_2$ (ml/kg/min)
20 min	15	3.5 × 15 = 52.5
16 min	18.75	3.5 × 18.75 = 65.63
13 min	23.08	3.5 × 23.08 = 80.78

$\dot{V}O_2max$

Leger and Mercier (1984)

- For speeds between 8 and 25 Km/h, the following linear equation could accurately describe the gross energy cost of track running.

$\dot{V}O_2$ (ml/kg/min) = 3.5 × Speed (Km/h)

$\dot{V}O_2max$

- Often used to assess the aerobic capacity of endurance athletes.
  - Direct Measurement during Maximal Work
    - Provide the most accurate value.
    - Technically demanding and require access to expensive laboratory equipment and skilled personnel.
  - Field Test (e.g., Cooper's 12-minute run/walk Test)
    - Requires great motivation and a knowledge of pacing.

$\dot{V}O_2max$

Uth et al. (2004)

- Formula to estimate $\dot{V}O_2max$ simply by using heart rates (r = 0.87).

$$\dot{V}O_2max\ (ml/kg/min) = 15.0 \times \frac{HR_{max}}{HR_{rest}}$$

$\dot{V}O_2max$

Exercise Prescription using $\dot{V}O_2max$

- Problems
  - Equipment
  - Portability

$\dot{V}O_2max$

Exercise Prescription using $\dot{V}O_2max$

- ACSM (2014)
  - Very light: < 37% $\dot{V}O_2max$
  - Light: 37 to < 46% $\dot{V}O_2max$
  - Moderate: 46 to < 64% $\dot{V}O_2max$
  - Vigorous: 64 to < 91% $\dot{V}O_2max$
  - Near maximal to maximal: ≥ 91% $\dot{V}O_2max$

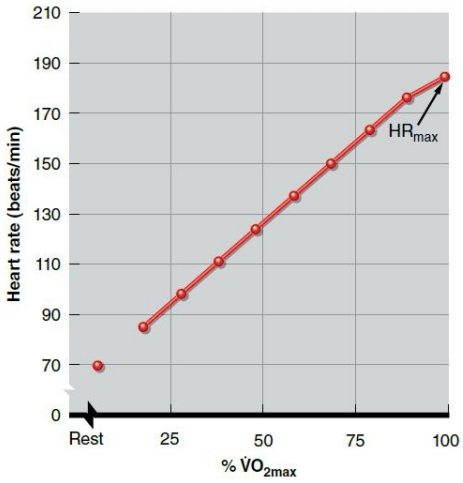
$\dot{V}O_2max$

Alternatives

- Heart Rates
  - Maximal Heart Rate (HR_{max}) Method
  - Heart Rate Reserve (HRR) Method

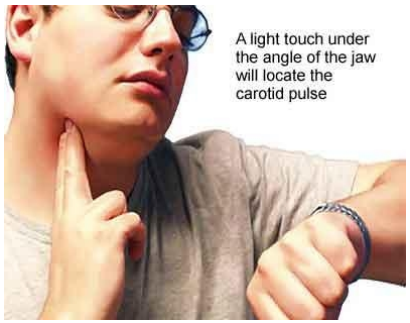
Heart Rates (HR)

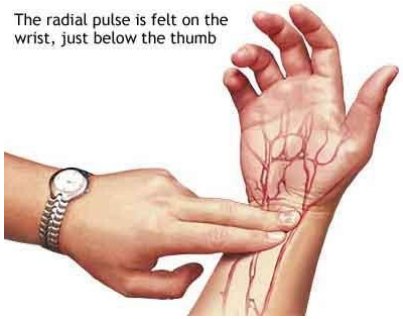
- HR increases directly in proportion to the increase in exercise intensity (i.e., %$\dot{V}O_2$max) until near-maximal exercise is achieved.
- As maximal exercise intensity is approached, HR begins to plateau even as the exercise workload continues to increase.



Measurement of HR

Measurement of HR





HR_{max}

Kenney, Wilmore & Costill (2015)

- Maximal heart rate (HR_{max}) is the highest HR value achieved in an all-out effort to the point of volitional fatigue.
- Once accurately determined, HR_{max} is a highly reliable value that remains constant from day to day.
- A slight but predictable decrease of about one beat per year beginning at 10 to 15 years of age.

HR_{max}

Swain et al. (1994)

- $\%HR_{max}$ for Men
  $= (0.643 \pm 0.010)\%\dot{V}O_2max + (36.8 \pm 1.0)$
- $\%\ HR_{max}$ for Women
  $= (0.628 \pm 0.014)\%\dot{V}O_2max + (39.0 \pm 1.3)$
- The value of $\%\ HR_{max}$ for women averaged 1 percentage point higher than men at each exercise intensity. However, the F ratio for a sex effect was not significant.

Measurement of HR_{max}

Direct Measurement during Maximal Work

- Provide the most accurate value.
- Require access to expensive laboratory equipment and skilled personnel.

Alternatives

- Age-prediction equations
  e.g., $HR_{max} = 220 - Age$

HR_{max}

National Council on Strength & Fitness

% VO_2max	% HRmax	Speed
50%	70%	Very Slow (warm up, cool down, recovery)
60%	75%	Slow Running (early measure of a long run, recovery day)
70%	82%	Steady Running (off-season; maybe challenging for LIT runs)
80%	88%	Half Marathon Pace; Just above Marathon Pace
90%	95%	10K Speed
95%	98%	5k Speed
100%	100%	3K Speed
110%	100%	1500 Speed

Age–prediction Equations for HR_{max}

Most Popular in Textbooks and Research Papers

- $HR_{max} = 220 - Age$

Sharkey & Gaskill (2013)

- However, HR_{max} is highly variable, with a standard deviation (SD) of 12 bpm.
  - 68% of subjects fall within ±1 SD, 95% of subjects fall within ±2 SD, and 99% of subjects fall within ±3 SD.
  - 1 in 100 subjects of 40 years old will have a HR_{max} below 144 or above 216 bpm.

Age–prediction Equations for HR_{max}

Robergs & Landwehr (2002)

- No published record of research for this equation.
- The origin of the formula is a superficial estimate, based on observation, of a linear best fit to a series of raw and mean data compiled by Fox and Haskell (1971).
- There remains no formula that provides acceptable accuracy of HR_{max} prediction.

$v\dot{V}O_2max$

- Noakes (2013)

Athlete	VO_2max (ml kg^{-1} min^{-1})	Marathon Time
Gary Tuttle	82.7	2:17:00
Graig Virgin	81.1	2:10:26
Joan Benoit	78.6	2:24:52
Bill Rodgers	78.5	2:09:27
Don Kardong	77.4	2:11:15
Alberto Salazar	76.0	2:08:13
Amby Burfoot	74.3	2:14:28
Kenny Moore	74.2	2:11:36
Grete Waitz	73.0	2:25:42
Buddy Edelen	73.0	2:14:28
Zithulele Sinqe	72.0	2:08:05
Frank Shorter	71.3	2:10:30
Willie Mtolo	70.3	2:08:15
Derek Clayton	69.7	2:08:34

$v\dot{V}O_2max$

- $\dot{V}O_2max$ is considered a good performance predictor in heterogeneous groups where members possess a wide variety of aerobic capacities.
  - Athletes possessing higher values of $\dot{V}O_2max$ generally have better performances, or vice versa.
- However, it is not the case with homogeneous groups, such as a group of elite long distance runners.
  - Athletes possessing similar values of $\dot{V}O_2max$ may vary greatly in performances, or vice versa.

$v\dot{V}O_2max$

Billat & Koralsztein (1996)

- $v\dot{V}O_2max$, introduced by Daniels et al. in 1984, refers to the velocity at $\dot{V}O_2max$.
- It is the lowest running speed which elicits a $\dot{V}O_2$ equal to $\dot{V}O_2max$.
- $v\dot{V}O_2max$ is a useful variable that combines $\dot{V}O_2max$ and running economy into a single factor which can explain individual differences in performance that $\dot{V}O_2max$ or running economy alone cannot.

Running Economy

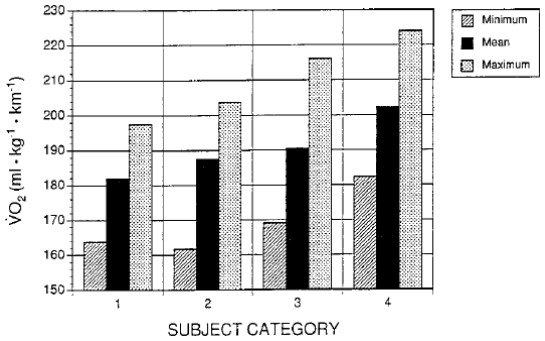
Saunders et al. (2004)

- Running economy (RE) is typically defined as the energy demand for a given velocity of submaximal running.
- Runners with good RE use less energy and therefore less oxygen than runners with poor RE at the same velocity.
- There is a strong association between RE and distance running performance, with RE being a better predictor of performance than $\dot{V}O_2max$ in elite runners who have a similar $\dot{V}O_2max$.

Running Economy

Bassett & Howley (2000)

- Elite runners had a better RE than the other groups of runners.
- All running groups were better than the group of untrained subjects.



Minimum, mean, and maximum aerobic demand values for elite runners (Category 1), sub-elite runners (Category 2), good runners (Category 3), and untrained subjects (Category 4).

Running Economy

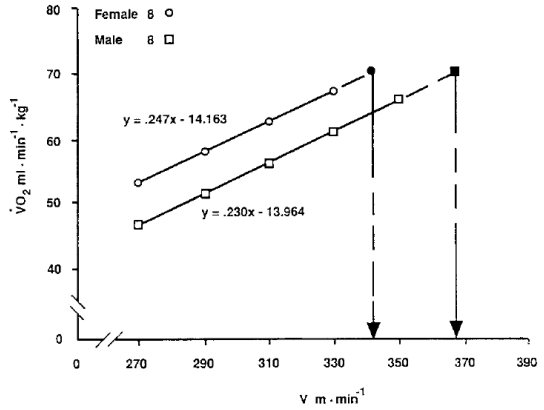
Karp (n.d.)

- RE is the volume of oxygen consumed at submaximal running speeds.
  - If two runners have the same VO_2max, but Runner A uses 70% and Runner B uses 80% of that VO_2max while running at 7:00 pace, the pace feels easier for Runner A because Runner A is more economical.
  - Runner A can run at a faster pace before feeling the same amount of fatigue as Runner B.

Running Economy

Bassett & Howley (2000)

- The difference in RE resulted in a clear difference in the speed that could be achieved if that race were run at $\dot{V}O_2max$.



A plot of male and female runners equal in terms of VO_2max, but differing in running economy.

Running Economy

Karp (n.d.)

- Factors influencing RE include:
  - biomechanics, muscle fiber type, leg mass, clothing, shoe weight, wind, air resistance, terrain, ...
- Runners tend to be most economical at the speed they train most, so athletes should train at race pace to improve economy at race pace.

v$\dot{V}O_2$max & Running Prescription

Denadai et al. (2006)

- 5000 m at 90-95% $\dot{V}O_2$max.
- 1500 m at 105-115% $\dot{V}O_2$max.

Bragada et al. (2010)

- 3000 m running velocity ranged between 97 and 101% (mean = 100%) $\dot{V}O_2$max.
- Determination of v$\dot{V}O_2$max provides an important tool which can be used in training.
  - e.g., as a speed suitable for use during interval training.

v$\dot{V}O_2$max & Running Events

Denadai et al. (2006)

- v$\dot{V}O_2$max has been used with success in prescribing exercise intensities for middle and long distance runners.

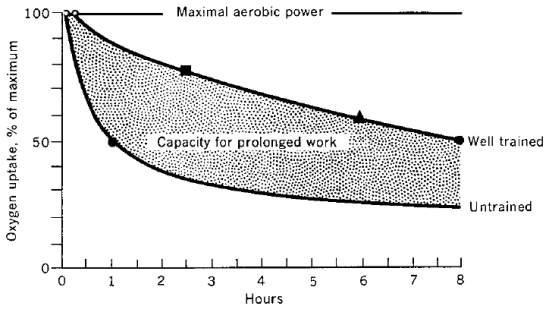
Joyner & Coyle (2008)

- Much of the 42-Km marathon is run at approximately 75-85% $\dot{V}O_2$max.
- 10 Km is performed at 90-100% $\dot{V}O_2$max.
- 5 Km at close to $\dot{V}O_2$max.

v$\dot{V}O_2$max & Running Prescription

Bassett & Howley (2000)

- Trained individuals functioned at higher %$\dot{V}O_2$max than untrained subjects for the same duration of time.



Approximate percentage of a subject's VO_2max during work of different duration and how this is affected by training state (Astrand & Rodahl, 1970).

Wong-Sir's Comments on v$\dot{V}O_2$max Running Prescription

- Since Billat & Koralsztein (1996) pointed out that the average value of time limit at 100% v$\dot{V}O_2$max is close to 6 minutes, it is reasonable to conduct a 6-minute all out run to estimate the v$\dot{V}O_2$max (i.e., the minimum speed that elicits $\dot{V}O_2$max.
- With reference to Bragada et al. (2010), Denadai et al. (2006), and Joyner & Coyle (2008), runners should emphasize training at the speeds close to and slightly above the %v$\dot{V}O_2$max of their major running events.

Wong-Sir's Comments on v$\dot{V}O_2$max Running Prescription

Wong-Sir's Running Formulae

- This is absolutely not an earthshaking invention.
- Simply conduct a 6-minute time trial first, and then input the result (e.g., 1600 m) and other data (optional) into the Excel spreadsheet.
- Based on the predicted $\dot{V}O_2$max speed using the 6-minute time trial (e.g., 1600 m ÷ 360 s = 4.44 m/s or 16 km/h), calculate the speeds for the different percentages of $\dot{V}O_2$max with the Excel spreadsheet.

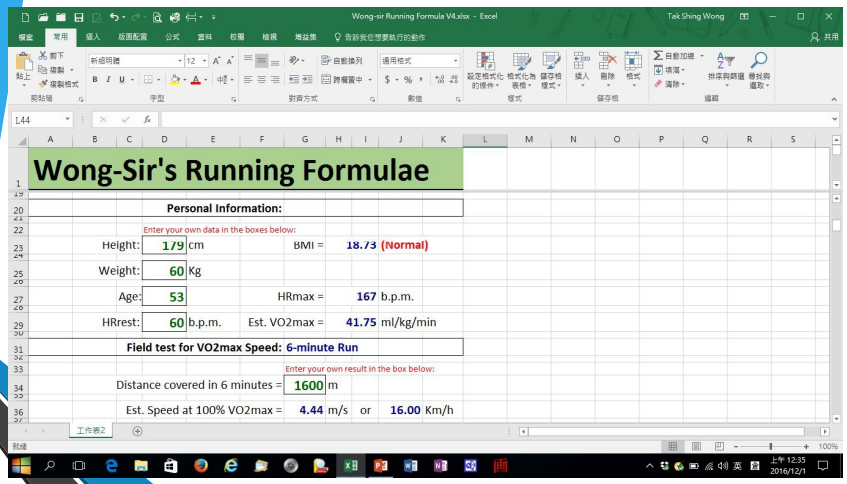
Wong-Sir's Comments on v$\dot{V}O_2$max Running Prescription

Major Distance Running Events	Training Speed (% v$\dot{V}O_2$max)
1,500 m, 1 mile (1,609 m), 2K (2,000 m)	100 to 115%
3K (3,000 m), 5K (5,000 m)	95 to 105%
10K (10,000 m), 15K (15,000 m)	90 to 100%
Half Marathon (21,097 m)	85 to 95%
Marathon (42,195 m)	75 to 85%

Remarks:

1. *Data adjusted (by me) for local runners.*
2. *3000 m is considered as running close to 100% for elite runners.*

Wong-Sir's Comments on v$\dot{V}O_2$max Running Prescription



Wong-Sir's Running Formulae

Rationales:

(Billat & Koralsztein, 1996; Bragada, et al., 2010; Denadai, et al., 2006; Joyner & Coyle, 2008; Ushi et al., 2004)

1. Percent VO2max speed of different running events:
   1,500 m, 1 mile (1,609 m), 2K (2,000 m) = 100 to 115% VO2max
   3K (3,000 m), 5K (5,000 m) = Near 100% VO2max
   10K (10,000 m), 15K (15,000 m) = 90 to 100% VO2max
   Marathon (42,195 m) = 75 to 85% VO2max
2. The average value of time limit at 100% vVO2max is close to 6 minutes.
3. Predicted 3000 m Speed = 0.646 + 0.626 x V4 Speed + 0.416 x vVO2max Speed
   (All speeds measured in Km/h)
4. Mass-specific VO2max = 15* (HRmax/HRrest)
   (in ml/kg/min)

Personal Information:

Enter your own data in the boxes below:

Height: 179 cm BMI = 18.73 (Normal)

Weight: 60 Kg

Age 53 HRmax = 167 b.p.m.

HRrest: 60 b.p.m. Est. VO2max = 41.75 ml/kg/min

Field test for VO2max Speed: 6-minute Run

Enter your own result in the box below:

Distance covered in 6 minutes = 1600 m

Est. Speed at 100% VO2max = 4.44 m/s or 16.00 Km/h

Optional test for V4 Speed: 3000-m Time Trial

Enter your own result in the boxes below:

Time to finish 3000 m = 12 min 0 s

Average speed = 4.17 m/s or 15.00 Km/h

Est. V4 (i.e., lactate threshold) Speed = 12.30 Km/h

Percent VO2max at V4 Speed = 76.86 %

At 100 % VO2max speed, or	4.44 m/s,	or	16.00 Km/h
Time to run 100 m =	22.5 s, or	0 min	22.5 s
Time to run 200 m =	45.0 s, or	0 min	45.0 s
Time to run 300 m =	67.5 s, or	1 min	7.5 s
Time to run 400 m =	90.0 s, or	1 min	30.0 s
Time to run 600 m =	135.0 s, or	2 min	15.0 s
Time to run 800 m =	180.0 s, or	3 min	0.0 s
Time to run 1000 m =	225.0 s, or	3 min	45.0 s
Time to run 1200 m =	270.0 s, or	4 min	30.0 s
Time to run 1600 m =	360.0 s, or	6 min	0.0 s
Time to run 2000 m =	450.0 s, or	7 min	30.0 s

At 95 % VO2max speed, or	4.22 m/s,	or	15.20 Km/h
Time to run 100 m =	23.7 s, or	0 min	23.7 s
Time to run 200 m =	47.4 s, or	0 min	47.4 s
Time to run 300 m =	71.1 s, or	1 min	11.1 s
Time to run 400 m =	94.7 s, or	1 min	34.7 s
Time to run 600 m =	142.1 s, or	2 min	22.1 s
Time to run 800 m =	189.5 s, or	3 min	9.5 s
Time to run 1000 m =	236.8 s, or	3 min	56.8 s
Time to run 1200 m =	284.2 s, or	4 min	44.2 s
Time to run 1600 m =	378.9 s, or	6 min	18.9 s
Time to run 2000 m =	473.7 s, or	7 min	53.7 s

At 90 % VO2max speed, or	4.00 m/s,	or	14.40 Km/h
Time to run 100 m =	25.0 s, or	0 min	25.0 s
Time to run 200 m =	50.0 s, or	0 min	50.0 s
Time to run 300 m =	75.0 s, or	1 min	15.0 s
Time to run 400 m =	100.0 s, or	1 min	40.0 s
Time to run 600 m =	150.0 s, or	2 min	30.0 s
Time to run 800 m =	200.0 s, or	3 min	20.0 s
Time to run 1000 m =	250.0 s, or	4 min	10.0 s
Time to run 1200 m =	300.0 s, or	5 min	0.0 s
Time to run 1600 m =	400.0 s, or	6 min	40.0 s
Time to run 2000 m =	500.0 s, or	8 min	20.0 s

At 115 % VO2max speed, or	5.11 m/s,	or	18.40 Km/h
Time to run 100 m =	19.6 s, or	0 min	19.6 s
Time to run 200 m =	39.1 s, or	0 min	39.1 s
Time to run 300 m =	58.7 s, or	0 min	58.7 s
Time to run 400 m =	78.3 s, or	1 min	18.3 s
Time to run 600 m =	117.4 s, or	1 min	57.4 s
Time to run 800 m =	156.5 s, or	2 min	36.5 s
Time to run 1000 m =	195.7 s, or	3 min	15.7 s
Time to run 1200 m =	234.8 s, or	3 min	54.8 s
Time to run 1600 m =	313.0 s, or	5 min	13.0 s
Time to run 2000 m =	391.3 s, or	6 min	31.3 s

At 110 % VO2max speed, or	4.89 m/s,	or	17.60 Km/h
Time to run 100 m =	20.5 s, or	0 min	20.5 s
Time to run 200 m =	40.9 s, or	0 min	40.9 s
Time to run 300 m =	61.4 s, or	1 min	1.4 s
Time to run 400 m =	81.8 s, or	1 min	21.8 s
Time to run 600 m =	122.7 s, or	2 min	2.7 s
Time to run 800 m =	163.6 s, or	2 min	43.6 s
Time to run 1000 m =	204.5 s, or	3 min	24.5 s
Time to run 1200 m =	245.5 s, or	4 min	5.4 s
Time to run 1600 m =	327.3 s, or	5 min	27.3 s
Time to run 2000 m =	409.1 s, or	6 min	49.1 s

At 105 % VO2max speed, or	4.67 m/s,	or	16.80 Km/h
Time to run 100 m =	21.4 s, or	0 min	21.4 s
Time to run 200 m =	42.9 s, or	0 min	42.9 s
Time to run 300 m =	64.3 s, or	1 min	4.3 s
Time to run 400 m =	85.7 s, or	1 min	25.7 s
Time to run 600 m =	128.6 s, or	2 min	8.6 s
Time to run 800 m =	171.4 s, or	2 min	51.4 s
Time to run 1000 m =	214.3 s, or	3 min	34.3 s
Time to run 1200 m =	257.1 s, or	4 min	17.1 s
Time to run 1600 m =	342.9 s, or	5 min	42.9 s
Time to run 2000 m =	428.6 s, or	7 min	8.6 s

At 85 % VO2max speed, or	3.78 m/s,	or	13.60 Km/h
Time to run 100 m =	26.5 s, or	0 min	26.5 s
Time to run 200 m =	52.9 s, or	0 min	52.9 s
Time to run 300 m =	79.4 s, or	1 min	19.4 s
Time to run 400 m =	105.9 s, or	1 min	45.9 s
Time to run 600 m =	158.8 s, or	2 min	38.8 s
Time to run 800 m =	211.8 s, or	3 min	31.8 s
Time to run 1000 m =	264.7 s, or	4 min	24.7 s
Time to run 1200 m =	317.6 s, or	5 min	17.6 s
Time to run 1600 m =	423.5 s, or	7 min	3.5 s
Time to run 2000 m =	529.4 s, or	8 min	49.4 s

At 80 % VO2max speed, or	3.56 m/s,	or	12.80 Km/h
Time to run 100 m =	28.1 s, or	0 min	28.1 s
Time to run 200 m =	56.3 s, or	0 min	56.3 s
Time to run 300 m =	84.4 s, or	1 min	24.4 s
Time to run 400 m =	112.5 s, or	1 min	52.5 s
Time to run 600 m =	168.8 s, or	2 min	48.8 s
Time to run 800 m =	225.0 s, or	3 min	45.0 s
Time to run 1000 m =	281.3 s, or	4 min	41.3 s
Time to run 1200 m =	337.5 s, or	5 min	37.5 s
Time to run 1600 m =	450.0 s, or	7 min	30.0 s
Time to run 2000 m =	562.5 s, or	9 min	22.5 s

At 75 % VO2max speed, or	3.33 m/s,	or	12.00 Km/h
Time to run 100 m =	30.0 s, or	0 min	30.0 s
Time to run 200 m =	60.0 s, or	1 min	0.0 s
Time to run 300 m =	90.0 s, or	1 min	30.0 s
Time to run 400 m =	120.0 s, or	2 min	0.0 s
Time to run 600 m =	180.0 s, or	3 min	0.0 s
Time to run 800 m =	240.0 s, or	4 min	0.0 s
Time to run 1000 m =	300.0 s, or	5 min	0.0 s
Time to run 1200 m =	360.0 s, or	6 min	0.0 s
Time to run 1600 m =	480.0 s, or	8 min	0.0 s
Time to run 2000 m =	600.0 s, or	10 min	0.0 s

At	70 % VO2max speed, or	3.11 m/s,	or	11.20 Km/h
Time to run	100 m =	32.1 s, or	0 min	32.1 s
Time to run	200 m =	64.3 s, or	1 min	4.3 s
Time to run	300 m =	96.4 s, or	1 min	36.4 s
Time to run	400 m =	128.6 s, or	2 min	8.6 s
Time to run	600 m =	192.9 s, or	3 min	12.9 s
Time to run	800 m =	257.1 s, or	4 min	17.1 s
Time to run	1000 m =	321.4 s, or	5 min	21.4 s
Time to run	1200 m =	385.7 s, or	6 min	25.7 s
Time to run	1600 m =	514.3 s, or	8 min	34.3 s
Time to run	2000 m =	642.9 s, or	10 min	42.9 s

At	65 % VO2max speed, or	2.89 m/s,	or	10.40 Km/h
Time to run	100 m =	34.6 s, or	0 min	34.6 s
Time to run	200 m =	69.2 s, or	1 min	9.2 s
Time to run	300 m =	103.8 s, or	1 min	43.8 s
Time to run	400 m =	138.5 s, or	2 min	18.5 s
Time to run	600 m =	207.7 s, or	3 min	27.7 s
Time to run	800 m =	276.9 s, or	4 min	36.9 s
Time to run	1000 m =	346.2 s, or	5 min	46.2 s
Time to run	1200 m =	415.4 s, or	6 min	55.4 s
Time to run	1600 m =	553.8 s, or	9 min	13.8 s
Time to run	2000 m =	692.3 s, or	11 min	32.3 s

At	60 % VO2max speed, or	2.67 m/s,	or	9.60 Km/h
Time to run	100 m =	37.5 s, or	0 min	37.5 s
Time to run	200 m =	75.0 s, or	1 min	15.0 s
Time to run	300 m =	112.5 s, or	1 min	52.5 s
Time to run	400 m =	150.0 s, or	2 min	30.0 s
Time to run	600 m =	225.0 s, or	3 min	45.0 s
Time to run	800 m =	300.0 s, or	5 min	0.0 s
Time to run	1000 m =	375.0 s, or	6 min	15.0 s
Time to run	1200 m =	450.0 s, or	7 min	30.0 s
Time to run	1600 m =	600.0 s, or	10 min	0.0 s
Time to run	2000 m =	750.0 s, or	12 min	30.0 s

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For 1500 m to 2000 m Runners

- Frequency: 3 to 4 sessions per week
- Intensity & Volume
  e.g., For a runner with 100%$\dot{V}O_2max$ speed = 4.44 m/s.
  - At least 2 sessions at 100 to 115% $\dot{V}O_2max$ speed.
    - 1:1 work/rest ratio or below (mild jogging during rest period).
    - Each run should last from 100 m to 1000 m (30 s to 3 minutes).
    - Repeat running for 1.5 to 2 times the racing distance.

At	55 % VO2max speed, or	2.44 m/s,	or	8.80 Km/h
Time to run	100 m =	40.9 s, or	0 min	40.9 s
Time to run	200 m =	81.8 s, or	1 min	21.8 s
Time to run	300 m =	122.7 s, or	2 min	2.7 s
Time to run	400 m =	163.6 s, or	2 min	43.6 s
Time to run	600 m =	245.5 s, or	4 min	5.4 s
Time to run	800 m =	327.3 s, or	5 min	27.3 s
Time to run	1000 m =	409.1 s, or	6 min	49.1 s
Time to run	1200 m =	490.9 s, or	8 min	10.9 s
Time to run	1600 m =	654.5 s, or	10 min	54.5 s
Time to run	2000 m =	818.2 s, or	13 min	38.2 s

At	50 % VO2max speed, or	2.22 m/s,	or	8.00 Km/h
Time to run	100 m =	45.0 s, or	0 min	45.0 s
Time to run	200 m =	90.0 s, or	1 min	30.0 s
Time to run	300 m =	135.0 s, or	2 min	15.0 s
Time to run	400 m =	180.0 s, or	3 min	0.0 s
Time to run	600 m =	270.0 s, or	4 min	30.0 s
Time to run	800 m =	360.0 s, or	6 min	0.0 s
Time to run	1000 m =	450.0 s, or	7 min	30.0 s
Time to run	1200 m =	540.0 s, or	9 min	0.0 s
Time to run	1600 m =	720.0 s, or	12 min	0.0 s
Time to run	2000 m =	900.0 s, or	15 min	0.0 s

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For 1500 m to 2000 m Runners

- Frequency: 3 to 4 sessions per week
- Intensity & Volume
  e.g., For a runner with 100%$\dot{V}O_2max$ speed = 4.44 m/s.
  - At least 2 sessions at 100 to 115% $\dot{V}O_2max$ speed.
    - e.g. 1: Training at 110% $\dot{V}O_2max$ speed.
      12-15 x 200 m in 41 s, jog 41 s between each.
    - e.g. 2: Training at 100% $\dot{V}O_2max$ speed.
      4-5 x 600 m in 2:15, jog 2:15 between each.

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For 1500 m to 2000 m Runners

- Frequency: 3 to 4 sessions per week
- Intensity & Volume
  e.g., For a runner with 100%$\dot{V}O_2max$ speed = 4.44 m/s.
  - At least 2 sessions at 100 to 115% $\dot{V}O_2max$ speed.
    - e.g. 3: Training at 100% $\dot{V}O_2max$ speed.
      3-4 x 800 m in 3:00, jog 3:00 between each.
    - Intervals longer than 800 m, which have exceeded 3 minutes will not be very efficient to improve the $\dot{V}O_2max$ of this runner.

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For 3000 m to 5000 m Runners

- Frequency: 3 to 4 sessions per week
- Intensity & Volume
  - 1 to 2 sessions at 100 to 115% $\dot{V}O_2max$ speed.
    - 1:1 work/rest ratio or below (mild jogging during rest period).
    - Each run should last from 200 m to 1000 m (30 s to 3 minutes).
    - Repeat running for up to 3 to 4 K.

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For 1500 m to 2000 m Runners

- Frequency: 3 to 4 sessions per week
- Intensity & Volume
  e.g., For a runner with 100%$\dot{V}O_2max$ speed = 4.44 m/s.
  - Other sessions at 85 to 95% $\dot{V}O_2max$ speed to improve AT.
    - e.g. 1: Training at 90% $\dot{V}O_2max$ speed.
      3-4 x 1000 m in 4:10, jog 4:10 between each.
    - e.g. 2: Training at 85% $\dot{V}O_2max$ speed.
      4000 m in 17:40, i.e., 4:25/Km pace.

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For 3000 m to 5000 m Runners

- Frequency: 3 to 4 sessions per week
- Intensity & Volume
  - Other sessions at 85 to 95% $\dot{V}O_2max$ speed to improve AT.
    - 1:1 work/rest ratio or below (mild jogging during rest period).
    - Use longer intervals (e.g., 600 m or above).
      - Repeat running for 1 to 1.5 times the racing distance.
    - 20 to 40 minutes Tempo Run at 90% $\dot{V}O_2max$ speed or above.

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For 10000m (10 K) Runners

- Frequency: 3 to 4 sessions per week
- Intensity & Volume
  - At least 1 sessions at 100 to 115% $\dot{V}O_2max$ speed.
    - 1:1 work/rest ratio or below (mild jogging during rest period).
    - Each run should last from 200 m to 1000 m (30 s to 3 minutes).
    - Repeat running for up to 3 to 4 K.

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For Marathon Runners

- Intensity & Volume (Average Marathon time = 3:30)
  - Porter (1984), Grand et al. (1984), Holmich et al. (1989)
    - On the average of 60 Km/week.
    - 70% runners did 30 to 90 Km/week.

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For 10000m (10 K) Runners

- Frequency: 3 to 4 sessions per week
- Intensity & Volume
  - Other sessions at 85 to 95% $\dot{V}O_2max$ speed to improve AT.
    - 1:1 work/rest ratio or below (mild jogging during rest period).
    - Use longer intervals (e.g., 1000 m, 2000 m, or above).
      - Repeat running for 1 to 1.5 times the racing distance.
    - 30 to 60 minutes Tempo Run at 85-90% $\dot{V}O_2max$ speed or above.

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For Marathon Runners

- Intensity & Volume (Average Marathon time = 2:40)
  - Holmich et al. (1988)
    - 2/3 of the runners did 90-150 Km/week, with only one training session per day.
    - 5 out of the total 60 runners did more than 150 Km/week and train more than 2 sessions per day.

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For Marathon Runners

- Intensity & Volume
  - Billat et al. (2001)
    - 2:11 to 2:16 Marathon Time: 168 to 206 Km/week (Men)
    - 2:32 to 2:38 Marathon Time: 150 to 166 Km/week (Women)
  - Karp (2007)
    - 2:15 to 2:22 Marathon Time: 144 to 156 Km/week (Men)
    - 2:40 to 2:48 Marathon Time: 113 to 136 Km/week (Women)

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For Marathon Runners

- Frequency: 4 to 6 sessions per week
- Intensity & Volume
  - At least 1 session at 100 to 115% $\dot{V}O_2max$ speed.
    - 1:1 work/rest ratio or below (mild jogging during rest period).
    - Use longer intervals (e.g., 400 m to 1000 m).
    - Repeat running for up to 3 to 4 K.

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For Marathon Runners

- Frequency: 4 to 6 sessions per week
- Intensity & Volume
  - Anderson (2013), "The Marathon is a Power Race."
  - Men Marathon Record – 2:02:57
    - Average speed: 17.5 s/100 m or 1:10/400 m
  - Women Marathon Record – 2:15:25
    - Average speed: 19.3 s/100 m or 1:17/400 m

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For Marathon Runners

- Frequency: 4 to 6 sessions per week
- Intensity & Volume
  - 1-2 sessions at 80 to 90% $\dot{V}O_2max$ speed to improve AT.
    - 1:1 work/rest ratio or below (mild jogging during rest period).
    - Use longer intervals (e.g., 800 m or above).
    - Repeat running for up to 10 to 15 K.

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For Marathon Runners

- Frequency: 4 to 6 sessions per week
- Intensity & Volume
  - Emil Zatopek
    - 20 x 200 m,
      40 x 400 m,
      20 x 200 m,
      a total of 24 K
      in one workout.

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

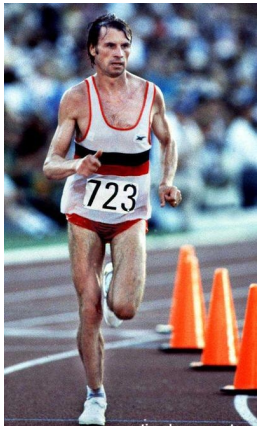
For Marathon Runners

- Frequency: 4 to 6 sessions per week
- Intensity & Volume
  - Other sessions at 75 to 85% $\dot{V}O_2max$ speed.
    - Accumulating up to 60 to 80 Km/week, including all other sessions mentioned in this section for Marathon Runners before.

Wong-Sir's Comments on $v\dot{V}O_2max$ Running Prescription

For Marathon Runners

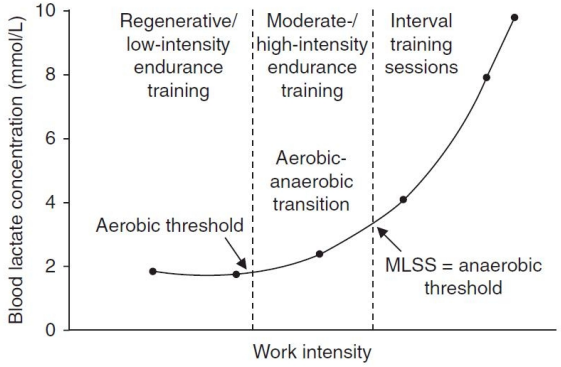
- Frequency: 4 to 6 sessions per week
- Intensity & Volume
  - Carlos Lopes (2:07:11)
    - 2 interval sessions per week
      - 15 x 400 m at 3000 m pace
      - 6 x 2000 m at 10000 m pace
    - 200-240 Km/week throughout the year



One More Thing...

Anaerobic Threshold

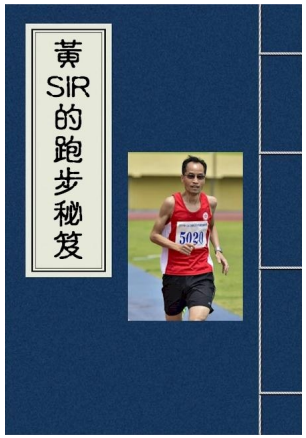
- To be continued next year...
- Thank you!!!



Running Training Q&A

長跑訓練 Q&A

Want to know more...



http://www.tswongsir-runners.guide