Heart Rate Fundamentals for Runners

This article discusses the following heart rate topics: Resting HRrest, Maximum HRmax, Heart Reserve, and Heart Rate Recovery.

First, a fundamental concept: "**Cardio-Output**," is simply the heart rate times the stroke volume [i.e., the amount of blood] per pump. Your cardio output always attempts to meet the needs of all tissues and organs in your body, from resting to any form of activity.

Resting Heart Rate [HRrest] is the fundamental base measurement; it is a quantitative value of the heart's potential capacity. Your resting heart rate [HRrest] is a good indicator of your heart's relative stroke volume. To illustrate, assume a sedentary person with an HRrest of 84 beats/minute [84bpm] and a runner with an HRrest of 42bpm. The sedentary person, with an HRrest of 84bpm, can only rest when their HR is 84bpm. However, the runner, with an HRrest of 42bpm, can actually walk fast or jog at the same 84bpm. The runner's stroke volume is obviously twice as great. [This illustration assumes the stroke volume remains the same and only the rate has changed; this is an oversimplification, but close enough for this example.] Speed training increases the heart's size and thus the stroke volume. HRrest is a good indication of the heart's overall condition.

Runners, especially, should know their HRrest and keep track of it as a reference benchmark. Any significant unaccounted-for changes should be a cause for concern. For example, if it's been 48bpm +/- 4bpm for years, and then it becomes 56bpm for no apparent reason, a cardiologist should be consulted. Whenever you are involved with any medical personnel, always inform them of your HRrest and that you are a runner. Medical personnel rarely see anyone with an HRrest less than 60bpm, and they have a term for this condition "bradycardia," [slow heart rate] and may consider treatment is needed, which of course may be a false alarm for runners.

To get started, measure and record your HRrest [count your pulse for 30 seconds and multiply by 2] before getting out of bed in the morning and at about 2pm when you are resting quietly. Some folks are lowest in the morning and some in the afternoon. Do this every day or two for about 2 weeks, until you are satisfied the HRrest measurements are stable. Then, check it every month or so and whenever your training regiment changes.

Most runners who regularly run at least 4 times a week, and do some speed work, should expect to have an HRrest of less than about 50bpm, 40/42bpm, or even less is common.

Maximum Heart Rate [HRmax] is the maximum rate at which your heart beats to satisfy your current activity. This is a very important point! Your biking HRmax will typically be about 10bps less than your running HRmax and your cross-country skiing will be about 10bpm higher. Why? Because biking utilizes fewer muscle groups and cross-country skiing utilize more muscle groups.

The most accurate method for measuring HRmax is by undergoing a cardiac stress test, performed by an exercise or sports physiologist. Theoretically, cardiologists can probably do it, but most of them have little experience with healthy athletes and thus do not typically push subjects to their absolute limit.

However, you can come close to measuring your running [only] HRmax using the following methods. Both are best done with a heart-rate monitor. I recommend all serious runners have one. Go to the track or to a flat or slight upgrade hill, preferably with someone who can run faster than you. Warm up for a ½ mile or so, do 3 or 4 short sprints, and then run about 800m [½ mile] at about 90%. Rest for 60 seconds. Finally, run as fast as you can for about 1200m [3/4mi]. The "someone faster than you's responsibility is fuss and cuss to drive you to your maximum rate. He or she should run a step ahead of you, to "pull" you along. The benefit of a heart-rate monitor for this test should be obvious. Without one, stop at about 1000m and immediately count your beats for 10 seconds and multiply by 6.

The second method is simpler, monitor your heart rate during races. Obviously, it requires an HR monitor. Most folks find their maximum rate occurs a few hundred meters before the finish. You should repeat the test several times over about a month, at least until your measurements are stable and repeatable.

Several formulas have been derived to predict running HRmax as it relates to age. The most respected formula is HRmax = 206 - (0.68 x age). Undoubtedly, you have heard or read about the 220-age formula; it is somewhat inaccurate. For example, at 15, the 220-age formula predicts HRmax= 205bpm, and the 206 (0.68 x age) formula predicts 196bpm. At 70, the 220-age formula predicts 150, and the 206 - (0.68 x age) formula predicts 158. Check your predicted HRmax using both formulas. The standard deviation [variance] for all formulas has not been established. I've seen everything from +/- 6bpm to 12bpm in the literature. Note, both formulas predict that we lose about 7bpm every 10 years.

It is generally assumed that HRmax, for healthy persons, is primarily determined by age, genes, and muscle mass utilized during exercise and that it is independent of their sports-fitness condition. However, case studies can easily be found that report finding an HRmax increase observed when sedentary, older people embark on a strenuous exercise program. Personally, I've observed that most new runners, especially those over 40 and whose HRmax is less than the predicted rate by the formula above, see an HRmax increase as they train to run faster. There is no evidence that training can increase HRmax once the maximum is achieved.

Our HRmax is directly affected by muscle mass utilized during exercise. For example, most everyone has a higher HRmax when running than when biking, typically about 10bpm. Thus, our HRmax is sport specific and must be measured performing that sport. Maximum perceived effort is necessary, but not sufficient. Your measured HRmax will only occur when you are running at your extreme limit and your perceived effort will likewise be maximum. However, you can have a maximum perceived effort at a heart rate far less than your HRmax. Lifting weights is a good example.

Heart Reserve: Recall, in the first paragraph under "Resting Heart Rate," I said that a sedentary person with an HRrest=84bpm, can only rest when his or her HR is 84bpm; the runner can actually walk or jog at a reasonably good pace with a heart rate of 84bpm because the runner's stroke volume is obviously twice as great. This simple observation illustrates the fallacy of the so-called "Heart Target Training Zones" and "Heart Rate Training Targets" often mentioned in running magazines.

Your Heart Reserve determines your cardiovascular system's ability to meet your exercise demand. Let's illustrate. Your Heart Reserve is simply HRmax - HRrest. Assume your numbers are 175bpm and 45bpm; thus, your reserve is 130bpm. Your sedentary friend's heart rate, assuming he or she is healthy and is the same age, can only vary from 85bpm to 175bpm, i.e., his/hers reserve is only 90bpm.

The bottom line is that your Heart Reserve must be used for training purposes, and not simply a percentage of your HRmax. For example, assume you plan to run a long run at 50% and your reserve is 130bpm. Your target heart rate is 45bpm + .5x130 = 110bpm. Our sedentary friend at 50% will have a heart rate of 85bpm + .5x90= 130bpm.

There is a simple way to do mental arithmetic for calculating your target rate. Just take your reserve, e.g., 130 and divide it by 10, use this as beats/10%. For example, assume a reserve of 130, divide by 10, and get 13/10%. Now assume you want a 90% heart rate training interval, target heart rate = 175-13 = 162. So, 162 x .9 = 146bpm

Keep in mind that at HRmax the conditioned heart, as indicated by the slow HRrest, will have a greater stroke-volume. This obviously provides for superior endurance and hill climbing ability, etc.

Heart Rate Recovery: A slow Heart-Rate Recovery immediately following strenuous exercise near HRmax is an indicator of a potentially serious heart condition. To measure your recovery rate, exercise to raise your heart rate to near maximum and record it. Then wait exactly 2 minutes and measure the rate again. You should expect a difference of at least 20bpm. If it is less, consider seeking a professional cardiology evaluation.

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