

Comments on Physiology

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Reprinted from *Ultrarunning*, October 1983, pp 12-13

Good long-distance runners are born—not made. What this means is: if you were not born with certain physical attributes, there is no way you are ever going to make it to the top of the heap as a long-distance runner. I expect that most of us who are journeyman runners are fully aware that we don't have the guns to be champions. And, I expect that most of us recognize that heredity has something to do with this fact. However, many runners are probably not aware of what specific physical attributes are involved in the inborn ability of some people to run long distances at remarkably fast paces; and even fewer know how they rank personally in the possession of these attributes. So, my comments this time will be devoted to a review of the prime physical characteristic that separates the top seeds from the also-rans, and to an explanation of a simple technique from the scientific literature for measuring how well endowed you are personally with this characteristic.

In past discussions, I have emphasized that the ability to sustain high work loads for extended time periods is limited by the capacity of the body to make oxygen available to working muscles. A number of physical attributes are known or suspected to contribute to this "aerobic capacity"—such attributes as cardiac output, vital capacity and the relative proportion of the so-called "slow-twitch" fibers in the muscles. However, we don't really need to concern ourselves with any of these specific attributes in measuring the work capacity of an athlete because, whatever their individual contributions may be, that capacity is determined simply by how much capability these attributes provide the athlete for supplying oxygen where it is needed. Basically, what this means is: the athletes with high aerobic capacity win the races while those with low aerobic capacity are also-rans.

The ability of an athlete to provide oxygen to working muscles during exercise is the product of two contributions. The first is the inborn capacity to deliver oxygen that results from the several physical attributes I have already mentioned. We call this characteristic "maximum aerobic capacity." It is a measure of the athlete's maximum possible rate of oxygen uptake and utilization. It is the point at which, if the work load is increased, the body will not increase oxygen uptake -it will simply sustain the additional work load with anaerobic (oxygen-independent) metabolism. However, maximum aerobic capacity is not necessarily the rate at which the body can provide oxygen during sustained work. It is merely an indicator that the potential exists for high rates of oxygen uptake—if that potential has been developed through physical conditioning. This expression of aerobic potential is the second contribution that is required if a runner expects to take a place at the top of the heap.

To illustrate, I know a fellow who owns a sports car which has the potential for cruising speeds in excess of 150 mph. Presently, however, it groans mightily when pushed past 80. It is not in condition. It will always have the potential to be a super racing car—a potential that his neighbor's old Chevy will never have—but that capability will be realized only when and if the car is put into racing condition. The same situation exists with endurance athletes. It's not enough to be born with physical attributes that can be used to develop high rates of oxygen uptake. These attributes have to be trained to express themselves. Thus, we find that maximum aerobic capacity (the potential) increases only slightly with training, while the ability to tap that potential for the support of sustained exercise (the expression) increases substantially as the result of training. From performance alone, then, we can never be sure what proportion of the result is due to the

potential and what proportion is due to the expression of that potential. To help sort this out in individual cases, it is useful to be able to determine the potential (maximum aerobic capacity) directly.

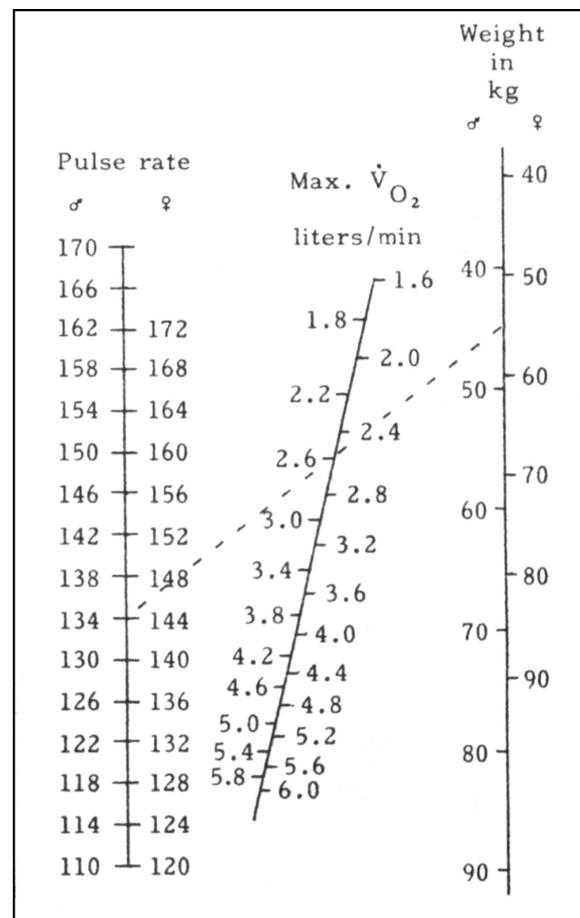
In fact, this measurement is done routinely in exercise physiology laboratories. However, the average journeyman runner seldom has access to such facilities or the money to take advantage of them. So, we will consider a simple alternative that will allow you to estimate this attribute with reasonable accuracy and without the need for any sophisticated equipment. All you need is a "step" (stool, bench, platform, whatever) that is sturdy enough that you can step onto and off of it at a fairly rapid rate for several minutes. The step should be 33 cm (13 inches) high for females and 40 cm (15.75 inches) high for males.

To conduct the test, you must mount and dismount the step with each foot at a rate of 22 cycles per minute. Don't ask me why they decided on this odd rate, but I have a fairly convenient way to pace oneself during the test. At the required rate, one performs 90 movements each minute (two steps up, two steps down per cycle). If you hold a stopwatch as you perform the test, you can establish a kind of waltz beat—making three movements every two seconds. After a couple of minutes, you will have become accustomed to the cadence and you can go on to the next task, which is to measure your pulse rate—while you keep up the cadence. This may sound a bit awkward, but it's not all that bad—and it can be made easier by enlisting the help of a friend.

The pulse is best taken on the carotid artery, which is in the neck along the windpipe. The idea of the test is to establish the maximum rate your heart will achieve at that level of sustained work. When you have made that determination (you may want to do it several times and take an average), you can determine your estimated maximum aerobic capacity using the nomogram I have provided. Just find your body weight in kilograms (2.2 pounds per kilogram) on the scale for your sex on the right and your maximum step-test heart rate on the scale for your sex on the left and connect these two points with a straight line. Where this line crosses the center scale, you can read your maximum aerobic capacity in liters of oxygen uptake per minute. To obtain the more familiar units of ml/kg/min, multiply the value obtained from the center scale by 1000 and divide the result by your weight in kilograms.

For example, a female runner weighs 55 kg and has a maximum heart rate in the step test of 144. When she connects these two values in the nomogram, the line crosses the center scale at 2.6 L/min, which is her maximum aerobic capacity. Translated to ml/kg/min. It is 51.

This simple technique should provide an estimate of where you fit into the hierarchy of natural ability among distance runners. If you find that your maximum aerobic capacity is higher



than that of runners who finish ahead of you, perhaps it's time to re-evaluate your conditioning program.