PULSE RATE AND LACTATE THRESHOLD (ref Peter G. J. M. Janssen, M.D.)

In everyday practice of training, pulse rate is used as a standard for the intensity of the workout. The reason for using pulse rate as a standard of exertion is the discovery that there is a correlation between pulse rate on the one hand and workout intensity on the other.

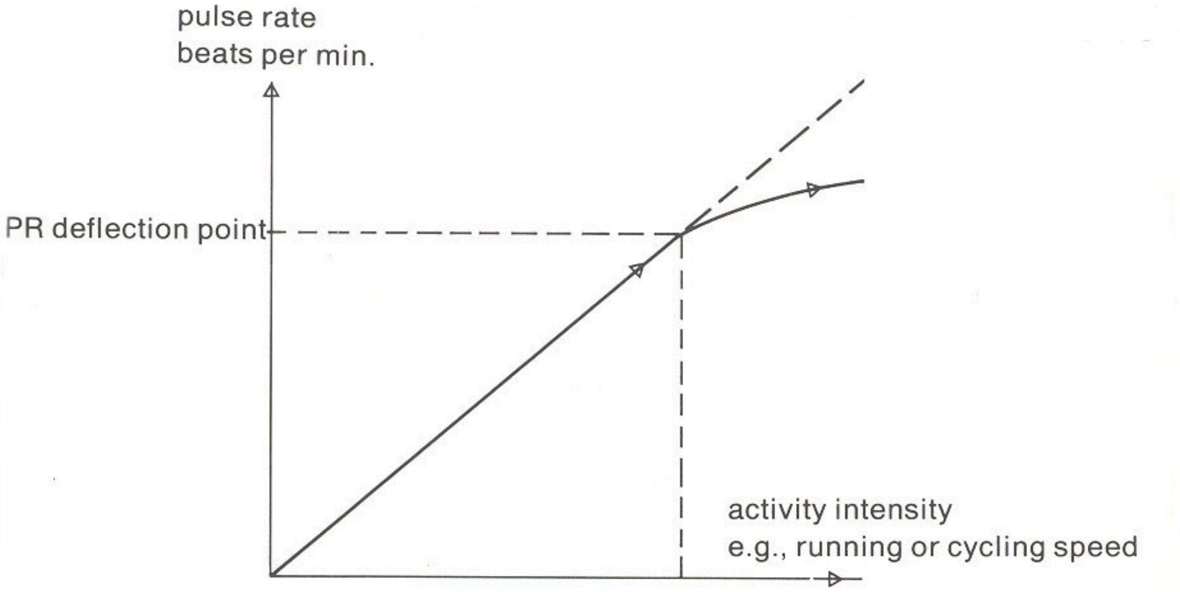
For endurance training it can be said that the best training stimulus is obtained at an intensity at which the complete oxygen-transporting system is activated to the maximum, while lactate accumulation in the muscles is not yet reached.
This intensity range is also called the aerobic-anaerobic passing zone.

Many endurance workouts are done at a pulse rate (PR) of about 180 beats per minute. This intensity of training, however, seen in the light of the aerobic-anaerobic passage, is mostly too high. The aerobic-anaerobic passage may vary widely from person to person. Roughly speaking it lies within a PR range between 140 and 180 beats per minute. One athlete is training his endurance capacity best at a PR of 140; the other will have to train at a PR of 180 in order to improve his endurance capacity.

CONCONI'S PRINCIPLE

Professor Conconi advised Francesco Moser in his successful attempt to break Eddy Merckx' world hr record. Conconi made use of the correlation between activity intensity and pulse rate. He found, as other investigators had found before, that at very intensive activity, pulse rate and intensity do not run parallel. After a certain point, the increase of pulse rate lags the increase in activity intensity. This point is the PR deflection point.

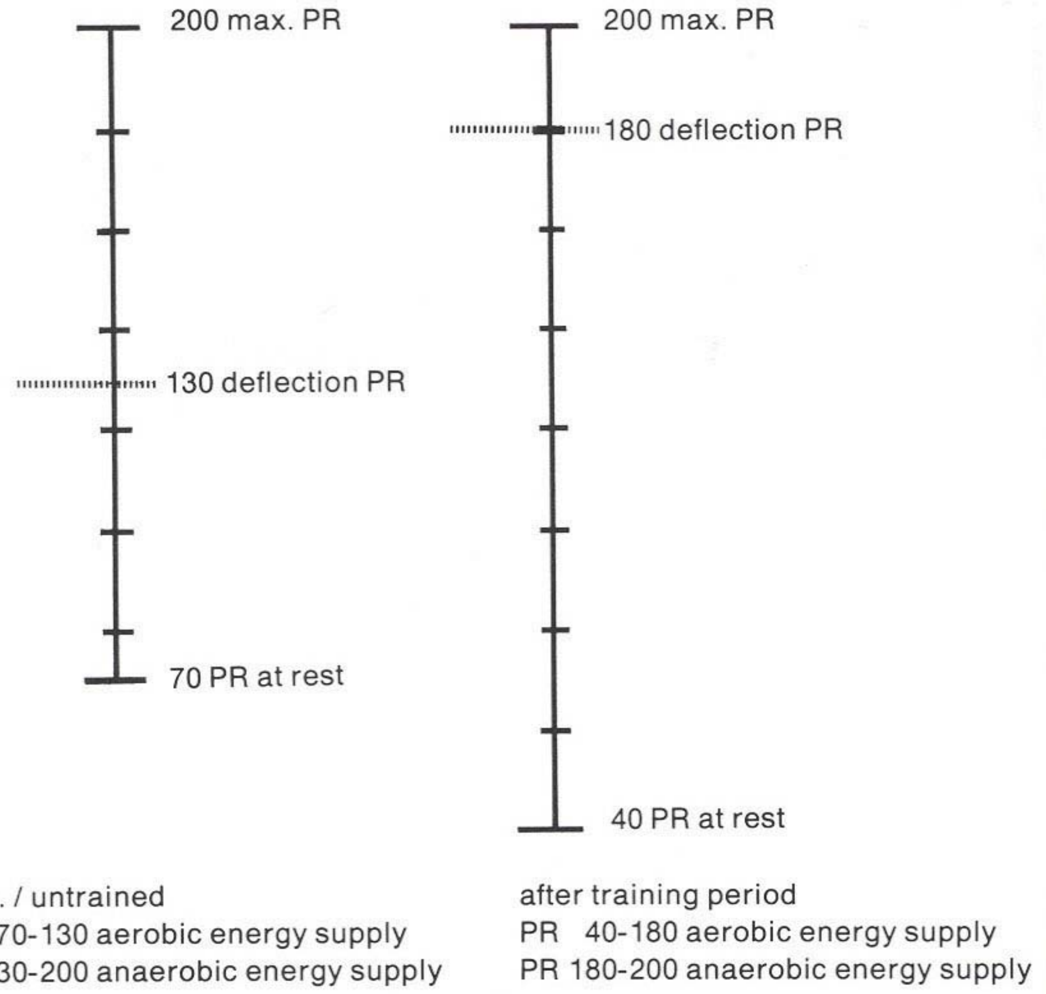
The workout intensity corresponding to this point is the maximum activity that can be done with aerobic energy supply. The deflection in the curve marks the point at what PR or what activity intensity (e.g., the speed of running or cycling) the athlete shifts from aerobic to mainly anaerobic energy supply; it also marks the anaerobic or *lactate threshold*. In this way Conconi could exactly establish the speed that Moser had to maintain without getting exhausted prematurely.



The bend marks the maximum speed that corresponds with the PR deflection point which can be maintained during a long period of time. It is the highest speed or PR which is supplied of energy fully aerobically. If the speed is increased, an accumulation of lactate will arise. In this situation the aerobic energy supplying system does not suffice; the anaerobic system is called upon, with the result is an increasing accumulation of lactate.
A great advantage of Conconi's method is that taking blood samples is not necessary.

THE INFLUENCE OF ENDURANCE TRAINING ON PULSE RATE

After a period of endurance training the reaction of pulse rates, at the same level of exertion, has undergone considerable changes. The example at the left shows the PR range of an untrained person. At the right, the same person after a period of endurance training.

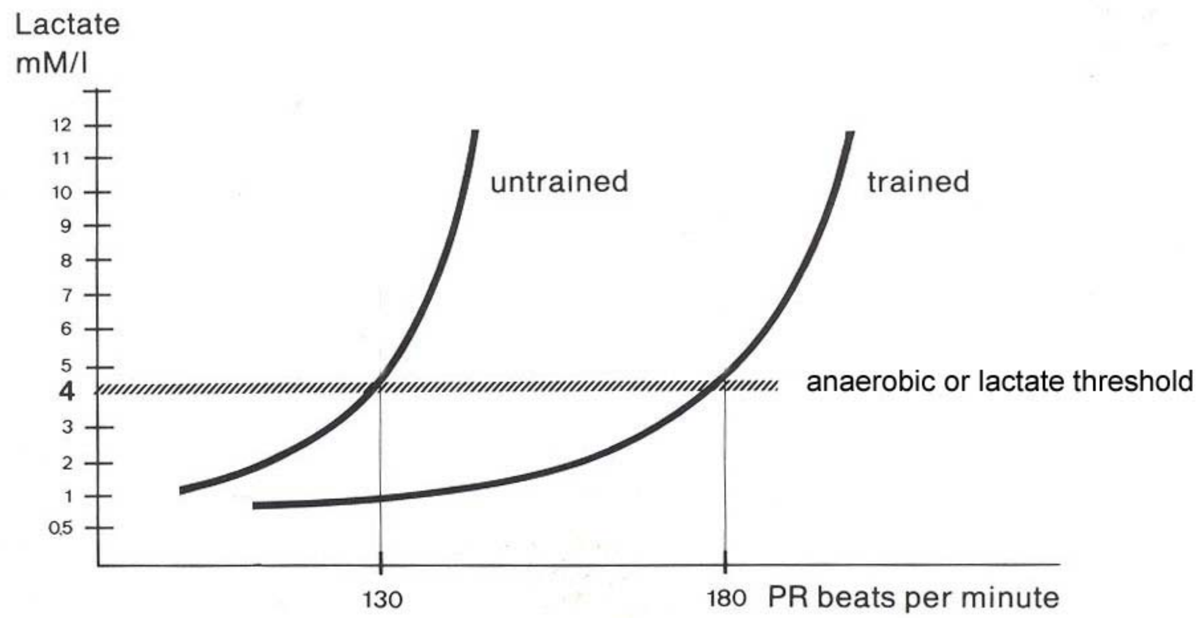


The maximum pulse rate
In the example, the untrained athlete has a maximum pulse rate of 200 beats per minute. After a period of training the maximum PR remains at the same level. So whether trained or untrained the maximum PR does not depend on conditioning. In very well-trained endurance athletes a drop in maximum PR may arise.
The maximum pulse rate can only be established when the athlete has fully rested. A complete recovery after the latest workout is necessary. It is established as follows:
After a warm-up period of some 15 minutes the athlete does an all-out 5 minutes of running or cycling. The last 20 to 30 seconds are sprinted. The maximum pulse rate can now simply be read on the pulse rate meter. Counting the pulse is less accurate due to the fast drop of pulse rate immediately after the exertion.

Pulse rate at rest
For well-trained endurance athletes the pulse rate at rest is low. For untrained persons the pulse rate at rest is between 70 to 80 beats per minute. As the endurance capacity is improved, the PR at rest will gradually decrease. In well-trained endurance athletes (cyclists, marathon runners), PR values at rest are counted between 40 and 50 beats per minute. Even under 40 beats per minute is sometimes seen. Women have a pulse rate at rest of about 10 beats more than men of the same age. Generally, in the morning this rate is about 10 beats less than in the same situation in the evening. This also applies for the maximum pulse rate.

Pulse rate at the deflection point
The most important change arising after a period of endurance training is a shift of the deflection point or lactate threshold to a higher PR. In the example the untrained person has an lactate threshold of 130.
After a period of endurance training the deflection point moves from 130 to a PR of 180 beats per minute. An exertion with an intensity beyond the PR of the deflection point goes together with an accumulation of lactate. In well-trained endurance athletes the PR range within which energy supply is completely aerobic has strongly increased. The larger PR range within which energy is only supplied aerobically means a great aerobic capacity. This great aerobic capacity enables the athlete to maintain an endurance exertion longer and at a higher pace. The athlete has more stamina. Only for exertions with a very high intensity the anaerobic system is called upon, with the nasty consequence of lactate accumulation.

The pulse rate-lactate curve
The pulse rate-lactate curve is different for every individual, and a change in state of conditioning influences the course of the curve. The left-hand curve is one of an untrained person. His deflection point is at a PR of 130 beats per minute. The right-hand curve shows that after a period of training, the PR at the deflection point has shifted to 180 beats per minute.

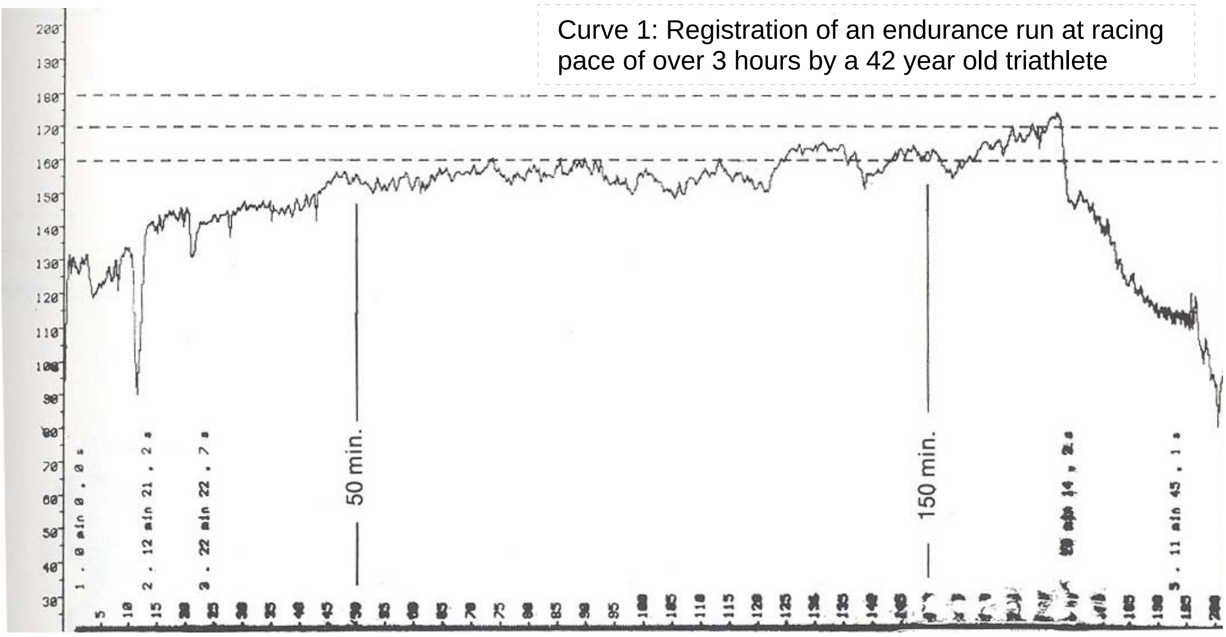


The untrained person can maintain an exertion for a long time at a PR of not more than 130. The trained athlete can perform a long time at a PR 180. This intensity of exertion has turned out to correspond with a blood lactate content of 4 millimoles per liter. This point is called the anaerobic or lactate threshold. An exertion beyond the level of the lactate threshold is accompanied by a strong increase of lactate content.

THE INFLUENCE OF AGE ON THE DEFLECTION PR

Whatever goes for the maximum PR also goes for PR at the deflection point. When you grow older, the PR at the deflection point gradually decreases. There are large individual differences.

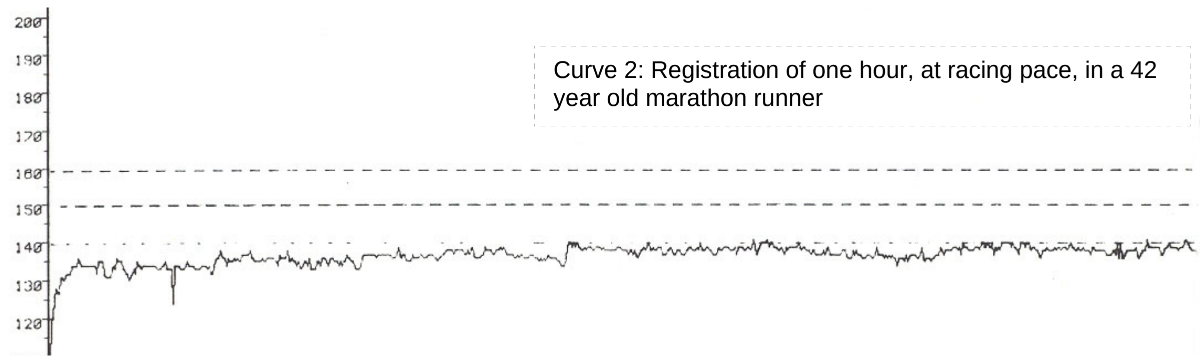
In the example below, the PRs of two athletes of similar athletic performance is examined.



Curve 1: Registration of an endurance run at racing pace of over 3 hours by a 42 year old triathlete

Athlete A’s deflection PR is established on a bicycle ergometer to be 160 beats per minute. His maximum PR is 187 beats per minute. For a 42 year old, athlete A has a high maximum PR.

Reviewing curve 1, the first 50 minutes could have been done faster since athlete A’s deflection PR was established at a PR of 160. The intensity of the run between the 50 and 150th minute is optimal since the PR is very close to the deflection point. During the final part athlete A has some reserves left and is able to run with a PR higher than the deflection point.



Curve 2: Registration of one hour, at racing pace, in a 42 year old marathon runner

For athlete B (marathoner), his maximum PR, which is reached in a sport-specific test, is 167 beats per minute. The PR at the deflection point was established as 142. As opposed to athlete A, athlete B has a rather low maximum PR for his age.
Athlete B has done an excellent endurance workout with a PR that is always close to 140 per minute. He runs just below his PR at his deflection point.

The data of these two well-trained athletes show how large the variations between different individuals of the same age may be. Athlete A will have to train his endurance capacity at a PR very different from that of athlete B.