Why are Stryd and Polar Running Power numbers different?

The recent breakthrough of running power meters has led to a fierce competition between various suppliers. Stryd was the first to introduce running power with their motion sensor technology (housed in a foot pod today) in 2016. Since then apps have been developed using GPS, barometer and accelerators in mobile phones, for example Power2Run, or as I/Q app Running Power Estimator for Garmin watches. Recently, a Power2Run app for Apple watch was launched which uses the Apple-watch GPS and barometric data. Meanwhile, Garmin and Polar, the traditional suppliers of running watches, have also developed running power technology based on the sensors in their watches.

While this competition is all good news to the running community as it leads to lower cost and better quality, runners and in particular triathletes have noticed one particularly confusing and troublesome aspect: **the power numbers of Polar (and Garmin) are much higher (around 25-30%) than the power numbers of the other suppliers and the power numbers in cycling. Why is this so and what do the numbers mean**?

Recently, we have tested the Polar Vantage V and we also found these differences. We have had some intensive discussions with Polar on the reasons and the interpretation of the results. In this paper we will first discuss the background of the force plate method that Polar uses to calibrate their algorithm. On top of the force plates, Stryd calibrates their power meters with metabolic data of VO_2 of test runners. As a result their numbers match the universal theory of sports from our books The Secret of Running and The Secret of Cycling (www.thesecretofrunning.com and www.thesecretofcycling.com). Finally, we will explain why Polar Running Power numbers are so high as compared to Stryd and how this should be interpreted.

The use of force plates

Polar calibrates their running power algorithm with force plates.

These record the horizontal and vertical components of the force applied by the runner. The horizontal force and the vertical force (minus the body weight) can be integrated to calculate the horizontal and vertical velocities and finally the kinetic and potential energies. The running power can then be determined from the total of the kinetic and potential energies divided by time. The method to calculate power from the force measurements has first been described in 1975[1]

The method is well documented and can stand the test of scientific scrutiny. Next to Polar, Garmin has opted for this method too.

The universal theory of sports

In our books, we have explained our universal model of sports and the applications for running and cycling. In short, the model is based on the concept of the 'human engine', which consists mainly of the heart-lung system and the muscles.

The capacity of the human engine can be described in terms of the maximum oxygen uptake (VO_2 max in ml O_2/kg/min) or in terms of Functional Threshold Power (FTP, in Watts/kg). As the oxygen is used to produce energy from the transfer of glycogen and fatty acids, there is a direct relationship between FTP and VO_2:

$$\mathbf{FTP = 0.072 * VO_2\ max}$$

The above equation is based on the following standard literature values: energy production through O_2 19.55 kJ/l, gross metabolic efficiency 25% and power duration factor FTP/VO_2 max = 0.88.

In our book we have presented many results of the validity of this model, including the fact that the world best performances in running and cycling are roughly equivalent to a VO_2 max of 89 ml O_2/kg/min and an FTP of 6.4 Watts/kg.

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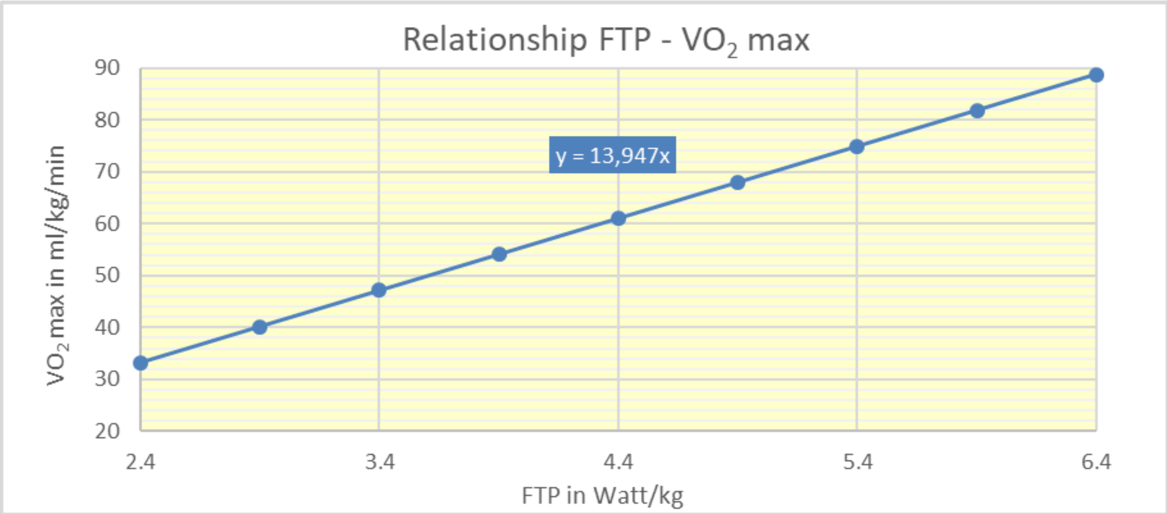
[1] G.A. Cavagna, Force platforms as ergometers, Journal of Applied Physiology, 1975 (39), 1, pp. 174-179



Stryd calibrates their power meters with metabolic data of the VO_2 of test runners. The resulting power meter data of Stryd match well with our universal theory. The same can be said from the data of the Power2Run App of Apple.

Why are the results different?

At first sight we were quite puzzled by the different results. After discussions with Polar, we believe that theoretically there are 2 possible explanations for the differences:

1. The Gross Metabolic Efficiency (GME)

Polar refers to fundamental research that indicates that muscle efficiencies may differ significantly, depending on the type of contractions (isometric, shorten, stretch, stretch-shorten). As a result the GME in running might be higher than 25%. However, we have gathered some literature data on the GME of different sports that seems to confirm that 25% is the upper limit in running and cycling. Lower numbers are found in sports with larger turbulent losses, such as rowing, skiing, ice-skating and swimming. So, while we cannot rule out the possibility that the GME is higher in running than in cycling, this does not seem very likely.

GME of various sports	
Walking	20-25
Running	20-25
Cycling	20-25
Stepping	23
Arm ergometry	16
Arm and leg erg.	18
Rowing	10-20
Skiing	10-15
Slide-boarding	10-15
Ice-skating	10-15
Swimming	3-7

2. The elastic energy recovery in (muscles and) tendons

The elastic energy recovery of the Achilles tendon and the lower leg muscles has been broadly discussed and acknowledged in literature. It is known that the Achilles tendon has a high capacity to store energy and this energy can be returned upon landing through elastic recoil. This recycling of energy would mean that in running the gross power could indeed be higher than in cycling as the recycled energy could be added to the net power of the human engine. This might be a good explanation why the force plates lead to higher power numbers than the metabolic data. It has been discussed in literature that it is realistic to estimate that the return of the elastic energy of the Achilles tendon (and other tendons) may increase the positive mechanical work by some 25-30% (at no metabolic cost). So, all in all, this seems the most logical explanation for the differences.

For practical purposes this means that we can interpret the Stryd Power numbers as the Net Running Power and the Polar Power numbers as the Gross Running Power, the difference being the Elastic Energy Recoil due to the Achilles tendon (and other tendons).

Conclusions and outlook

We remain very positive about the rapid developments in the field of running power. Competition brings better quality and lower cost, whereas new developments may lead the way to further improvements of the running power concept.
We hope that this paper will shed some light on the (confusing) differences between the running power numbers and will help in channeling the discussions on the interpretation of the data.
It seems to us that it will be very interesting to compare the Stryd and Polar data as this may provide more insight in the Elastic Energy Recoil of the Achilles tendon!

We hope that many readers will join us in these discussions. Let's share our data and conclusions on how we can improve our running! We are curious to the reactions and experiences of the readers, we welcome you to share these at www.thesecretofrunning.com**.**

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www.thesecretofrunning.com

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