

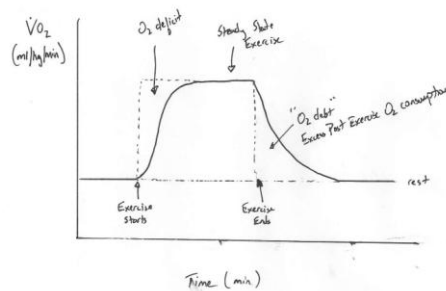
Power or Heart Rate?

Before reading this article, be sure to read ‘Should I buy an aero helmet?’ and ‘Why measure Heart Rate during exercise?’

We know that heart rate (HR) increases with exercise intensity ... but there is always a physiological ‘delay’ for HR to reach steady state. Heart rate follows VO₂ during endurance exercise and below is an illustration of how VO₂ changes as exercise demand changes. This is a classic figure used to represent what happens when someone is on a stationary bicycle and begins to pedal at a constant work rate. The ‘heavy-black’ line in the figure illustrates VO₂ response during exercise. The ‘square-light line’ represents the external load placed on the bike. For example, the bike resistance is set to 50 Watts and the person starts from pedaling. The 50 Watts is a constant resistance but the VO₂ takes a bit of time to reach a steady state level.

That delay in reaching steady state VO₂ is often referred to as ‘oxygen deficit’. There is a lot of neat research comparing the O₂ deficit to the VO₂ consumed after exercise stops. That is not the point of this article ... but that is fun reading if you want to know more about this topic.

The point of presenting this information is to recognize that the physiological system takes time to reach steady state. In the example below, the anerobic energy system must be contributing to meet the energy demand when the aerobic system has not had time to reach steady state.



When cycling outdoors, we established earlier that the propulsion force causing the bike to move forward is represented by this equation:

$$F_p + (-F_{air}) + (-F_r) + (-F_b) + (-F_s) = ma$$

- Propulsion from wheel (F_p)
- Air resistance (F_{air})
- Rolling resistance (F_r)
- Bearing resistance (F_b)
- Slope resistance (F_s)

When velocity of the bike is constant, acceleration is zero and so the equation is reduced to this:

$$F_p = F_{air} + F_r + F_b + F_s$$

In my presentation above, I talked about a bike's resistance setting in terms of Watts (i.e., 50 Watts). The equation above is in units of 'Newtons'. To complete this discussion, let's multiply both sides of the equation by velocity of the bike:

$$F_{pv} = (F_{air} + F_r + F_b + F_s)v$$

The F_{pv} term represents the power the cyclist can generate. Therefore, rearranging the parameters in the equation, we have:

$$v = (F_{pv}) / (F_{air} + F_r + F_b + F_s)$$

In words, the velocity of the bike is a ratio of power the cyclist can generate to the resistance forces (again, this is why cyclists spend a lot of money and time reducing the resistance as much as possible!).

Power is an instantaneous measure ... it can be measured at the crank (crank based system) or hub (hub based system) ... remember, the cranks are the pedals of the bike and the hub is the axel of the rear wheel. Each time the person pushes on the medal and causes the pedal to move (with some velocity), power is generated.

So measuring power is just another tool for monitoring exercise intensity. As power increases, exercise intensity increases. The advantage of using a power meter is that there is instantaneous feedback regarding the demand of exercise. Whereas there is always a delay in HR response to changes in exercise demand.

Sometimes, having the instantaneous feedback is important in training and monitoring intensity during a race. However, not all cyclist need a power meter nor will they benefit from having a power meter. Whether someone should purchase a power meter is an individual choice and you would need to know the level of competition someone is trying to achieve and level of knowledge of understanding how to use power to monitor intensity.

In most cases, athletes can get sufficient information from a HR monitor. However, as we saw in class, not many people take the time to determine the maximum HR and therefore the use of HR to set intensity zones is limited in scope. Along with this, the usefulness of a power meter is really built around the idea of determining the power level that can be sustained ... if an athlete is not willing to perform the tests needed to establish these markers, the use of either HR or power data is limited.

That being said, it is fun to record and analyze data and a lot can be learned by reviewing HR and/or power data collected during training and/or racing.