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Review of force production and fatigue during cycling at different pedal cadences, taken from:

Sarre et al (2005). **Stability of pedalling mechanics during a prolonged cycling exercise performed at different cadences.** Journal of Sports Sciences

Following the huge success of cycling superstar Lance Armstrong, it seems that every cyclist and triathlete now favours a higher cadence during training and competition. Is this phenomenon supported by scientific research or is it fashion ?

Sarre et al examined the effects of pedalling at different cadences upon fatigue and power distribution during the pedal cycle. It is fair to say that a circular pedalling action is better than push...push...push and this is not disputed. Cyclists attempt to develop a smooth action which involves not only pushing the pedal down, but pulling backwards at the bottom of the stroke and upwards on the return. The dispute lies in the speed at which the pedals go round, namely the 'cadence', measured in revolutions per minute (RPM).

Although the research on pedal cadence has not yet been fully conclusive, there are some common factors. Higher cadence produces higher heart rates and oxygen consumption, but encourage greater blood flow through the tissues and less force production by muscles. By comparison, big gears and slow cadence results in lower heart rate and breathing, coupled with reduced blood flow to exercising muscles and greater muscle force, possibly resulting in earlier fatigue.

Following the cycle tests, which involved 1 hour of steady state cycling (65% maximum) at different cadences. Sarre found that the highest cadence produced the highest amount of fatigue. The quadriceps muscles were less able to produce force following 1 hour at 110 RPM, when compared to 1 hour at 50 RPM. These findings are the opposite to that which you may expect, but similar to those found in previous studies.

Let's go back to the 'circular pedalling' and even power distribution throughout the full 360° pedal revolution. It is much easier to apply pressure through the full 360° when riding in a larger gear at slower cadences. When using larger gears, you can feel the pedal pressure throughout the full pedal cycle. By comparison, when riding at a cadence of 110 RPM it proves very difficult to maintain constant 360° pressure, especially on the upstroke. In simple terms, you just can't pull up fast enough !!

Laursen noted that during the higher cadences, the amount of power being produced during the upstroke was relatively low. This meant that the cyclists had to push harder on the down stroke to maintain their pre-set work level. Laursen hypothesised that it was this which resulted in the greater quadriceps fatigue.

The majority of past research indicates that a low pedalling cadence of 60-70 RPM is the most economical in terms of energy and heart rate, whilst cadences of 80-90 RPM induce the least fatigue. By comparison, cadences of 100RPM and above induce the most fatigue and are the least economical (Takaishi 1996).

What does this mean in practical terms ?

- If you would like to train / strengthen your muscles to work effectively throughout the full pedal cycle, you may benefit from using a cadence of 70-80 rpm to allow you to apply pedal pressure throughout the full 360°. This could be utilised during specific drill or technique sessions.
- Until physiological adaptations have occurred, pedalling at higher cadences may induce more fatigue than pedalling slowly. When coaching cyclists, the optimal cadence should be between 80-90 RPM.
- Unless the cyclist has a large aerobic capacity and has extensively practiced, pedalling at high cadences (100 RPM +) will result in fatigue and poor performance.

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