The Limits of Human Power

UNIV 197K-01
The Limits of Human Performance
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What does it mean to be “powerful”

- In simple language: being able to produce high velocity of movement, while maintaining relatively high muscle force output
- So what, specifically, is power?
- From physics, power (P) can be computed from force (F) and velocity (v)
  \[ P = F \times v \]
- In the sports performance literature, this is sometimes referred to as “speed-strength”

Muscle Force, Velocity, and Power

- How much force muscle can generate depends on the velocity of shortening
- The faster a muscle shortens, the less force it can produce
- Known as the force-velocity relation

If you multiply the value on the X axis (velocity) by the value on the Y axis (force), you get power output
  \[ P = F \times v \]
- This yields the power-velocity relation
Muscle Force, Velocity, and Power

- At low and high speeds, muscle power output is low.
- Power output is maximized at about 1/3 of peak muscle shortening velocity.
- Actual peak power differs a lot between different muscles.

Any type of training that increases muscle force or speed, will lead to greater power.

In practice, explosive training techniques (e.g., plyometrics) benefit power the most.

Muscle Fiber Type

- In 1678 Lorenzi observed the gross anatomical difference between red (slow) & white (fast) fibers.
- In 1873 Ranvier typed muscle on the basis of speed of contraction and fatigability.
- Currently 3 basic fiber types are used, based on speed of contraction and muscle metabolism:
  - Type I: Slow-twitch Slow oxidative (SO)
  - Type IIa: Fast-twitch Fast oxydative-glycolytic (FOG)
  - Type IIx: Fast-twitch Fast glycolytic (FG)

In these muscle cross-sections, ST fibers are stained light, and FT fibers are stained dark.
Muscle Fiber Type and Power Output

- At a given speed of shortening, a muscle with more fast-twitch fibers can produce more power than a muscle with more slow-twitch fibers.
- This will translate into a performance advantage in certain sports.

Power athletes, such as sprinters, tend to have a higher than average percentage of fast twitch fibers in their limb muscles.

Powerlifters vs. Weightlifters

- Competitive powerlifting consists of the squat, bench press, and deadlift.
- Competitive (Olympic) weightlifting consists of the clean-and-jerk and snatch.
- Are powerlifters more powerful?

Peak power output (elite-level competitors)
- Weightlifting: 22 W/kg (~2600 W)
- Powerlifting: 6 W/kg (~840 W)

Up next ...

- Factors that determine and limit human reaction time and coordination.
- Also on the horizon:
  - another article
  - a short assignment
  - start thinking about topics