Racing to the finish line: Why are elite male athletes typically faster than elite female athletes in endurance sports?

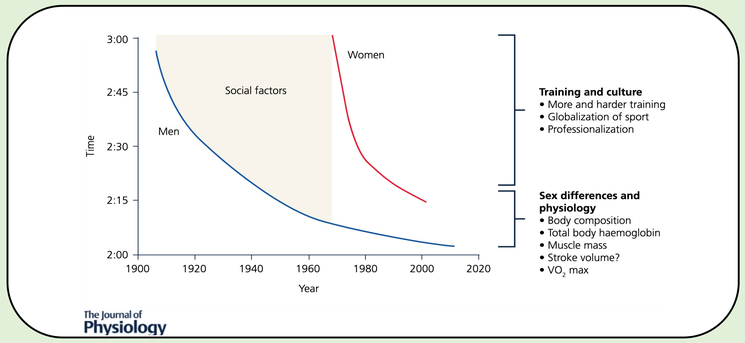
by Marie Walker

An Overview of:
Physiological limits to endurance exercise performance: influence of sex by Michael J. Joyner

undergraduate poster showcase

Introduction

Marathon times for elite male and female athletes over time



Historical factors

Prior to the 1960s, there was not a lot of female participation in endurance sport, due to banning women from competition or restricting race distances. In the 1960s, the restrictions began to lift, and females began competing in long distance endurance sport, like marathons.

- An increase in females competing caused faster marathon times

Training and culture

- Increasing training volume and intensity caused faster marathon times
- Elite female athletes were able to do this in a shorter time frame (1970s-1980s) compared to males because this was when bans were lifted from females in endurance sport

Women were still restricted from doing the 1500m swim in 2016

Methods

- Publicly available data (marathon/Olympic race times of elite and sub-elite athletes)
- Laboratory studies
- Physiological models of exercise performance
- Short (2-6 months) and medium (~1 year) term training studies

Main Differences

Sociological/Historical factors

- Restrictions & bans against females in endurance sports

Other factors

- Thermoregulation (only applicable in sub-optimal conditions)
- Pacing patterns: females typically better at pacing than males so that they don't slow-down in the second half of the race. Although, this is less of a factor at elite levels, since pacing patterns of males and females are relatively similar.

Physiological factors
- VO_2 max
- Lactate threshold
- Running economy

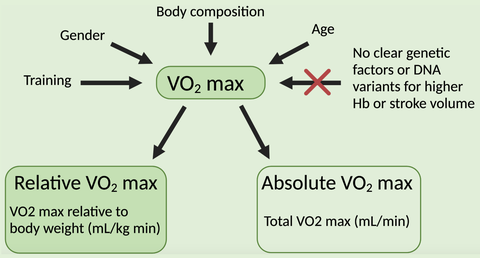
Steady state effort
This overview mainly covers consistent effort sports (ex: long distance running compared to cycling where there is a change in terrain & effort)

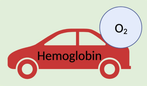
Results

VO_2 max

VO_2 max: maximal oxygen consumption

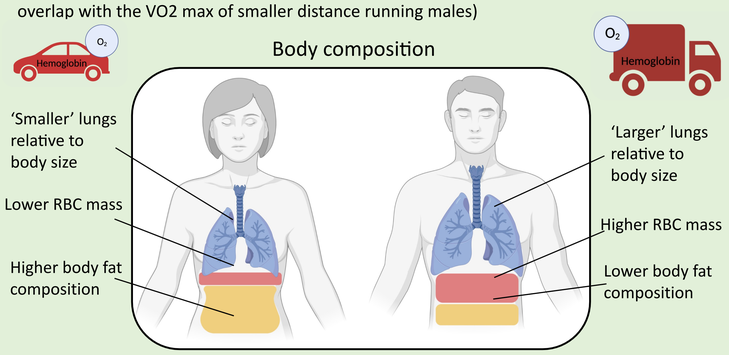
A higher hemoglobin and a higher stroke volume (amount of blood pushed out of the heart in a heartbeat) contribute to a higher VO2 max





Female VO_2 max ~10% lower

Some female VO2 max can overlap with some males (ex: elite female rowers VO2 max overlap with the VO2 max of smaller distance running males)



- Running: elite cohort of women are 10-12% slower than their male counterparts
- Swimming has less of a difference in males vs females (only ~7% slower), this could be due to fat being buoyant in water, so body composition differences are less of a factor

Running Economy (Running Efficiency)

Running economy: the oxygen cost of a given running speed

1. Biomechanics
   - Vertical movement
   - Braking
   - Elastic properties of muscle and connective tissue
   - Fiber type
2. Short foot contact on the ground
   - As seen in East African distance runners

Running speed varies in elite athletes by 15-20% when they are below their VO2 max

Less is known about the biological determinants of running economy, more research is needed

Acknowledgements

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References

1. Joyner, M.J. Physiological limits to endurance exercise performance: influence of sex. *The Journal of Physiology* **595**, 2949-2954 (2017).

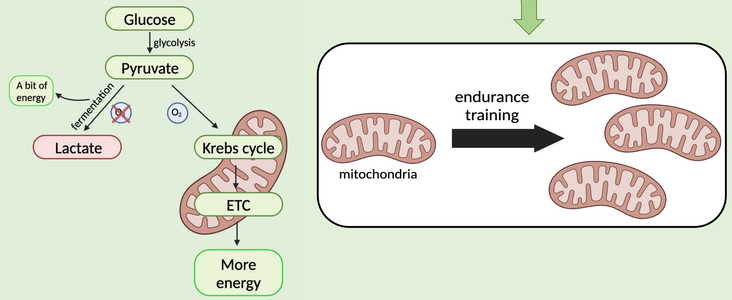
Results (continued)

Lactate threshold

Lactate threshold: the running intensity at which lactate levels start to increase rapidly

=> Both sexes can sustain a running pace at ~80% of their VO2 max, associated with a noticeable, but not extreme increase in lactate <=

Endurance training causes the creation of more mitochondria, which increases lactate threshold

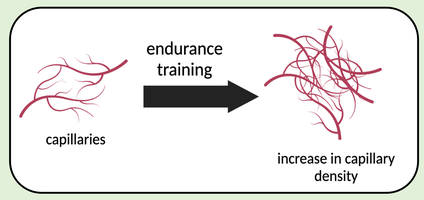


A higher lactate threshold means that an athlete can sustain a higher running intensity.

More mitochondria means that more pyruvate can turn into acetyl CoA, and overall generate more energy (ATP)

Endurance training causes an increase in capillary density

An increase in capillary density means that an athlete can spend longer above their lactate threshold, because they have more oxygen supply



Conclusion

The main physiological difference between elite male and female athletes is VO_2 max. Running economy and lactate threshold may also play a role, but to a lesser extent, along with thermoregulation and pacing patterns.

This overview mainly focuses on consistent effort endurance sports (running), and more research is needed for other sports. In general, more data is needed for female athletes as well.

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