



WORLD-CLASS ATHLETIC PERFORMANCE

The Physiology: Genetics and Heritable Traits

CUTTING TO THE CHASE

- In Olympic sports (and world-class performances)
 - Athletes in a sport = generally more physically similar to one another than you are to your sibling.
- In track & field
 - Can pick out athletes' events by their body dimensions:
 - 400m, 800m, & hurdlers?
 - Marathoners?

FEMALE ATHLETES

- Nonathlete women = wider **pelvic bones** than nonathlete **men**
- BUT,
 - Female swimmers → more narrow pelvic bones than nonathlete men
 - Female divers → more narrow than female swimmers
 - Female sprinters → more narrow than female divers
 - Female gymnasts → narrowest of all

➤ Smaller hips make for efficient running & linear motion.

SPRINTERS

- Females
 - much longer legs than nonathlete women
 - About as long as nonathlete men
- Males
 - About 2" taller than nonathlete men
 - 100% of that is in legs!
 - When seated, both male sprinters & nonathlete men = same height

SWIMMERS

- Males
 - > 1.5" taller than sprinters
 - But legs = 0.5" shorter!
 - Michael Phelps (6'4") vs. Hicham El Guerrouj (5'9")
 - 32" inseam is shorter than El Guerrouj's

➤ Longer trunks + shorter torsos = advantageous for moving along water surface

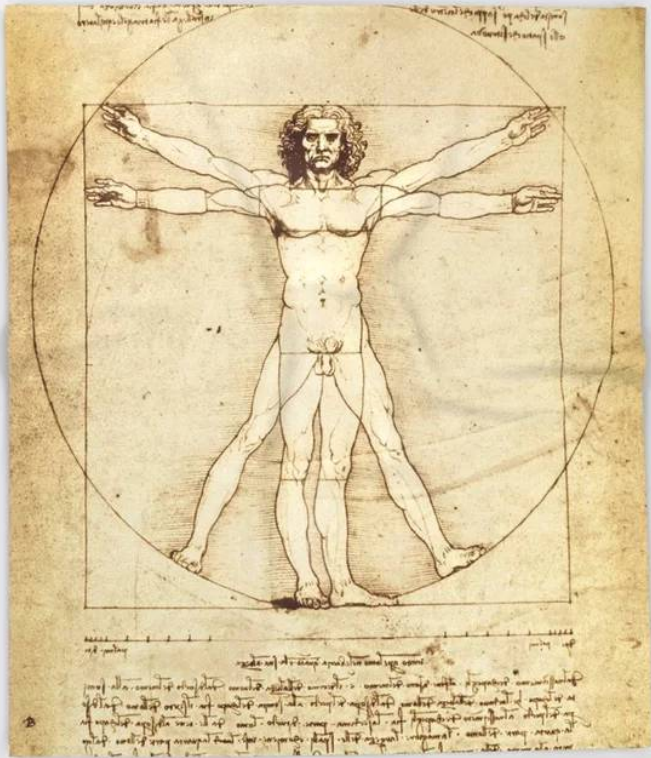
BRACHIAL INDEX

- Forearm length relative to the upper arm
 - High index = better suited to propulsion
 - Swimmers, lacrosse players, kayakers
 - Low index = better suited to stability and strength
 - Weight lifters, wrestlers

HEIGHT

- 68% of American men are in the 5'7"-6'1" range
- 5% of American men are 6'3" or taller
 - Less than 20,000 American men are 6'8" or taller
- Average height of NBA player... 6'7"
- Short people don't generally make the NBA
 - Unless they have other extraordinary talents, like jumping
 - Nonetheless: number of players ever drafted into NBA who couldn't grab the rim: **0**

ARM-SPAN-TO-HEIGHT RATIO



- DaVinci's *Vitruvian Man*
 - Arm span equal to height
 - Approx. 1:1
- Like you, me, and most people

CONT'D.

- Average arm-span to height ratio of an NBA player = 1.063
 - (Aside: average for Marfan syndrome diagnosis = 1.05)
- Average-height NBA player (6'7") has wingspan of 7'
 - Elton Brand (6'8") has wingspan of 7'5")
- Players deemed as undersized for their position
 - make up for it with favorable ratio

CONT'D.

- Advantages
 - Blocked shots
 - Offensive & defensive rebounds
 - Tip-off
- Chuck Hayes – Center, Houston Rockets, 2006-2011
 - Shortest starting center in NBA history
 - 6'5.5" → wingspan 6'10"!
- A few rare exceptions
 - JJ Redick
 - Yao Ming (but at 7'5"...)

ETHNIC & ANTHROPOMETRIC FACTORS

- Successful body types WITHIN a sport = more similar than body types BETWEEN sports
 - Regardless of ethnicity
- However, some trends are evident in Olympics
 - African, African American, African Canadian, Afro-Caribbean
 - More linearity
 - Longer legs & narrower pelvic breadth

CONT'D.

- No BEST overall body type
 - But, some fit a particular sport better than the others
- Linear, longer-limbed East Africans
 - Excellence in endurance events
- Short-limbed Eastern Europeans & Asians
 - History of success in weight lifting and gymnastics
- In NBA, wingspan differences between white & black athletes
 - 1.035 and 1.071 respectively.

BELLY BUTTONS

- At a same height
 - Black adults have a COM that is ~3% higher than in white adults
 - 3% difference translates into 1.5% running speed advantage for higher COM (black athletes)
 - AND, 1.5% swimming advantage for lower COM (white athletes)

WEIGHTLIFTING: PHYSICAL PROPORTIONS

- Ideal:
 - Brachiomorphic body type
 - Shorter femurs
 - Ability to slightly hyperextend elbows
 - Larger hands
 - Shorter stature

GENETIC DIVERSITY

- More genetic variation in populations from Africa
 - More possible “spellings” than any other place in the world
- Up until [very] recently (< 90,000 y.a.), the entirety of human genetic information = contained in Africa
- Humans split from last common ancestor with chimpanzees
 - ~5,000,000 y.a.
 - Humans have been outside of Africa for a very brief time!
 - Suggestion is that both the slowest **and** the fastest runners are there.

JAMAICAN SPRINTING DOMINANCE

- Western sub-Saharan Africa
 - Malaria
 - Sickle cell disease
 - Low hemoglobin
 - Reduced O₂ capacity
- Shift toward anaerobic metabolism & Type II fibers
 - Endowment for sports of brief duration and high intensity!

CONT'D.

- Epidemiological studies:
 - Athletes with sickle-cell trait = underrepresented in athletic endeavors requiring AEROBIC ENDURANCE
 - ...AND, are almost entirely absent in events lasting longer than 800m

TRELAWNY

- Tiny parish, northwest Jamaica
 - Hotbed for producing world's top sprinters
 - National champions from U.S., Great Britain, Canada, and other countries are expats from Jamaica
 - Specifically from Trelawny
 - Why is this important?

CONT'D.

- Trelawny
 - Located in Jamaica's "Cockpit Country"
 - Mountainous highlands
 - Thick and dense rain forest
 - Star-shaped valleys
 - Steep, impenetrable limestone cliffs and sinkholes
 - Surrounded by ocean, and difficult to escape
 - 1655, British Navy fought the Spanish for control of island
 - The slaves, there, largely of Ghanaian and Nigerian origin
 - Fled into Cockpit Country amidst the chaos
 - Founded communities, became known as Maroons
 - Mastered the territory

TAKE HOME MESSAGE

- Strongest people taken from Africa
- The strongest of those survived the brutal voyage to Jamaica
- The strongest of those fled to Trelawny's Cockpit Country
- Olympic sprinters come from that stock

ACTN3

- Alpha-actinin-3
 - Gene for speed
 - Structural impact on how explosively a fiber can contract
 - Having one copy = desirable for sprint & power performance
 - Nearly all African populations have at least one copy
- Populations deficient in ACTN3
- Smaller FT fibers, more metabolically efficient FT fibers
 - Spread rapidly following transition from H-G to agriculture

OTHER NOTABLE GENES

- UGT2B17
 - Gene variant allowing athlete to dope without detection
 - T/E ratio
 - Normal ratio is ~1:1
 - 4:1 is suspicious
 - 10% of European-descended people
 - 2/3 of Koreans

NFL CORNERBACKS

- Position typically exclusively occupied dominated by African Americans
 - Very few white cornerbacks over the past 20 years
 - Sometimes moved to the Safety position
- JSCR
 - in terms of athleticism across 15 positions in NFL
 - Cornerback = most
 - Offensive guards = least

RUNNING ECONOMY

- What is it?
- Factors influencing RE