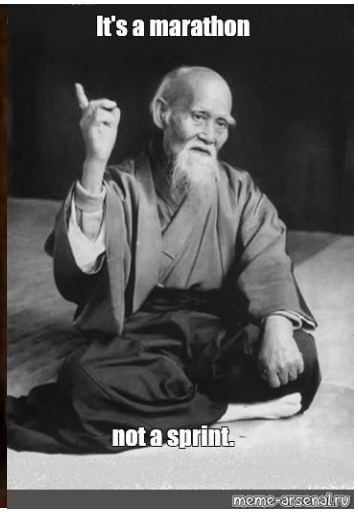
Muscle Endurance

In for the long haul – how genetics influences physical endurance



The stamina factor

Most of us are familiar with the 'it's a marathon, not a sprint' trope, which has spawned a multitude of internet memes. Back in ancient Greece, the marathon was named after a historic battle and the story of a Greek soldier who reputedly ran from the Attic plains in the northeast to Athens to report on the outcome of the first clash with the invading Persians (it was 1–0 to the outnumbered Greeks).

This makes the ancient Greeks the original endurance athletes, creators of the Olympic Games, which even now – so many centuries later – still endure as the test of peak performance at a global competitive level. The marathon was included as an endurance event in the first Games in 1896 and has been a feature ever since.

These days, the Kenyans dominate the leaderboard when it comes to marathons, and have done so for many years. What makes Kenyans such excellent endurance athletes? Research into this is still ongoing to pinpoint exactly which characteristic – or combination of elements – makes them literally dominate the field. One research paper[1] studied a particular tribe – the Kalenjin – and others have looked at various characteristics, such as the ability to convert fuel efficiently to effect a slow release for sustained effort, and a superior ability to assimilate oxygen[2].

Other factors of influence include diet, adaptation to high altitudes, and high aerobic capacity from sheer habituation to running long distances. The jury's still out on just what the magic ingredient is that puts Kenyans generally streaks ahead of the competition, but it is likely that genetics plays a major part.

Power dynamics

Many elements combine to produce muscular force over a sustained amount of time or through repeated movements, and the ability to convert fuel efficiently and quickly is critical to performance.

Different sports make different demands on the body's muscles. Whether it's the short, sharp burst of speed for the track or the long, sustained effort of the distance event, so-called 'fast-twitch'

muscle fibres are best at delivering speed for sprinting, while ‘slow-twitch’ muscles are more resistant to fatigue, and therefore better for endurance.

So the muscles themselves can differentiate whether you would make a good marathon runner, or whether you’re better suited to the 100 metre sprint track – whether you’re more a Mo Farah rather than a Linford Christie. And your DNA can help you find out into which camp you fall.

Written in your genes?

When it comes to our body’s muscles, and delivering the power for different physical tasks, it’s not just the level of fitness or conditioning, it’s also in the genes.

For those more interested in distance events, there is much to be read from their genetic make up, because the gene variants, or SNPs, can tell a story of a predisposition towards endurance.

Muscles & metabolism

The body’s metabolism is a complex, intricate system with many factors in play. Some genes are expressed in a huge variety of different cells and are associated with many different physiological processes. When it comes to muscle endurance, one variant of the ADRB2 gene – SNP rs1042713 – has been associated with a possible positive response to endurance training[3], with the AA combination of alleles being the strongest indicator. However, further studies are needed to confirm these links[4].

SNP rs1042713

We don’t know what variant you have at position rs1042713 as you aren't logged in.
Please log in or sign up to discover your variant.

Fat as fuel

Activities that require short bursts of exertion and intense anaerobic performance mainly use glucose in muscle metabolism. For more sustained physical activity over a longer time or distance, fat as fuel is superior in meeting the requirement for sustained energy release.

The PPAR-α gene is a metabolic regulator and some versions of it, such as SNP rs4253778, can affect the use of fat as fuel, depending on the combination of its C and G alleles. The GG combination in this position can be a positive indicator of the ability to metabolise fat efficiently in order to sustain activity over time.

SNP rs4253778
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Fast vs slow twitch

Power for physical activity is delivered by the contraction of muscle fibres and of the two types, fast-twitch is best for speed and power in short bursts, while slow-twitch is better for endurance.

Of the polymorphism rs1815739 in the ACTN3 gene, the T allele is more likely to activate the slow-twitch muscles, so a TT combination in this position would appear beneficial for endurance athletes, such as marathon runners.

SNP rs1815739
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Angiogenesis & O_2 transfer

Fuel for the muscle is one thing; the other critical factor for optimal function is oxygen.

The body’s adaptation to exercise by facilitating the transport of oxygen to the muscle is vastly improved by angiogenesis, the process that ultimately increases blood flow to an area through an increased blood-vessel network, and the vascular endothelial growth factor A (VEGFA) gene can beneficially influence this.

For SNP rs2010963**,** the CC allele combination is the most associated with increased aerobic capacity and can therefore be a good indicator of endurance.

SNP rs2010963
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The inflexible variant

Muscles would be nowhere without the tendons and ligaments that connect them in the human form. Stiff tendons are often associated with an increased injury risk, yet for endurance events such as long-distance running, this very stiffness can be an advantage since less mobility in the Achilles tendon delivers energy more efficiently, therefore promoting the endurance factor.

The collagen type V alpha 1 (COL5A1) gene and its variant rs12722 are involved in such connective tissue functions and paradoxically, have the potential to both aid and compromise athletic performance.

SNP rs12722
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Please log in or sign up to discover your variant.

In for the long haul

Our fitness goals are as individual as we are, but achieving them can be made easier by playing to our inherent strengths. Our genetic code can give the key pointers here and inform whether we are likely to be most committed – and therefore successful – in buckling down for the last set of repetitions in the gym, or whether our unique genome might see us happiest out on the open road, with a system best suited to going the last mile of that marathon.

References

[1] Demographic characteristics of elite Kenyan endurance runners ——>

[2] Aerobic exercise capacity at sea level and at altitude in Kenyan boys, junior and senior runners compared with Scandinavian runners ——>

[3] Associations of polymorphisms of eight muscle- or metabolism-related genes with performance in Mount Olympus marathon runners ——>

[4] Trp64Arg polymorphism in ADRB3 gene is associated with elite endurance performance ——>