Physiological Characteristics of a Marathoner
PART 1

Dr Brendan O'Brien Physiology Coordinator UB WestVic Academy of Sport

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Recently, our country cheered on local lad Shane Nankervis in the marathon at the Commonwealth Games. While Shane's success in representing his country is tremendous testament to his dedication to years of grueling training, he was born with several physiological characteristics that have assisted him on his journey to be an international standard athlete. So what are the characteristics that distinguish champion marathon runners, like Shane and local legend Steve Moneghetti from your average Joe who struggles just to jog the 6 km of track around Lake Wendouree?

Most importantly, international standard marathon runners' possess an extra-ordinary capability to use oxygen to produce energy. Energy can be produced aerobically (with oxygen) and anaerobically (without oxygen). Providing carbohydrate from our diet (one of the fuels oxygen uses to produce energy) can be supplied at the rate it is used, aerobic energy production does not result in muscle fatigue. However, if the athlete runs at a pace exceeding his bodies capability to produce energy aerobically, their body has to supplement the required energy needs with anaerobic energy. The consequence of using anaerobic energy is that it results in the formation of "metabolites', chemical compounds that quickly cause muscle fatigue.

Part of the explanation underlying Shane and Monas international marathon success is that their muscles have the potential to produce aerobic energy at twice the rate of healthy sedentary individuals of the same age. Therefore they can run at far greater speeds before their bodies have to supplement the energy required with fatigue inducing anaerobic energy. The physiological explanation for their superior aerobic capability is attributed to two major traits. First, they possess larger or more powerful hearts (complemented by an elastic and extensive network of blood vessels) capable of pumping large amounts of oxygen-rich blood to their exercising muscles.

Secondly, their muscle cells are better adapted to use the oxygen to produce energy. Specifically their muscle cells contain larger and more abundant mitochondria, cellular structures that use oxygen in combination with carbohydrate or fat to produce energy. There are other physiological factors that allow Shane and Mona's to sustain running speeds far greater than your mere mortal and these will be discussed in the up coming weeks!

PART 2

Physiological Characteristics of a Marathoner (continued)

Part of the reason Shane Nankervis and Steve Moneghetti are such excellent marathon runners - they are able to produce aerobic energy at twice the rate of a healthy sedentary individual of the same age because of their more powerful hearts, and muscles that are suited to producing energy aerobically. In the exercise physiology laboratory at the University of Ballarat an individual's maximal capability to use oxygen during exercise can be assessed. The individual generally either runs on a treadmill or rides a cycling ergometer where the speed, incline or resistance is increased every minute or two. Oxygen consumption is simultaneously measured and increases in proportion to the increase in exercise work-rate but eventually plateaus when the heart is unable to supply enough oxygen rich blood to the tissues, or the muscle's capability to use oxygen are exceeded. This plateau in oxygen consumption coincides with the individual's inability to continue much further with the exercise work-rate resulting in the individuals desire to stop exercising!

The maximal oxygen value attained before termination of exercise is known in scientific circle's as VO2 max. The average males VO2 max is about 40-45 millilitres per kilogram of muscle mass they possess. Shane's and Mona's value is more closer to 80-90 millilitres per kilogram of muscle mass. However running success is not solely attributed to VO2 max or the percentage of VO2 max where anaerobic metabolism is used to assist in the energy demands of the task (commonly known as anaerobic threshold)

Recent studies reveal that Kenyan and Scandinavian runners actually possess similar VO2 max values, yet Kenyan runners dominate running events over 5 km compared to their Scandinavian competitors. So what enables elite Kenyans runners to have a competitive edge if their maximal capability to pump blood to the tissues or maximal oxygen utilization capability is similar to Scandinavian runners?

It appears that a greater proportion of Kenyan runners have superior running economy, that is they require slightly less oxygen per stride than their Scandinavian counterparts. As they require less oxygen per stride they use less carbohydrate and consequently have more "fuel in the tank" available during a race. The superior economy allows the Kenyans to have a greater stride rate at the same energy requirement as a Scandinavian. The reason for their greater economy is explained by their long slender legs (have a look at a Kenyan's calf muscles, which are generally quite small but defined) that require less inertia to overcome, resulting in less energy expenditure per stride. Consequently a gold medal winning performance requires marathon runners to not only possess a big engine (VO2 max) but an economic one as well.

PART 3 - IMPROVED PERFORMANCE

Brendan O'Brien UB WestVic Academy of Sport
Coordinator Exercise Physiology

While it helps to have the genetic advantage of a larger heart and muscles primed for aerobic energy production or long slender legs to be an international standard endurance athlete most normal people can substantially improve endurance performance a few weeks of initiating regular endurance training. Sustained rhythmic exercise such as running, cycling and swimming performed for at least 20 minutes three-five times a week at an intensity of 65-80% of maximal heart rate over 12 weeks may improve the aerobic power of the body (VO2 max) by approximately 20%.

Alternatively, VO2 max can be improved by very short intense exercise. A recent study revealed that VO2max can be improved by 2-3 minute workouts performed three times a week! The workouts consisted of cycling furiously for 30 seconds (with a 5 minute break between efforts) 4-6 times. However as interesting as this study is, I would recommend individuals engage in the more conservative rhythmic sustained training program when initiating an exercise program.

The improvement in performance is a consequence of the body adapting to the stress incurred during exercise. The heart adapts to exercise by becoming a more powerful pump. At maximal and sub-maximal exercise more blood is ejected from the heart. As the heart can eject more blood each beat, heart rate during sub-maximal exercise slows down, conserving the energy expenditure of the heart. The arteries also become more elastic facilitating the flow of blood to the muscles. The muscles become more aerobically tuned as the ratio of blood vessels serving the muscles increases, enhancing oxygen transport to the muscles. The muscles themselves develop more mitochondria to produce energy aerobically, and more fat and carbohydrate are stored within the muscle providing the mitochondria with more fuel to produce energy.

As a consequence of these adaptations the body is able to sustain greater exercise intensities before it has to resort to fatigue inducing anaerobic energy production.

However, it is important to realize adaptations to exercise are generally specific to the mode of exercise training. That is cycling training will improve cycling performance but will not necessarily have a big impact on running or swimming performance and vice a versa. Furthermore the magnitude of adaptation to exercise is individual specific. Whilst most people will generally improve their VO2 max by approximately 20% within 2-3 months of regular training the actual range observed from longitudinal exercise training studies varies from 0-40%. I advise you speak to a personal trainer (preferably someone with a Human Movement or Exercise Science degree) or an accredited exercise physiologist before initiating an exercise program to ensure your training program is safe, and structured optimally to improve performance.
