Why do Athletes Have a Higher Maximum Heart Rate and Why is it Important? How Can It be Increased (Aerobic Conditioning)?

Abstract: One's maximum heart rate (MHR) is simply the amount of heartbeat/ minute under maximum stress. It is used as a benchmark to determine the maximum output each athlete's body can produce. The number could help to curate specific training intensities or 'training zones' to maximize workouts and prevent injuries. During dynamic exercise, it is generally assumed that heart rate increases due to both a parasympathetic withdrawal and an augmented sympathetic activity (prepare vs. to relax the body) in intense physical activity. A MHR can vary significantly from person to person, and a higher or lower MHR is neither good nor bad. Instead, using it as a reference to build a structured training plan focused on specific exercise intensities is what makes all the difference.

How Can One's MHR be Assessed?: Estimating or Measuring
The more convenient option, to estimate by using the formula: (211 – 0.64 x Age). While it may not be 100% precise, it is an excellent theoretical estimate. The actual maximum heart rate that an athlete can reach will vary across different sports.

A much more formal (and accurate) way to determine maximum heart rate would be to take a supervised laboratory test. Also known as the VO2 max test, such analysis tests the athlete's physiological capabilities and, therefore, pushes athletes to the absolute maximum.
The protocol is quite simple – an athlete runs on a treadmill or other cardio exercises, with an ever-increasing speed/power until complete exhaustion. Throughout the test, data on athlete's current fitness is recorded: oxygen intake, speed of lactate build-up, and lots of other 'fun' data…

*To measure the oxygen level (oxygen saturation) of the blood and how well oxygen is transported throughout the body furthest from your heart (e.g., arms and legs), an Oximetry Test may be performed.

Why Is It Important:
An athlete's MHR affects an athlete's performance and overall health. A 'heart rate zone' is, essentially, a range of exercise intensities within which the current heart rate measurement falls in. These are always defined as a percentage of MHR. Therefore, it is critical to determine an MHR that is accurate to achieve desired results from training. This is because our body reacts differently to various stress levels. As the intensity changes, so do physiological processes in the body. The easiest way to determine heart rate zones would be to use a Target Heart Rate formula or Karvonen formula:

Target Heart Rate = [MHR – Resting HR] * X% + Resting HR

There are five heart rate training zones, each with their training benefit:

Zone	Target Heart Rate	Benefit from Training
Z1	50% – 60%	Warmup / Recovery
Z2	60% – 70%	Aerobic Base
Z3	70% – 80%	Aerobic Endurance
Z4	80% – 90%	Anaerobic Capacity
Z5	90% – 100%	Speed Training

*Setting an MHR benchmark too low would cause under-exertion and not get the optimal benefit from training. On the contrary, over-exertion could lead to fainting, injury, and m.

How Is A Person's MHR Determined?

An Athlete's MHR is affected by four interconnected factors:

Stroke Volume and Cardiac Output

- ➢ SV: "The amt. of blood pumped by the heart's left ventricle in one contraction (Normally, only about 2/3 of the total blood in the ventricle is expelled/ per beat.

CO: The amt. of blood, the heart pumps through the circulatory system/ minute. The stroke volume x heart rate = cardiac output.

- ➢ In sum, a higher Stroke Volume allows fewer heartbeats and an overall lower resting heart rate. There will also be a more significant gap between resting and maximal heart rate, and an athlete will take longer to reach its MHR.

AVO2 Difference

- ➢ The arteriovenous oxygen difference (AVO2) is the difference in oxygen content of the blood between the arterial (oxygenated) and venous (lower O2) blood. It indicates how much O2 is removed from the blood in capillaries as the blood circulates throughout the body. In essence, AVO2 is the muscle's ability to withdraw oxygen from the blood. Endurance and high-intensity exercise increases one's AVO2 difference by expanding one's ventricular muscle tissue thickness.

Lactate Threshold (LT)

- ➢ When the body is unable to receive sufficient oxygen in order to initiate the breakdown of glucose to get energy, the body resorts to anaerobic respiration. Anaerobic respiration does not require oxygen, therefore, causing the byproduct, LT (one of the chemical reactions in the body due to an increased oxygen and body temperature during intense exercise).
- ➢ A person's LT is there: "point of the exercise at which lactate begins to accumulate in the blood faster than able to be removed"; the unbuffered acid is accumulated in the blood, creating a nauseous, 'need-to-quit' sensation immediately, increase in breathing, heart rate, and fatigue.
- ➢ Interval training or 20-30 mins of non-stop intensity workouts right below or on-par with one's lactate threshold can slowly increase one's LT. Also, a proper pre and post-workout diet are required. (Less controllable variables that make up a person's LT are age, size, sex, and blood type). *Remember: Training far beyond one's LT is detrimental!!!* Soon higher performance will become more sustainable for more extended periods with less recovery, repeatedly -- raising the body's tolerance to the acid, thus increasing the threshold.

VO2max

- ➢ "greatest amount of oxygen a person consumes when exercising at a high rate of intensity"; it is 50% hereditary and dependent on all of the above. As an Athlete's performance requires a higher intensity, more oxygen is needed to engage its muscles. Therefore, the more oxygen that reaches the muscles, the better an athlete performs.
- ➢ According to the national heart association: "VO2 levels were more accurate at predicting a person's likelihood of dying of certain diseases than high blood pressure or the number of risk factors the person had. Low VO2 levels are associated with many potentially fatal conditions, including type 2 diabetes, dementia, Alzheimer's, depression, and heart disease. Therefore higher VO2 levels from training improve health.

*The body is suited to perform better at lower work output due to all of the above adaptations, and higher heart rates are more difficult to reach.

Disclaimer: In only emergencies, stimulating the sympathetic nervous system, will the body reach its MHR. However, one's MHR has a direct relationship to its "exercising MHR."

Works Cited

"Lactate Threshold: ResearchIT CT OneSearch for High Schools." *ResearchIT CT OneSearch for High Schools*, 2019, https://eds.b.ebscohost.com/eds/detail/detail?vid=7&sid=2dc16f32-e714-4538-868d-012c0bc8e23e%40pdc-v-sessmgr05&bdata=JkF1dGhUeXBlPWNvb2tpZSxpcCxjcGlkJmN1c3RpZD1jc2wmc2l0ZT1lZHMtbGl2ZSZzY29wZT1zaXRl#AN=137502365&db=ers.

"The Exercise Heart Rate Profile in Master Athletes Compared to Healthy Controls - PubMed." *PubMed*, pubmed.ncbi.nlm.nih.gov/25532888/.

Ungvarsky, Janine. "VO2 Max." *Salem Press Encyclopedia of Science*, Salem Press, 2019. *EBSCOhost*, search.ebscohost.com/login.aspx?direct=true&AuthType=cookie,ip,cpid&custid=csl&db=ers&AN=119214386&site=eds-live&scope=site&profile=eds_high.