

Maximizing Human Aerobic Capacity

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BORN TO RUN

A Hidden Tribe, Super Athletes,
and the Greatest Race the World
Has Never Seen

Christopher McDougall



<http://www.barefooted.com/born2run.jpg>

The Tarahumara Tribe

- ▶ Live in northern Mexico in the Sierra Madre Occidental
- ▶ Call themselves the Rarámuri—meaning “fast runner” or “he who walks well”
- ▶ 106,000 tribesmen



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The Tarahumara Tribe

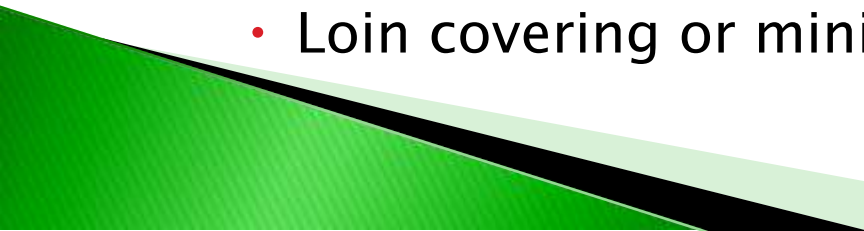
▶ Diet:

- High in vegetables (especially corn– creating alcohol)
- High in carbohydrates– more coming from processed noodles and chips
- Low in animal foods

▶ Traditional footraces:

- Women– fling a hoop with a stick while running
- Men– kick a baseball size wooden sphere while running along a rocky trail

▶ Traditional clothing:

- Huaraches (sandals) or barefoot
 - Loin covering or minimal covering
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Evolution of *Homo sapiens*

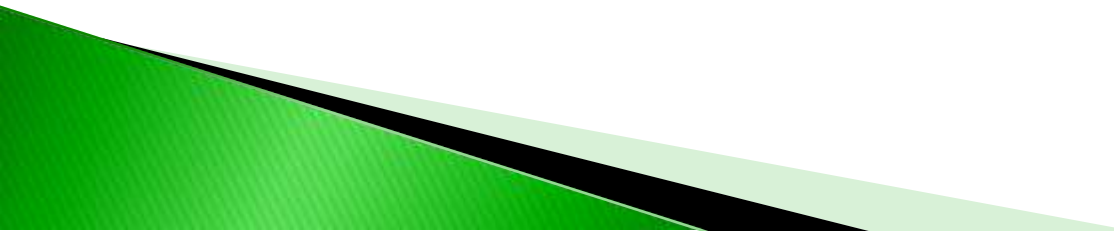
▶ Cause of evolution:

- A theory states that humans needed to either scavenge or chase animals in order to get energy rich food (meat, marrow, and brain)
- To catch animals or to beat them to the already dead animals, the *hominids* evolved to sustain running and jogging for long distances

▶ From ape to *hominid* group

- Difference in body structure make running a possibility for the *hominid* group
 - Longer “spring-like” tendons
 - Achilles tendon has a wider and taller attachment location
 - Wider articulate surfaces of joints in legs


Changes in the Human Body to Increase Aerobic Capacity

- ▶ Mitochondrial changes
 - Density
 - ▶ Muscle changes
 - Type of fibers
 - ▶ Heart changes
 - Size
- 

Mitochondrial Density

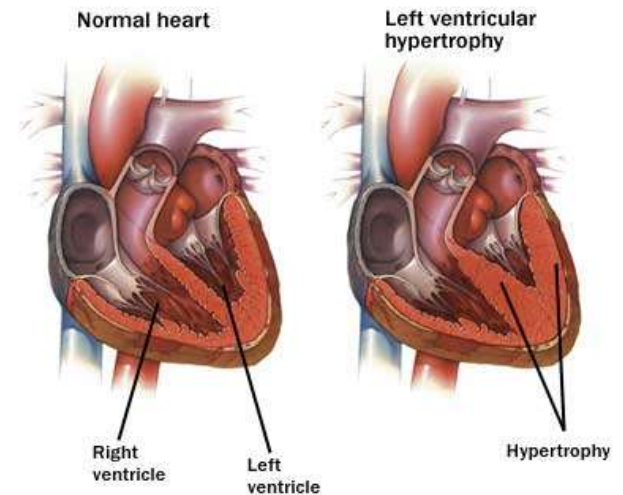
- ▶ Powerhouse of the body
- ▶ Exercise upregulates the transcription gene
 - Upregulation occurs in the first 24 hrs. of recovery
 - Repetitive endurance training will maintain upregulation of the gene
- ▶ Due to increase in density, allows greater oxidative metabolism to occur and thus more ATP (energy) produced

Muscle Fibers

- ▶ **Type 1 – Slow Oxidative Fibers**
 - Aerobic activities
 - Oxidative metabolism
 - Resistance to fatigue
 - ▶ **Type 2a– Fast Oxidative Glycolytic Fibers**
 - Middle–distance activities
 - Both oxidative and glycolytic metabolism
 - Resistant to fatigue but not as well as Type 1
 - ▶ **Type 2b– Fast Glycolytic Fibers**
 - Sprinting and explosive activities
 - Glycolytic metabolism
 - Fatigue easily
- 

Heart Size

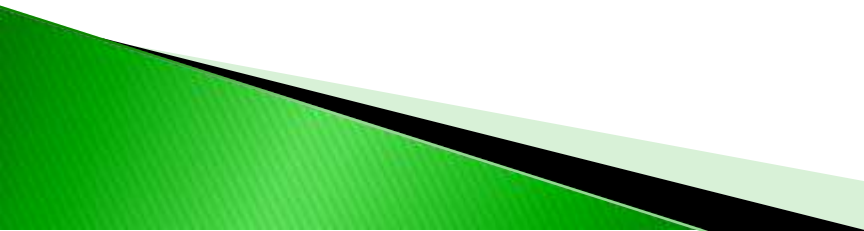
- ▶ Increase in the left ventricle (LV) size
 - LV is the major pump that delivers oxygenated blood to the whole body
 - Hypertrophy of the muscle allows more pumping force
- ▶ Increase LV size also causes a decreased heart rate (more efficient at rest)



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http://www.riversideonline.com/source/images/imageopu/ans7_lvh.jpg

Measurements for Aerobic Capacity

- ▶ VO_2 max—measures the amount of oxygen inspired versus the amount of oxygen and carbon dioxide expired by the subject
 - ▶ Respiratory Quotient (RQ)— the ratio of the amount of carbon dioxide produced to the volume of oxygen consumed
 - $\text{RQ} < 1.0 \rightarrow$ energy from proteins and fats (oxidative metabolism)
 - $\text{RQ} > 1.0 \rightarrow$ energy from carbohydrates (glycolytic metabolism)
- 

Measurements for Aerobic Capacity

- ▶ Rate of Perceived Exertion (RPE)– a scale from 9–20 from which the subject chooses their level of full body exertion
- ▶ Maximum heart rate= $220 - \text{age}$
 - Used to determine the maximum value subject should reach during the test



Data for Male Subject

The VO₂ Max test protocol, for the male subject, used for his first test on February 18, 2011. The time in the trial, the speed, the grade, the heart rate (HR), the blood pressure (BP), and the RPE are shown in the table.

Time (min)	Speed (mph)	Grade (%)	HR (beats*min ⁻¹)	BP (mmHg)	RPE
1	5.5	1.0	132		9
2	5.5	2.0	146	144/64	12
3	6.0	3.0	153		13
4	6.5	3.5	160	158/64	13
5	7.0	4.0	169		14
6	7.5	4.5	173	160/64	15
7	8.0	5.0	176		17
8	8.5	5.5	184	162/64	19
9	8.5	7.5	190		20
10	9.5	8.5	194		

Maximum VO₂ max (mL/kg/min)= 74

Maximum RQ= 1.13



Data for Male Subject

The VO₂ Max test protocol, for the male subject, used for his second test on April 13, 2011. The time in the trial, the speed, the grade, the heart rate (HR), the blood pressure (BP), and the RPE are shown in the table.

<u>Time (min)</u>	<u>Speed (mph)</u>	<u>Grade (%)</u>	<u>HR (beats*min⁻¹)</u>	<u>BP (mmHg)</u>	<u>RPE</u>
1	5.5	1.0	134		10
2	5.5	2.0	141	142/72	13
3	6.0	3.0	151		14
4	6.5	3.5	155	140/70	15
5	7.0	4.0	169		16
6	7.5	4.5	173	158/70	16
7	8.0	5.0	179		18
8	8.5	5.5	181	178/72	19
9	8.5	7.5	187		19
9:40	9.5	8.5	193	178/72	19

Maximum VO₂ max (mL/kg/min)= 65.4

Maximum RQ= 1.19

Data for Female Subject

The VO₂ Max test protocol, for the female subject, used for her first test on February 18, 2011. The time in the trial, the speed, the grade, the heart rate (HR), the blood pressure (BP), and the RPE are shown in the table.

<u>Time (min)</u>	<u>Speed (mph)</u>	<u>Grade (%)</u>	<u>HR (beats*min⁻¹)</u>	<u>BP (mmHg)</u>	<u>RPE</u>
1	5.5	1.0	166		9
2	5.5	2.0	173	138/68	11
3	5.5	2.0	176		12
4	5.5	3.0	184	140/68	12
5	5.5	3.0	187		13
6	5.5	4.0	190	156/68	14
7	5.5	5.0	193		15
8	6.0	5.5	196	168/68	15

Maximum VO₂ max (mL/kg/min)= 44.8

Maximum RQ= 1.03



Data for Female Subject

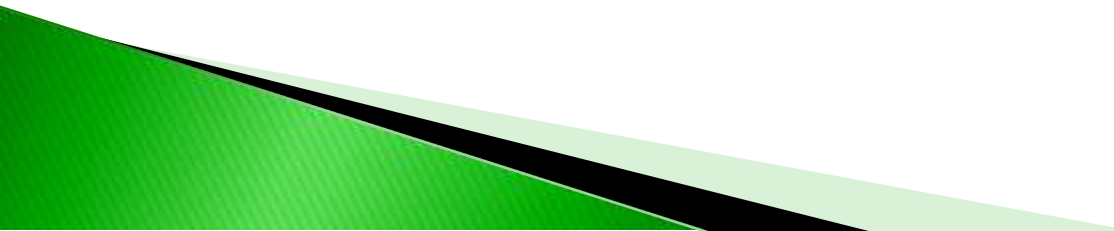
The VO₂ Max test protocol, for the female subject, used for her second test on April 14, 2011. The time in the trial, the speed, the grade, the heart rate (HR), the blood pressure (BP), and the RPE are shown in the table.

<u>Time (min)</u>	<u>Speed (mph)</u>	<u>Grade (%)</u>	<u>HR (beats*min⁻¹)</u>	<u>BP (mmHg)</u>	<u>RPE</u>
1	5.5	1.0	162		10
2	5.5	2.0	176	114/68	12
3	5.5	2.0	179		13
4	5.5	3.0	184	124/68	13
5	5.5	3.0	187		14
6	5.5	4.0	193	132/68	16
7	5.5	5.0	193		17
8	6.0	5.5	196	142/68	18

Maximum VO₂ max (mL/kg/min)= 42.9

Maximum RQ= 1.01

Training

- ▶ After the pre-VO₂ max testing, both subjects started to train consistently and continuously
 - For a 9 week period
 - At least 25 minutes for 3 times per week
 - Note: the subjects were not given specific training regiments to maintain
 - ▶ Minimal interval training done by both participants during course of 9 weeks
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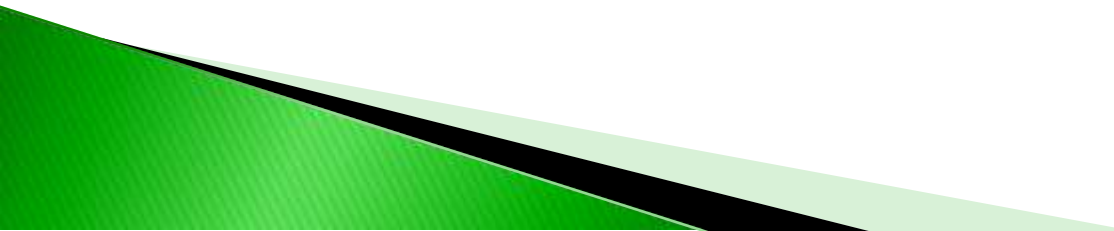
Results

- ▶ Due to altitude, the VO₂ max results will be approximately 10% lower compared to running at sea level
 - Male Subject → pre 81.4 mL/kg/min post 71.9 mL/kg/min
 - Female Subject → pre 49.3 mL/kg/min post 47.2 mL/kg/min
- ▶ Both the female and male VO₂ max results decreased from the pre- to the post- test
- ▶ Possible difference between continuous training versus interval training
 - Several studies support this hypothesis

Conclusion and Suggestions

- ▶ Include interval workouts among continuous training to keep up mileage while making muscles more efficient
- ▶ Suggestions for further study:
 - Increase the number of participants
 - Control training program
 - Incorporate hill training

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