Why does maximum heart rate drop with age?

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Researchers at the University of Colorado have new insight into the age-old question of why maximum heart rate (maxHR) decreases with age. This decrease in maxHR not only limits the performance of aging athletes but it is also a leading cause for nursing home admittance for otherwise-healthy elderly individuals who no longer have the physical capacity required for independent living. We say we're just getting old and slowing down, but exactly what is it that is slowing down?

Everybody knows that aerobic capacity decreases with age. You know that chart in your gym that shows your target heart rate decreasing as you get older? Well, that's not a senior discount to let the elderly get off easy on their treadmill workouts. It's because older hearts simply can't beat as fast as younger hearts. So the older person who's doing 120 beats per minute is probably working harder—at a higher percentage of maximum heart rate—than the younger person who is at 150 beats per minute.

A new study by a group led by Catherine Proenza, PhD and Roger Bannister, PhD from the University of Colorado School of Medicine reports that one of the reasons for the age-dependent reduction in maximum heart rate is that aging depresses the spontaneous electrical activity of the heart's natural pacemaker, the sinoatrial node.

A dissertation from Eric D. Larson, a graduate from Proenza's lab in the Department of Physiology and Biophysics, is described in the article. Larson said, "I utilized a method to record ECGs from conscious mice and found that maximum heart rate was slower in older mice, just as it is

in older people. This result wasn't unexpected. But what was completely new was that the slower maxHR was because the individual pacemaker cells—called sinoatrial myocytes, or 'SAMs'—from old mice just couldn't beat as fast as SAMs from young mice."

The researchers recorded the tiny electrical signals from the isolated cells and found that SAMs from old mice beat more slowly, even when they were fully stimulated by the fight-or-flight response which can be observed in these individual cells. The slower beating rate was due to a limited set of changes in the action potential waveform, the electrical signal that is generated by the cells. The changes were caused by altered behavior of some ion channels in the membranes of the older cells. (Ion channels are proteins that conduct electricity across the cell membrane. Imagine a balloon with little tiny pinholes that open and close to let the air in and out; ion channels are like the pinholes.)

Like most initial discoveries in basic science, this study opens many more questions and avenues for further research. But the significance of the study is that it raises the possibility that sinoatrial ion channels and the signaling molecules that regulate them could be novel targets for drugs to slow the loss of aerobic capacity with age. In the meanwhile, Proenza notes that "although maximum heart rate goes down for everybody equally, regardless of physical conditioning, people can improve and maintain their aerobic capacity at all ages by exercising."

This study will be published in the Oct. 14 *Proceedings of the National Academy of Sciences.*

More information: Depressed pacemaker activity of sinoatrial node myocytes contributes to the age-dependent decline in maximum heart rate, www.pnas.org/cgi/doi/10.1073/pnas.1308477110

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