



What is Heart Rate Variability?

(And Why Should I Care?)

First, a Word About Stress

Stress costs billions of dollars a year in health care—and incalculable costs in terms of human suffering. According to the American Psychological Association, three-quarters of all Americans experience symptoms related to stress in a given month, and half of Americans report lying awake at night due to stress. Workplace stress costs more than \$300 billion each year in health care costs, missed work and stress reduction.¹ Stress contributes to heart disease, hypertension, strokes and other diseases, and is responsible for many negative behaviors such as alcoholism, drug addiction, smoking, and others.²

When we are stressed, our bodies shift into “fight or flight” mode as the body prepares to confront danger or flee from it. This may be an inappropriate response when your supervisor asks to see you in her office—but our bodies still respond as if we had just encountered a saber-toothed tiger. Adrenaline and other hormones flood our bodies, accelerating heart and lung action. We may flush or pale, and begin sweating. Many processes such as digestion slow or cease. And none of this is good for our bodies or minds over a prolonged period of time.

But stress—while not entirely avoidable—can be managed without resource to prescription medication or expensive treatments. Any individual who wants to control stress can do so. Heart rate variability (HRV) is one of the ways stress can be monitored. By understanding HRV and monitoring it regularly, you can control and lower your stress levels.

Heart Rate Variability

HRV is the variation in the time interval between one heartbeat and the next.

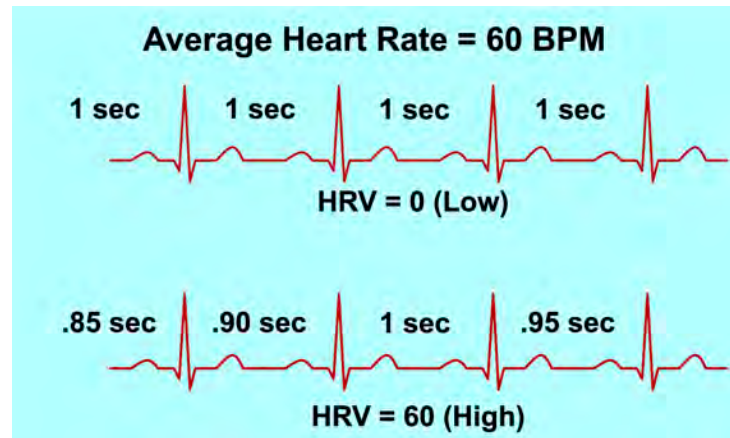
When we think of our heart rate, we generally think of a number between 60 and 90 beats per minute. This number represents the range for the average heart rate. In fact, your heart rate changes from beat to beat. When you inhale your heart rate speeds up and when you exhale it slows down. So rather than referring to a fixed pulse of, say, 60, the heart rate will actually vary between, say, 55 and 65. HRV is a measure of this naturally occurring irregularity in the heart rate. Nearly a quarter-century of clinical research has shown that when HRV levels are high, a person experiences low levels of

¹ American Institute of Stress, New York.

² The Health Resource Network, Inc.

stress and greater resiliency. When HRV levels are low, this is an indication of greater stress and lower resiliency (see Figure 1)

Figure 1. The higher the HRV, the greater your resilience and the lower your stress.

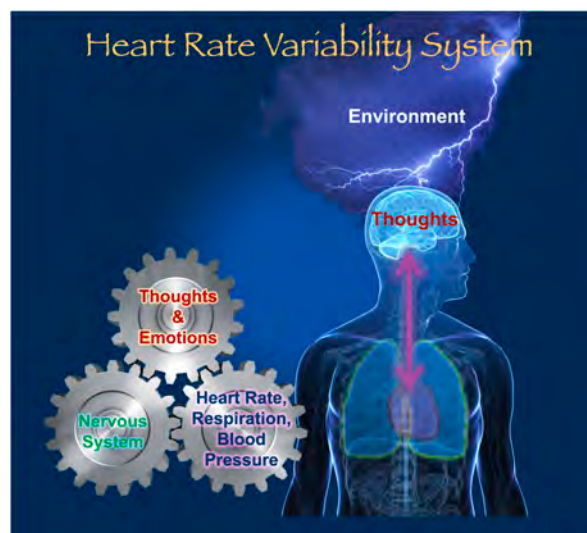


Source: SweetWater Health, LLC

The heart continually oscillates between acceleration and deceleration in a tug-of-war within the autonomic nervous system, controlled by two “pacemakers” in the heart that create the heart’s rhythms.

Our thoughts, emotions, and experiences of the external world are tightly connected to the functioning of our nervous system, heart rhythm and breathing (see Figure 2). The more flexible we are, the more capable we are of dealing with life’s inevitable stressors. This flexibility is reflected in our nervous system and can be measured, using HRV as an indicator.

Figure 2: Our thoughts, emotions, and external experiences are tightly coupled to our heart rhythm, emotions and thoughts.



Source: SweetWater Health, LLC, 2011

The Science of HRV

HRV has been studied for about 25 years. It has been researched as a factor in heart health, stress, athletic training, emotional health, and fitness, to name just a few areas.

The National Institutes of Health (NIH) have funded many studies on HRV, using HRV as a biomarker for disease or health. The NIH Clinical Center offers HRV monitoring to show patients how various stresses are affecting their bodies, and provide them with a biofeedback tool to help reduce stress by raising their HRV.

NIH is just one of the many institutions and individuals researching HRV and using HRV in the monitoring and treatment of patients. Mayo Clinic, Stanford University Hospital and Clinics, and Mount Sinai Medical Center and School of Medicine are among the many prestigious research centers studying HRV and using it in clinical practice.

Several studies have been conducted that indicate that HRV is an indicator of stress, including:

- “The Analysis of Mental Stress using Time-Frequency Distribution of Heart Rate Variability Signal”³
- “Ultra Short Term Analysis of Heart Rate Variability for Monitoring Mental Stress in Mobile Settings”⁴
- “Effects of Stress on Heart Rate Complexity—A Comparison Between Short-Term and Chronic Stress”⁵

Many studies have been conducted on HRV and its relationship to various aspects of health and wellbeing. A study published in 2000 by the American Heart Association showed that low HRV is associated with a higher risk of death in patients with heart disease and in the elderly. Low HRV is also associated with a higher risk of coronary heart disease in the general population.⁶

Low HRV has also been associated with other disease states, including hypertension⁷, diabetes⁸, and chronic obstructive pulmonary disease⁹, among many others.

³ “The Analysis of Mental Stress Using Time-Frequency Distribution of Heart Rate Variability Signal,” H.M. Seong; J.S. Lee; T.M. Shin; W.S. Kim; Y.R. Yoon; Y.R. Yoon; Proceedings of the 26th Annual International conference of the IEEE EMBS, September 2004.

⁴ “Ultra Short Term Analysis of Heart Rate Variability for Monitoring Mental Stress in Mobile Settings,” Lizawati Salahuddin; Jaegel Choi; Myeong Gi Jeong; Desok Kim; Proceedings of the 29th Annual International Conference of the IEEE EMBS, August 2007.

⁵ “Effects of Stress on Heart Rate Complexity—A Comparison Between Short-Term and Chronic Stress” “Effects of Stress on Heart Rate Complexity—A Comparison Between Short-Term and Chronic Stress” C. Schubert; M. Lambert; R.A. Nelson; W. Bardwell; J.-B. Choi, J.E. Dimsdale; *Biological Physiology*, 80 (2009).

⁶ “Low heart Rate Variability in a 2-Minute Rhythm Strip Predicts Risk of coronary heart Disease and Mortality from Several Causes: The ARIC Study,” Jacqueline Dekker, PhD; Richard S. Crow, MD; Aaron R. Folsom, MD, MPH; Peter J. Hannon, MStat; Duanping Liao, MD, PhD; Cees A. Swenne, PhD; Evert G. Schouten, MD, PhD; American Heart Association, 2000, <http://circ.ahajournals.org/cgi/content/full/102/11/1239>

⁷ “Salt-Sensitive Men Show Reduced Heart Rate Variability, Lower Norepinephrine and Enhanced Cortisol During Mental Stress,” C.S. Weber; J.F. Thayer; M. Rudat; A.M. Sharma; F.H. Perschel; K. Buchholz; H.C. Deter; *Journal of Human Hypertension*, 2008.

⁸ “Time and Frequency Domain analysis of Heart Rate Variability and their Correlations in Diabetes Mellitus,” P.T. Ahamed Seyd; V.I. Thajudin Ahamed; Jeevamma Jacob; Paul Joseph K.; *International Journal of Biological and Life Sciences*, 2008.

⁹ “Heart Rate Variability Reflects Severity of COPD in PiZ α_1 -Antitrypsin Deficiency,” Phyllis K. Stein; Patricia Nelson; Jeffrey N. Rottman; Daniel Howard; Suzanne M. Ward; Robert E. Leiger; Robert M. Senior; *CHEST*. American College of Chest Physicians, 1998.

In mainstream medical practice, HRV is largely used to assess the autonomic nervous system, so your GP may not be familiar with its other applications. However, if you are having your nervous system assessed via HRV, rest assured that your insurance will pay for it. Because HRV is the gold standard for non-invasive assessment of the autonomic nervous system, the insurance industry has created reimbursement codes (current procedural terminology, or CPT codes) for HRV-related procedures.

HRV and Stress

Lowered HRV can be due to a number of different factors, including age, gender, disease or stress, among many other things. Stress can be induced by many different influences, from internal worries to stress on the body caused by exertion or surgery. Stress acts directly on the autonomic nervous system, creating imbalance in the tug-of-war mentioned previously. When the autonomic nervous system is in balance, HRV tends to be higher, and when it is out of balance, HRV tends to be lower. This makes it a good biomarker for stress.

The good news is that individuals can easily train themselves to increase their HRV levels.¹⁰ Although HRV is a function of the body's autonomic nervous system and normally not under conscious control, when HRV is monitored so that people receive biofeedback on the results of what they think or do, they can learn to lower HRV through techniques such as conscious breathing, meditation, or physical relaxation. HRV monitoring is non-invasive and involves using an external heart monitor (a number of which are available to the general public today at reasonable prices). Monitors can be strapped on the chest, clipped onto the earlobe or finger, or even built into "smart" clothing. The signal from the monitor must be received and analyzed, and individuals must have some means of seeing and interpreting the signal in real time to become more proficient at controlling their HRV levels.

That is where SweetBeat™ comes in.

SweetBeat and Stress Reduction

SweetBeat is a mobile app from SweetWater Health™, LLC that uses a patented¹¹ algorithm to process the input from a heart monitor to measure HRV. SweetBeat's user interface shows your HRV and predicted stress level in real time. By recording your stress level during a session, you can learn to discern true, measured balance from your "everyday" way of feeling.

When you can see stress levels from moment to moment, you can also change what you are doing or thinking to reduce stress. Conscious breathing exercises balance the nervous system, and therefore you will see an immediate rise in HRV. Some may prefer to meditate, exercise, or do yoga—but whatever stress reduction method you employ, now you have real-time feedback, enabling you to take charge of reducing stress. Long-term behavioral modifications, including sustained fitness and good nutrition, will also reduce chronic stress.

¹⁰ <http://www.bfe.org/articles/hrv.pdf>

¹¹ Patent pending.

SweetBeat also allows you to upload your sessions to a secure database, where your data feeds into a personal calendar. You can see throughout a given day, week, or month exactly when your stress levels are highest, allowing you to be proactive in addressing stress-creation. For example, if your recorded sessions show that commute time is always highly stressful, you might choose to play relaxing music during the drive instead of listening to the news on the radio.

The [SweetWater Health web site](#) offers links to our health partners, who offer a variety of approaches to stress reduction ranging from fitness to meditation and yoga.

HRV's Other Applications

HRV can be used as an indicator for many other purposes beyond stress reduction. It can be used in fitness training and recovery, providing feedback on when to lighten up and when to push harder. It can be used to gauge how well you are connecting with others. It can also be used to remotely monitor the health and wellbeing of a family member who may be ill or elderly.

In the near future, SweetWater Health plans to introduce additional versions of SweetBeat tailored to these and other needs.