

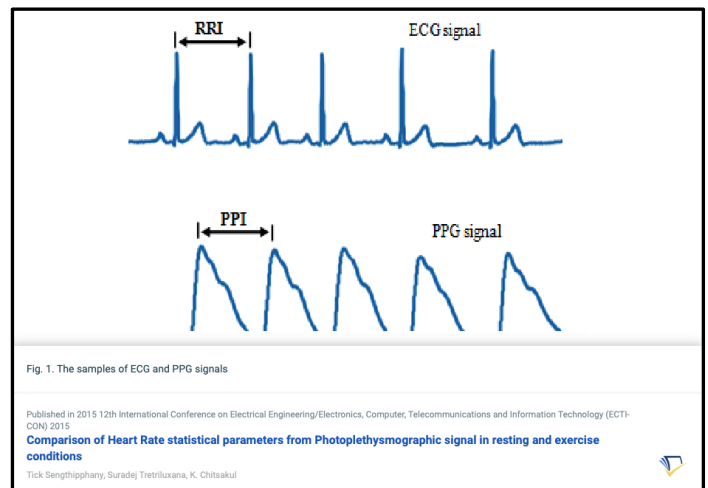


This Research Link Information Sheet compiled by the Dr. Sid E. Williams Center for Chiropractic Research is part of a series designed to provide information and research regarding topics of relevance to the patients and profession of Chiropractic.

Heart Rate Variability

Introduction:

Heart Rate Variability (HRV) is a measure of the beat-to-beat interval differences that occur between consecutive heartbeats. It can be measured through use of a traditional electrocardiogram (ECG) or through photoplethysmography (PPG). Where an ECG measures the electrical activity of the heart using electrical leads placed on the chest or limbs, PPG measures changes in the blood volume under the skin through use of an optical sensor placed on the wrist or finger. ECG is often used in clinical or research settings, and PPG technology has become readily available as a feature in pulse oximeters and modern smart watches or wearable fitness devices.



Whichever technology is used, the key to HRV is the detection of changes in the amount of time between heartbeats. This is important because a healthy nervous system and cardiovascular system are constantly adapting to different changes in the external and internal environment. If a person is healthy, they will have relatively more variability in the time between heartbeats. A person who is less healthy – individuals with cardiovascular disease, diabetes or metabolic syndrome – will have decreased variation between their heartbeats.

Control of Heart Rate Variability:

The Autonomic Nervous System (ANS) is the primitive portion of the nervous system that helps to balance the rate and strength of heart contractions. There are two main divisions of the ANS: the parasympathetic and the sympathetic systems. The parasympathetic system is responsible for slowing down the heart rate and aiding in digestion, often called the “rest and digest” system. The sympathetic system is referred to as the “fight or flight” system and is responsible for speeding up the heart and preparing the body to handle a stressful situation. Under normal conditions, the two systems are constantly working to either speed up or slow down the heart to maintain a healthy physiologic state. This is where the “variability” emerges in heart rate variability. When one of the systems – parasympathetic or sympathetic – is working too much or too little, the heart is not able to adapt as well to changes in demand. This shows up as a decrease in the variability of the time intervals between heartbeats.

This decrease in variability is associated with a number of clinical disease states or conditions. Box one provides a list of some of these conditions.

Box one: Sample list of conditions associated with abnormal HRV

• Myocardial infarction	• Hypertension	• Sudden Cardiac Death
• Coronary artery disease	• Metabolic syndrome	• Diabetes mellitus
• Brain injury	• Epilepsy	• Depression
• PTSD	• Anxiety	• Dementia
• Multiple sclerosis	• Sleep disorder	• Asthma
• Dizziness	• Migraine	• Chronic fatigue syndrome
• Chronic liver disease	• Fibromyalgia	• Viral infection

What do HRV readings represent?

HRV predominately indicates increases or decreases in the parasympathetic system. While changes in the sympathetic system have been inferred in some of the readings, the complexity of measuring the sympathetic responses suggests that results indicating changes in the sympathetic system, including sympathetic/parasympathetic ratio, should be interpreted with caution.

The interbeat intervals are measured using the difference in time between two consecutive R waves of the ECG. For PPG, the R waves are inferred using different methods. The two most common ways of analyzing HRV

data (R-R intervals) are the time and frequency domains. The time domain analysis is a statistically-based method that involves calculation of changes in time differences using variations of mean, standard deviation and root mean square. The frequency domain transforms the time data into frequency (Hz) or cycles per minute using Fast Fourier Transform. Samples of the types of measures used for each domain are shown in Box two.

Box two: Measures of Heart Rate Variability

Analysis Domain	Measure	Description
Frequency Domain	VLF (ms ²)	Absolute power in the very low frequency range <ul style="list-style-type: none"> • Temperature regulation/humoral responses • 0.0033 to .04 Hz (ex. 1 cycle/min)
	LF (ms ²)	Power in the low frequency range <ul style="list-style-type: none"> • Sympathetic and parasympathetic activity • 0.04 to 0.15 Hz (ex. 6 cycles/min)
	HF (ms ²)	Power in the high frequency range <ul style="list-style-type: none"> • Parasympathetic activity/respiratory rhythm • 0.15 to .4 Hz (ex. 15 cycles/min)
	LF/HF	Ratio of LF ms ² /HF ms ² ** some attribute sympathetic/parasympathetic balance; caution advised
Time Domain	SDNN (ms)	Standard deviation of all the NN intervals <ul style="list-style-type: none"> • Measure of autonomic influence on HRV
	RM SSD (ms)	The square root of the mean of the sum of the squares of differences between adjacent NN intervals <ul style="list-style-type: none"> • Vagally mediated changes reflected in HRV
Non-linear	SS	Stress Score <ul style="list-style-type: none"> • a non-linear method that analyzes a Poincare'-Plot to determine sympathetic modulation

Chiropractic and HRV

Research relating HRV to autonomic function has been around since the 1970s, so it is not surprising that some chiropractic and other manipulative therapies have researched changes in HRV before and after care. A 2018 review by Borges showed the cervical and lumbar adjustments or manipulations resulted in more parasympathetic changes. In contrast, more sympathetic responses were observed with stimulation to the thoracic spine. This is in alignment with relevant neuroanatomy. An earlier review by Bolton in 2012 that examined visceral responses to spinal manipulation also demonstrated support for the premise that chiropractic care may influence HRV, although the numbers and sizes of the studies were limited. Table one provides an overview of manual therapy research studies that showed a significant change following care. The direction of change varies with the study, intervention and location, indicating more research is needed.

Table one: Manual Therapy Articles Demonstrating Significant HRV Results

Last Name	Year	Intervention	Upper Cervical/Cranial	Lower Cervical	Thoracic	Lumbo-Sacral	Full Spine	Unspecified
Bayo-Tallon	2019	Manual Cranial Therapy	● ■ ★					
Budgell	2006	Chiropractic			★ ▲ ■			
Curi	2018	Manual Cranial Therapy	● ■ ▲ ★					
Giles	2013	Osteopathic	■ ● ★					
Rogan	2019	Physiotherapy			■ ★			
Roy	2009	Chiropractic				■		
Valenzuela	2019	Chiropractic					☾	
Welch	2008	Chiropractic	■ ★		★			
Win	2015	Chiropractic (no pain)	■ ■ ▲ ★	■ ■ ▲ ★				
Win	2015	Chiropractic (pain)	■ ■ ▲ ★	■ ■ ▲ ★				
Younes	2017	Chiropractic				● ■		
Zhang	2006	Chiropractic						● ■ ▲ ●

Key	Increase	Decrease
Outcome measures		
SDNN	●	●
RMSSD	●	●
HF	■	■
LF	▲	▲
LF/HF	★	★
SS	☾	☾

*** Detailed information regarding search criteria and abstracts provided at <http://www.CCR.LIFE.edu>
Only cranial or manual therapy studies with greater than 10 participants were included.

Resources:

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- Shaffer F, Ginsberg JP. An overview of heart rate variability metrics and norms. Front Public Health. 2017 Sep 28;5:258. doi: 10.3389/fpubh.2017.00258. eCollection 2017.