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Improved cardiac autonomic modulation assessed by Heart Rate Variability may predict short term out comes of Bariatric Surgery

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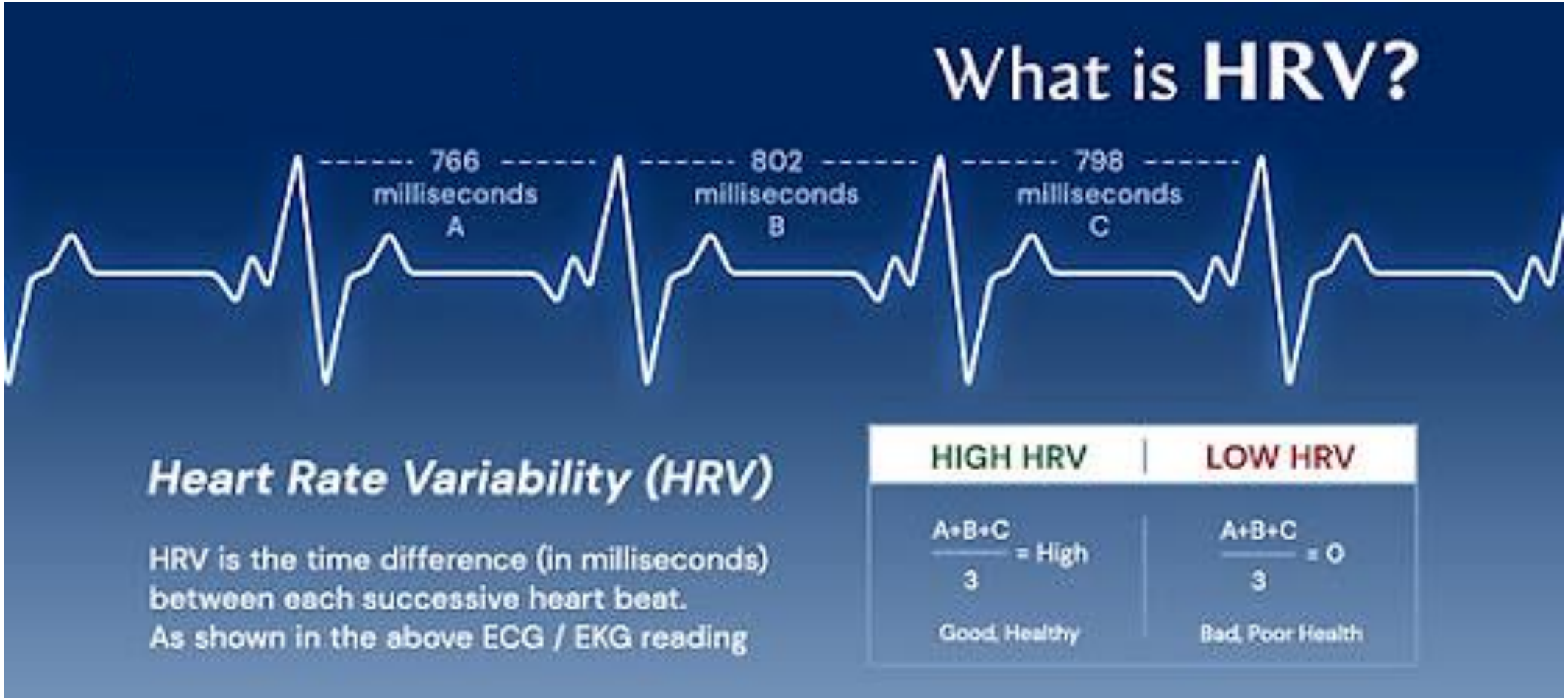
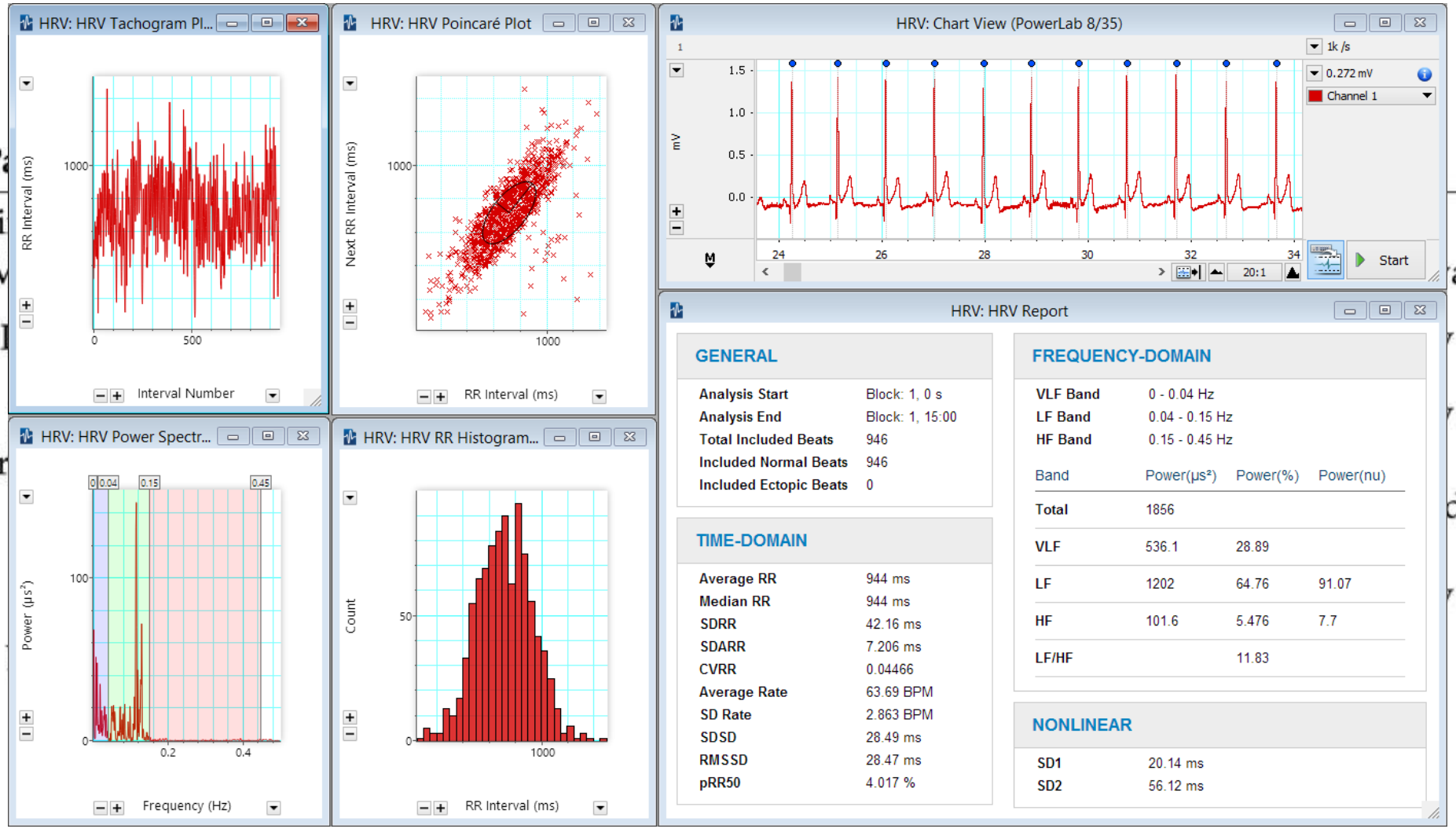

What is HRV?
766 milliseconds A
802 milliseconds B
798 milliseconds C
Heart Rate Variability (HRV)
HRV is the time difference (in milliseconds) between each successive heart beat.
As shown in the above ECG / EKG reading
HIGH HRV
LOW HRV
A+B+C / 3 = High
Good, Healthy
A+B+C / 3 = 0
Bad, Poor Health


HRV: HRV Tachogram Pl...
RR Interval (ms)
1000
0
500
Interval Number
HRV: HRV Poincaré Plot
Next RR Interval (ms)
1000
1000
RR Interval (ms)
HRV: Chart View (PowerLab 8/35)
1k /s
0.272 mV
Channel 1
mV
1.5
1.0
0.5
0.0
24
26
28
30
32
34
20:1
Start
HRV: HRV Power Spectr...
0
0.04
0.15
0.45
Power (µs²)
100
0
0.2
0.4
Frequency (Hz)
HRV: HRV RR Histogram...
Count
50
0
1000
RR Interval (ms)
HRV: HRV Report
GENERAL
Analysis Start Block: 1, 0 s
Analysis End Block: 1, 15:00
Total Included Beats 946
Included Normal Beats 946
Included Ectopic Beats 0
TIME-DOMAIN
Average RR 944 ms
Median RR 944 ms
SDRR 42.16 ms
SDARR 7.206 ms
CVRR 0.04466
Average Rate 63.69 BPM
SD Rate 2.863 BPM
SDSD 28.49 ms
RMSSD 28.47 ms
pRR50 4.017 %
FREQUENCY-DOMAIN
VLF Band 0 - 0.04 Hz
LF Band 0.04 - 0.15 Hz
HF Band 0.15 - 0.45 Hz
Band Power(µs²) Power(%) Power(nu)
Total 1856
VLF 536.1 28.89
LF 1202 64.76 91.07
HF 101.6 5.476 7.7
LF/HF 11.83
NONLINEAR
SD1 20.14 ms
SD2 56.12 ms

Heart Rate Variability in Obesity and the Effect of Weight Loss

Kristjan Karason, MD, Henning Mølgaard, MD, PhD, John Wikstrand, MD, PhD, and Lars Sjöström, MD, PhD

To investigate the effects of obesity and weight loss on cardiovascular autonomic function, we examined 28 obese patients referred for weight-reducing gastroplasty, 24 obese patients who received dietary recommendations, and 28 lean subjects. Body weight, blood pressure, and 24-hour urinary norepinephrine excretion were measured, and time and frequency domain indexes of heart rate variability (HRV) were obtained from 24-hour Holter recordings. A measure of long-term HRV, the SD of all normal RR intervals (SDANN), was used as an index of sympathetic activity and the high-frequency (HF) component of the frequency domain, reflecting short-term HRV, as an estimate of vagal activity. All 3 study groups were investigated at baseline, and the 2 obese groups were reexamined at 1-year follow-up. Obese patients had higher blood pressure, higher urinary norepinephrine excretion, and attenuated SDANN and HF values than lean subjects ($p < 0.01$). Obese patients treated with surgery had a mean weight loss of 32 kg (28%), whereas the obese group treated with dietary recommendations remained weight stable ($p < 0.001$). At follow-up the weight-loss group displayed decreases in blood pressure and norepinephrine excretion and showed increments in SDANN and HF values. These changes were significantly greater than those observed in the obese control group ($p < 0.05$). Our findings suggest that obese patients have increased sympathetic activity and a withdrawal of vagal activity and that these autonomic disturbances improve after weight loss.

(Am J Cardiol 1999;83:1242–1247)

Karason K, Mølgaard H, Wikstrand J, Sjöström L. Heart rate variability in obesity and the effect of weight loss. Am J Cardiol. 1999 Apr 15;83(8):1242-7.

Illustration of the deviations in the follow-up period after bariatric procedure

Author	Intervention	Time domain					Frequency domain					Geometric index		Poincare plot			Nonlinear	
		RMSSD	SDNN	SDANN	pNN50	NN50	HF (ms)	LF (ms)	HF nu)	LF (nu)	LF/HF	HRVi	TINN	SD1	SD2	SD1/SD2	DFA	SampEn
Lips et al. [40]	RYGB, AGB	↑												↑	↑	↑		
Gandolfini et al. [37]	RYGB		↑															
Wu et al. [38]	VSG	↑	↑	↔	↑		↑	↑			↓			↔	↔			
Maser et al. [39]	RYGB						↑	↑	↔	↔	↓							
Braga et al. [34]	RYGB	↑	↑		↑	↑	↔	↔			↔							
Lucas et al. [35]	RYGB	↑	↔		↑	↑												
Nault et al. [45]	BPD-DS	↑	↑	↑	↑		↑	↑			↔							
Machado et al. [44]	RYGB	↑	↑		↑													
Bobbioni-Harsch et al. [42]	RYGB	↑	↑		↑							↑	↑					
Alam et al. [43]	AGB, BPD	↑	↑														↓	↑
Perugini et al. [41]	RYGB	↑	↑	↑									↑					
Casellini et al. [36]	RYGB, SVG	↑	↑															
Ibacache et al.[46]	SVG	↑	↑		↑		↑	↑			↔			↑	↑			↔
Kokkinos et al. [47]	RYGB, SVG						↑	↑			↔							

RMSSD = square root of the mean of the square of the differences between adjacent normal RR intervals; SDNN = standard deviation of all normal RR intervals recorded in a time interval, expressed in ms; SDANN = the standard deviation of averaged RR intervals over a 5-minute period; pNN50 = percentage of adjacent RR intervals with a difference in duration greater than 50 ms; NN50 = number of RR intervals differing by more than 50 ms; HF = high-frequency component; LF = low-frequency component; LF/HF = ratio between low- and high-frequency components; HRVi = triangular index calculated from the total number of all RR intervals divided by the height of the histogram of all RR intervals; TINN = triangular interpolation of RR intervals histogram; SD1 = dispersion of points perpendicular to the identity line, instantaneous record of beat-to-beat variability; SD2 = scatter of points along the identity line; DFA = detrended fluctuation (fractal) analysis of RR intervals; SampEn = sample entropy; RYGB = Roux-en-Y gastric bypass; AGB = adjustable gastric banding; VSG = vertical sleeve gastrectomy; BPD-DS = biliopancreatic diversion with a duodenal switch; BPD = biliopancreatic diversion; SVG = sleeve gastrectomy.

Benjamim CJR, et al. Does bariatric surgery improve cardiac autonomic modulation assessed by heart rate variability? A systematic review. Surg Obes Relat Dis. 2021 Aug;17(8):1497-1509

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- **Objectives**:
  - To evaluate the impact of bariatric surgery on HRV
  - To identify any correlation between changes in autonomic behavior following the surgery and weight loss

- **Study Design:**
  - A prospective cohort study conducted on 100 patients undergoing Roux-en-Y gastric bypass surgery
  - HRV measurements taken at baseline (pre-surgery) and at 7 days, 1, 3, 6, 9, and 12 months post-surgery

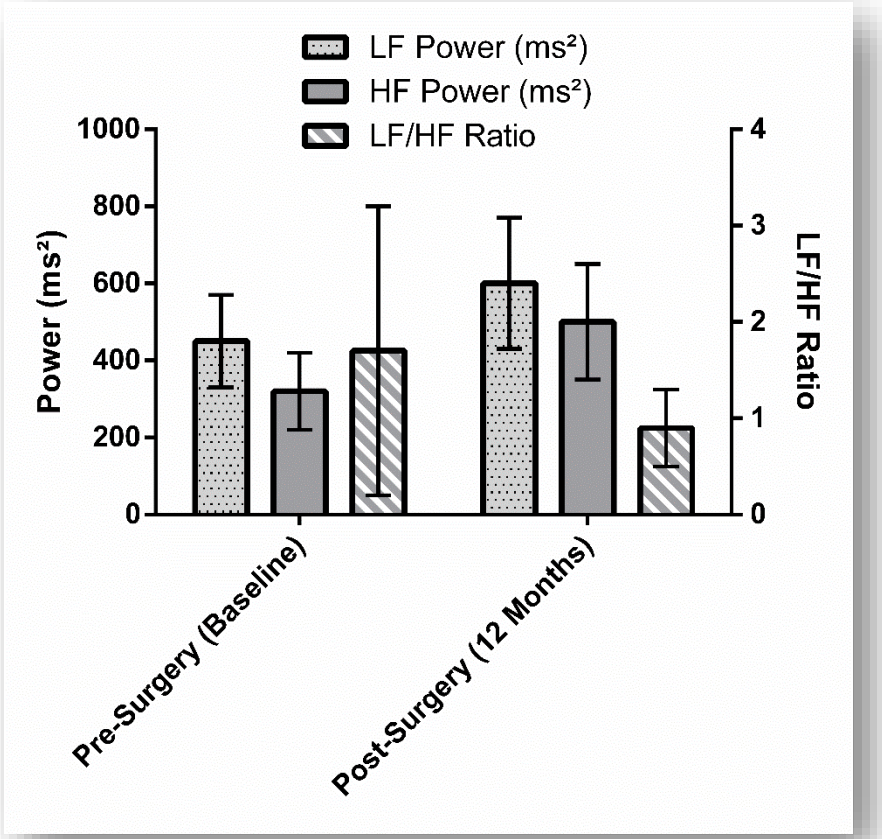
Mean Heart Rate: Decreased from a pre-surgery mean of 88 ± 7 beats per minute to 62 ± 10 beats per minute at 12 months ($P < 0.01$)

Changes in HRV Indices Over 12 Months Post-Surgery

HRV Parameter	*Baseline (Mean ± SD)*	*7 Days (Mean ± SD)*	*1 Month (Mean ± SD)*	*3 Months (Mean ± SD)*	*6 Months (Mean ± SD)*	*12 Months (Mean ± SD)*	*P-Value*
Mean HR (bpm)	88 ± 7	80 ± 8	75 ± 9	70 ± 9	65 ± 10	62 ± 10	<0.01
RMSSD (ms)	24 ± 8	30 ± 10	38 ± 12	45 ± 15	48 ± 18	52 ± 20	<0.01
SDNN (ms)	105 ± 25	120 ± 30	130 ± 35	140 ± 40	145 ± 42	152 ± 45	<0.01
pNN50 (%)	5% ± 5%	10% ± 6%	18% ± 9%	22% ± 11%	25% ± 12%	28% ± 12%	<0.01

Changes in Frequency-Domain HRV Indices Over 12 Months Post-Surgery

Frequency-Domain Parameter	*Baseline (Mean ± SD)*	*7 Days (Mean ± SD)*	*1 Month (Mean ± SD)*	*3 Months (Mean ± SD)*	*6 Months (Mean ± SD)*	*12 Months (Mean ± SD)*	*P-Value*
LF Power (ms²)	450 ± 120	480 ± 130	520 ± 140	550 ± 150	580 ± 160	600 ± 170	<0.05
HF Power (ms²)	320 ± 100	350 ± 110	390 ± 120	420 ± 130	460 ± 140	500 ± 150	<0.01
LF/HF Ratio	1.7 ± 1.5	1.4 ± 1.2	1.3 ± 1.0	1.1 ± 0.8	1.0 ± 0.6	0.9 ± 0.4	<0.05

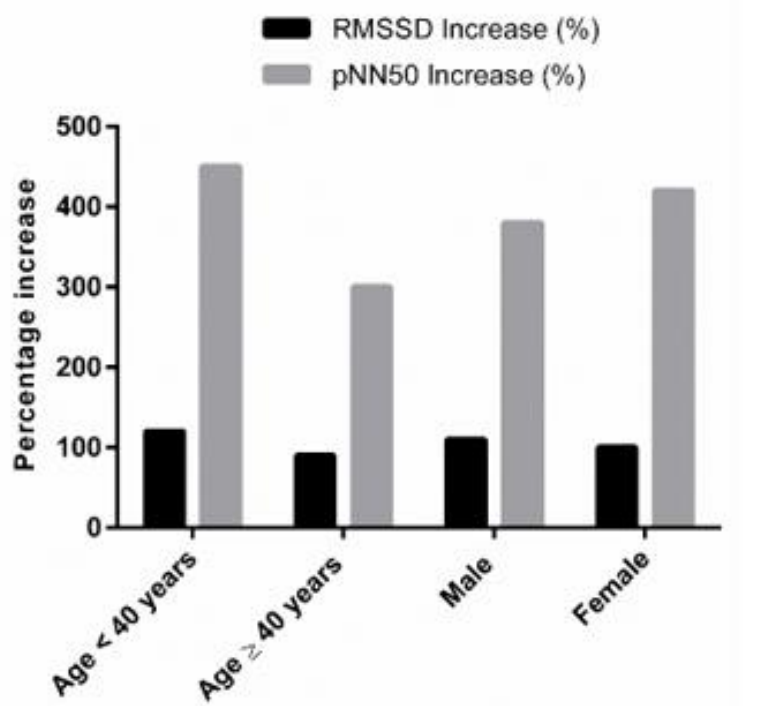


Early changes in HRV, particularly RMSSD and pNN50, can be predictors of excess weight loss at 12 months

Predictive Model Output of early changes in HRV

Early Changes RMSSD (ms)	*Early Changes pNN50 (%)*	*Predicted Weight Loss (%)*	*CI Lower Bound (%)*	*CI Upper Bound (%)*
5.0	10.0	3.03	0.04	6.55
10.0	14.44	7.81	4.72	10.76
15.0	18.89	12.63	8.65	16.12
25.0	27.78	21.60	18.09	24.50
35.0	36.67	28.07	24.34	31.06
40.0	41.11	33.40	29.64	36.55
50.0	50.0	42.46	38.95	45.19

Subgroup Analysis by Age and Gender



- **Conclusion**

Bariatric surgery improved the parasympathetic activity of cardiac autonomic function and improvements in HRV indices. Early improvements in RMSSD and pNN50 were associated with increases in excess weight loss at 12 months post-surgery, but the mechanism of these changes require further study