COMPARING NOVEL AND TRADITIONALLY CALCULATED SYMPATHETIC HRV MARKERS BEFORE AND AFTER MAXIMAL EXERCISE

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Introduction

- Heart rate variability (HRV) is a valuable tool for assessing autonomic nervous system function in athletes.
- New HRV indices known as *stress score* (SS) and *sympathetic:parasympathetic ratio* (SPS) are calculated from nonlinear metrics and reflect sympathetic activity but are not practical in field settings due to the need for specialized software and longer recording times.
- **The purpose of this investigation was to develop modified scores using ultra-short time-domain HRV metrics and to evaluate their responses to maximal exercise compared to SS and SPS.**

Methods

- Twenty male collegiate athletes performed a maximal graded exercise test, and HRV was assessed via electrocardiography for 10 minutes prior and 30 minutes post-exercise.
- Three time points (PRE, POST1, and POST2) were isolated as 5-minute recording periods to analyze and calculate HRV metrics.
- Nonlinear metrics SD1 and SD2 were calculated from the 5-minute period and used to determine SS and SPS. Time-domain metrics RMSSD and SDNN were calculated from 1-minute periods and used to determine modified SS and SPS (MSS & MSPS)

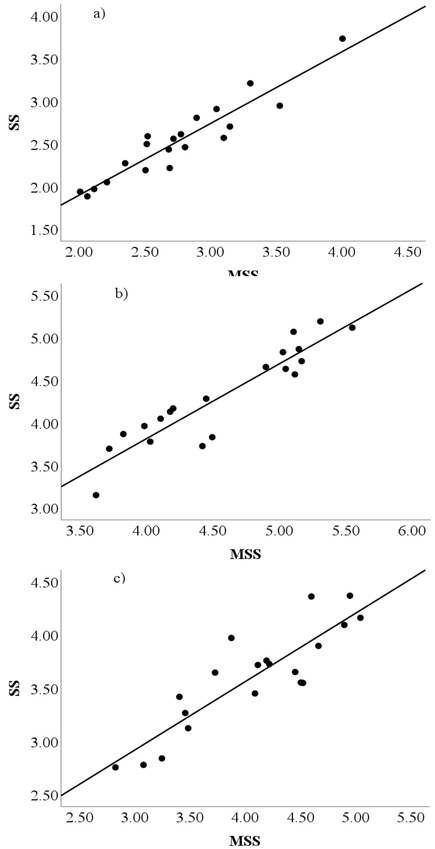
Results

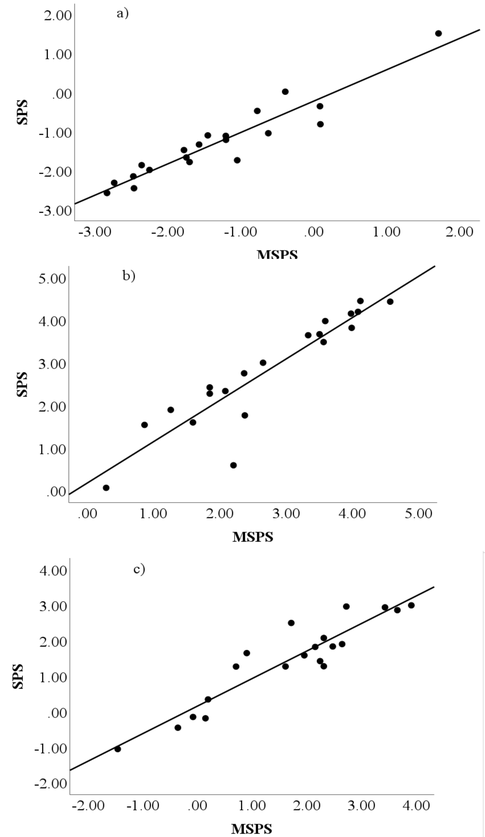
- SS and MSS were positively correlated at PRE, POST1 and POST2, (r = 0.87 to 0.94, $p < 0.001$).
- SPS and MSPS were positively correlated at PRE, POST1, and POST2, (r = 0.92 to 0.94, $p < 0.001$).
- Modified and traditional metrics both significantly increased from PRE to POST1 and decreased from POST1 to POST2 while remaining higher than PRE, ($p < 0.05$).

Conclusion

- **Modified SS and SPS calculated from ultra-short time-domain HRV metrics are highly correlated to traditional SS and SPS and are sensitive enough to detect acute changes to HRV from maximal exercise.**

We developed modified simple HRV scores that may help coaches and athletes monitor the immediate impact of a workout session more easily.





Supplemental Materials

Table 1. Changes of the HRV metrics from PRE, POST1, and POST2 surrounding treadmill GXT.

	PRE	POST1	POST2
Non-Linear			
SD1	3.82 ± 0.54	1.51 ± 0.76*	2.16 ± 0.74*†
SD2	4.38 ± 0.46	2.59 ± 0.56*	3.30 ± 0.48*†
SD1:SD2	0.59 ± 0.18	0.37 ± 0.21*	0.34 ± 0.13*
SS	2.53 ± 0.46	4.32 ± 0.56*	3.61 ± 0.48*†
SPS	-1.29 ± 0.96	2.81 ± 1.29*	1.45 ± 1.20*†
Time-Domain			
RMSSD	4.09 ± 0.66	1.87 ± 0.65*	2.41 ± 0.81*†
SDNN	4.16 ± 0.51	2.34 ± 0.59*	2.84 ± 0.65*†
MSS	2.75 ± 0.51	4.57 ± 0.59*	4.07 ± 0.65*†
MSPS	-1.34 ± 1.13	2.71 ± 1.22*	1.66 ± 1.44*†

PRE = HRV recording pre-GXT from 5-10min, POST1 = HRV recording post-GXT from 5-10min, POST2 = HRV recording post-GXT from 25-30min, SD1 = 5-min recording of standard deviation of Poincaré plot perpendicular to the line-of-identity, SD2 = 5-min recording of standard deviation of the Poincaré plot along the line-of-identity, SS = stress score, SPS = sympathetic parasympathetic ratio, RMSSD = 1-min recording of the root mean square of successive normal R-R interval differences, SDNN = 1-min recording of the standard deviation of normal to normal R-R intervals, MSS = modified stress score, MSPS = modified sympathetic parasympathetic ratio.
*Significantly different from PRE ($p < 0.017$)
†Similicantly different from POST1 ($p < 0.017$)

Table 2. Correlation coefficients of the relationships between each of the HRV metrics and the stress scores and parasympathetic:sympathetic ratios before (PRE), 5-10 min after (POST1), and 25-30 min (POST2) after a graded exercise test.

	SS			MSS			SPS			MSPS		
	r	*p*	*Qualifier*	*r*	*p*	*Qualifier*	*r*	*p*	*Qualifier*	*r*	*p*	*Qualifier*
PRE												
SD1	-0.72	< 0.001	*Very large*	- 0.92	< 0.001	*Nearly Perfect*	-0.60	0.005	*Large*	- 0.95	< 0.001	*Nearly Perfect*
SD2	-0.83	< 0.001	*Very large*	- 0.94	< 0.001	*Nearly Perfect*	-0.59	0.007	*Large*	- 0.86	< 0.001	*Very Large*
SD1:SD2	-0.14	0.565	*Small*	-0.30	0.202	*Small*	-0.30	0.200	*Small*	-0.34	0.137	*Small*
RMSSD	-0.63	< 0.001	*Large*	- 0.89	< 0.001	*Very Large*	-0.53	0.017	*Large*	- 0.98	< 0.001	*Nearly Perfect*
SDNN	-0.76	0.003	*Very large*	- 1.00	< 0.001	*Nearly Perfect*	-0.55	0.013	*Large*	- 0.96	< 0.001	*Nearly Perfect*
POST1												
SD1	-0.61	0.004	*Large*	- 0.77	< 0.001	*Very Large*	-0.60	0.005	*Large*	- 0.85	< 0.001	*Very Large*
SD2	-0.85	< 0.001	*Very large*	- 0.92	< 0.001	*Nearly Perfect*	-0.79	< 0.001	*Very Large*	- 0.94	< 0.001	*Nearly Perfect*
SD1:SD2	-0.21	0.372	*Small*	-0.15	0.526	*Small*	-0.29	0.221	*Small*	-0.24	0.311	*Small*
RMSSD	-0.70	< 0.001	*Large*	- 0.91	< 0.001	*Nearly Perfect*	-0.67	0.001	*Large*	- 0.98	< 0.001	*Nearly Perfect*
SDNN	-0.84	< 0.001	*Very large*	- 1.00	< 0.001	*Nearly Perfect*	-0.80	<0.001	*Very Large*	- 0.98	< 0.001	*Nearly Perfect*
POST2												
SD1	-0.72	< 0.001	*Very large*	- 0.85	< 0.001	*Very Large*	-0.64	0.002	*Large*	- 0.92	< 0.001	*Nearly Perfect*
SD2	-0.88	< 0.001	*Very large*	- 0.88	< 0.001	*Very Large*	-0.77	< 0.001	*Very Large*	- 0.91	< 0.001	*Nearly Perfect*
SD1:SD2	-0.51	0.021	*Large*	-0.51	0.021	*Large*	-0.53	0.017	*Large*	-0.46	0.041	*Large*
RMSSD	-0.67	0.001	*Large*	- 0.94	< 0.001	*Nearly Perfect*	-0.59	0.007	*Large*	- 0.99	< 0.001	*Nearly Perfect*
SDNN	-0.77	< 0.001	*Very large*	- 1.00	< 0.001	*Nearly Perfect*	-0.67	0.001	*Large*	- 0.98	< 0.001	*Nearly Perfect*

PRE = HRV recording pre-GXT from 5-10min, POST1 = HRV recording post-GXT from 5-10min, POST2 = HRV recording post-GXT from 25-30min, SD1 = 5-min recording of standard deviation of Poincaré plot perpendicular to the line-of-identity, SD2 = 5-min recording of standard deviation of the Poincaré plot along the line-of-identity, SS = stress score, SPS = sympathetic parasympathetic ratio, RMSSD = 1-min recording of the root mean square of successive normal R-R interval differences, SDNN = 1-min recording of the standard deviation of normal to normal R-R intervals, MSS = modified stress score, MSPS = modified sympathetic parasympathetic ratio.

Practical Applications

- Having simple and objective physiological metrics of stress allows coaches and athletes to better monitor adaptations to training programs and prevent potential overtraining and burnout.
- MSS and MSPS may allow coaches and athletes to have easier access to effective training monitoring based on HRV.

References

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