

PATHOPHYSIOLOGICAL MECHANISMS OF NONCARDIAC SYNCOPE IN ATHLETES

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PURPOSE

The investigation of the differences in orthostatic responses of individuals with a history of noncardiac syncope (NCS) between athletes and nonathletes

METHODS

Subjects

- 181 participants: 27 ± 12 years old (125 males, 56 females)
 - > 133 athletes: 54 with a history of recent NCS, 79 without history of NCS
 - > 48 nonathletes: 15 with a history of recent NCS, 33 without history of NCS
- Inclusion criteria:
 - > For athletes: > 5 years of exercise training experience
- Exclusion criteria:
 - > Smoking
 - > Recent alcohol consumption
 - > Chronic disease
 - > Use of drugs/ ergogenic aids with cardiovascular effects

Tilt test

- **Passive (without pharmacologic provocation) tilt test**
- **Supine for 5 min → 60° Head-up position for 30 min**
- **Characterization of positive response according to the modified VASIS classification**
 - > Mixed
 - > Cardioinhibitory
 - > Vasodepressor
- Measurements with Task Force Monitor (TFM) 3040i device (CNSystem, Graz, Austria)
 - > Haemodynamic parameters
 - > Heart rate variability (HRV): LFnu-RRi (marker of sympathetic activity), HFnu-RRi (marker of cardiac vagal activity), LF/HF (index of sympathovagal balance)
 - > Baroreflex sensitivity (BRS), Baroreflex effectiveness index (BEI)

RESULTS

- **Athletes with NCS: 18 with positive tilt test (13 mixed, 4 cardioinhibitory, 1 vasodepressor).**
- **Athletes without NCS: 5 with positive tilt test (1 mixed, 4 cardioinhibitory).**
- **Athletes with positive result vs athletes with negative result: ↑ females (p=0.018), ↓ BMI (p=0.031), ↔ age.**
- **Nonathletes with NCS: 3 with positive tilt test (3 mixed).**
- **Nonathletes without NCS: 8 with positive tilt test (7 mixed, 1 vasodepressor).**
- **Nonathletes with positive result vs nonathletes with negative result: ↑ females (p=0.005), ↔ BMI, ↔ age.**



Table 1. The relationship between age and parameters of haemodynamics, HRV and BRS during head-up tilt test in athletes and nonathletes.

	Associations with age, adjusted for gender, BMI and history of NCS					
	Athletes			Nonathletes		
	Unstandardized	SD	p	Unstandardized	SD	p
	β coefficient			β coefficient		
HR (bpm)	-0.174	0.12	0.166	-0.284	0.178	0.119
SBP (mmHg)	-0.162	0.13	0.221	0.164	0.140	0.248
DBP (mmHg)	0.225	0.10	0.029	0.370	0.129	0.007
MBP (mmHg)	-0.029	0.10	0.786	0.240	0.139	0.092
SI (mL/m ²)	-0.097	0.10	0.366	-0.126	0.080	0.123
CI [L/(min·m ²)]	-0.014	0.00	0.133	-0.022	0.007	0.004
TPRI (dyne·sec·m ² /cm ²)	14.477	6.66	0.032	21.579	11.69	0.072
LFnu-RRi (%)	0.160	0.12	0.217	0.008	0.169	0.963
HFnu-RRi (%)	-0.160	0.12	0.217	-0.008	0.169	0.963
LF/HF	0.027	0.02	0.219	0.025	0.037	0.493
Baroreflex slope (msec/mmHg)	-0.099	0.05	0.066	-0.148	0.041	0.001
BEI (%)	-0.369	0.13	0.006	-0.252	0.193	0.200

Table 2. The comparison of parameters of haemodynamics, HRV and BRS during head-up tilt test between males and females.

	Comparison between males and females after adjustment for age, BMI and history of NCS					
	Athletes			Nonathletes		
	Males (n=95)	Females (n=38)	p	Males (n=30)	Females (n=18)	p
HR (bpm)	83±11	87±13	0.600	85±12	89±24	0.953
SBP (mmHg)	132.4±12.4	117.5±10.2	<0.001	123.9±11.8	120.6±14.9	0.906
DBP (mmHg)	83.3±9.5	75.5±7.3	0.008	84.5±12.1	82.6±13.7	0.939
MBP (mmHg)	100.3±9.7	90.2±8.3	<0.001	97.1±11.8	95.4±14.2	0.967
SI (mL/m ²)	36.9±10.2	38.0±5.0	0.545	31.2±8.5	29.6±8.0	0.379
CI [L/(min·m ²)]	3.1±0.9	3.3±0.4	0.361	2.6±0.7	2.6±0.8	0.459
TPRI (dyne·sec·m ² /cm ²)	2808±752	2207±289	0.211	3126±1122	3307±1353	0.254
LFnu-RRi (%)	80.7(49.0 - 91.1)	72.8(51.2 - 87.1)	0.012	78.6(33.7 - 94.6)	70.1(11.4 - 80.6)	0.014
HFnu-RRi (%)	19.3(8.9 - 51.0)	27.2(12.9 - 48.8)	0.012	21.5(5.4 - 66.3)	29.9(19.4 - 88.6)	0.014
LF/HF	4.2(0.1 - 10.2)	2.7(1.0 - 6.8)	0.049	3.7(0.5 - 17.5)	2.4(0.1 - 4.2)	0.005
Baroreflex slope (msec/mmHg)	9.76(2.01 - 23.48)	9.72(5.46 - 29.89)	0.111	7.58(2.80 - 18.43)	11.31(4.08 - 20.65)	0.010
BEI (%)	71.59(37.42 - 91.35)	72.36(51.02 - 89.71)	0.169	64.58(28.57 - 89.67)	57.01(11.24 - 78.36)	0.344

Table 3. The relationship between BMI and parameters of haemodynamics, HRV and BRS during head-up tilt test in athletes and nonathletes.

	Associations with BMI, adjusted for age, gender and history of NCS					
	Athletes			Nonathletes		
	Unstandardized	SD	p	Unstandardized	SD	p
	β coefficient			β coefficient		
HR (bpm)	0.001	0.241	0.997	-0.317	0.589	0.593
SBP (mmHg)	1.183	0.253	<0.001	1.273	0.365	0.001
DBP (mmHg)	0.396	0.196	0.046	0.820	0.328	0.017
MBP (mmHg)	0.679	0.208	0.002	0.944	0.327	0.006
SI (mL/m ²)	-0.262	0.206	0.207	-0.316	0.265	0.240
CI [L/(min·m ²)]	-0.018	0.018	0.309	-0.026	0.024	0.295
TPRI (dyne·sec·m ² /cm ²)	49.251	12.823	<0.001	83.240	38.085	0.034
LFnu-RRi (%)	0.271	0.249	0.278	-0.229	0.560	0.685
HFnu-RRi (%)	-0.271	0.249	0.278	0.229	0.560	0.685
LF/HF	0.073	0.043	0.089	-0.108	0.121	0.378
Baroreflex slope (msec/mmHg)	0.001	0.109	0.990	0.160	0.133	0.236
BEI (%)	0.310	0.253	0.222	0.177	0.630	0.780

Table 4. Parameters of haemodynamics, HRV and BRS during head-up tilt test in athletes and nonathletes with a history of NCS and without NCS.

	Athletes		Nonathletes		p values adjusted for age, gender and BMI			
	NCS (n=54)	Without NCS (n=79)	NCS (n=15)	Without NCS (n=33)	Athletes	Nonathletes	NCS	Without NCS
	NCS vs no NCS	NCS vs no NCS	Athletes vs nonathletes	Athletes vs nonathletes	NCS vs no NCS	NCS vs no NCS	Athletes vs nonathletes	Athletes vs nonathletes
HR (bpm)	90 ± 11	81 ± 10	95 ± 24	83 ± 11	0.001	0.024	0.011	0.094
SBP (mmHg)	123.5 ± 11.6	131.3 ± 13.9	122.2 ± 14.5	122.8 ± 12.5	0.892	0.857	0.289	0.094
DBP (mmHg)	78.2 ± 9.1	83.1 ± 9.4	83.0 ± 13.7	84.2 ± 12.3	0.565	0.749	0.999	0.952
MBP (mmHg)	94.6 ± 9.5	99.3 ± 10.5	95.8 ± 14.4	96.8 ± 12.0	0.552	0.795	0.745	0.576
SI (mL/m ²)	38.8 ± 7.0	36.1 ± 10.1	25.4 ± 7.6	33.0 ± 7.5	0.599	0.003	<0.001	0.259
CI [L/(min·m ²)]	3.5 ± 0.7	2.9 ± 0.8	2.4 ± 0.9	2.7 ± 0.7	0.017	0.157	0.022	0.854
TPRI (dyne·sec·m ² /cm ²)	2227 ± 408	2918 ± 733	3744 ± 1606	2937 ± 880	0.039	0.030	0.001	0.841
LFnu-RRi (%)	74.8(49.0 - 88.4)	80.2(54.9 - 91.1)	71.3(11.4 - 94.6)	76.5(49.4 - 94.4)	0.708	0.228	0.149	0.203
HFnu-RRi (%)	25.3(11.6 - 51.0)	19.8(8.9 - 45.1)	28.7(5.4 - 88.6)	23.5(5.6 - 50.6)	0.708	0.228	0.149	0.394
LF/HF	3.0(1.0 - 7.6)	3.9(0.1 - 10.2)	2.5(0.1 - 17.5)	3.3(1.0 - 16.9)	0.874	0.518	0.667	0.578
Baroreflex slope (msec/mmHg)	9.63(4.93 - 29.89)	9.93(2.01 - 26.00)	8.05(4.08 - 20.65)	8.10(2.80 - 18.43)	0.200	0.911	0.581	0.471
BEI (%)	70.16(37.42 - 89.71)	72.19(48.49 - 91.35)	58.57(11.24 - 84.89)	66.97(28.57 - 89.67)	0.016	0.110	0.020	0.351

- **Athletes with NCS vs nonathletes with NCS: ↔ positive results of tilt test (after adjustment for age, gender and BMI).**
- **Athletes without NCS vs nonathletes without NCS: ↓ positive results of tilt test (p=0.031) (after adjustment for age, gender and BMI).**

CONCLUSIONS

- Parameters of haemodynamics, HRV and BRS during orthostasis were more advantageous with increasing age, BMI and in male gender, as well as in athletes.
- The possible main underlying mechanism for NCS during upright standing in athletes is the decreased TPRI, while the inadequate preservation of SI in nonathletes.

DECLARATION OF INTEREST

The Authors declare that there is no conflict of interest

Statistical analysis

- SPSS 16.0
- Kolmogorov-Smirnov test
- Expression of data
 - > Normal distribution: mean ± SD
 - > Skewed distribution: median (range)
- Independent-samples t test for normally distributed parameters
- Adjusted analysis
 - > Continuous dependent variable: Linear regression
 - > Categorical dependent variable: Logistic regression
- Two-tailed p value < 0.05: significant.