



Effects of Heat Stress on Platelet Function and Coagulatory Potential



SKIDMORE

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Abstract

The purpose of this study was to compare platelet function and coagulation following exercise-induced heat stress (EIHS) and passive heat stress (PHS) in young active males. Both conditions resulted in significantly elevated Tco (38.4°C and 38.5°C for EIHS and PHS respectively), and was achieved in a similar time period (51.1 and 46.7 min). There were significant increases in platelet number for both conditions (22% and 6% for EIHS and PHS, respectively). In both conditions, ADP-induced time to occlusion and PTT decreased significantly. Additionally, EPI-induced time to occlusion decreased significantly after EIHS. The findings of this study reveal that both EIHS and PHS activate coagulation and platelet function, and suggest that the combination of exercise and heat stress may cause greater activation than heat stress alone.

Introduction

It is well documented that regular physical exercise is associated with a decreased risk of cardiovascular disease (1). Despite all the beneficial effects of regular exercise, an acute bout of strenuous exercise, particularly in persons unaccustomed to physical activity, is associated with an increased risk of sudden cardiac death. Activation of platelets or enhanced coagulatory potential following high-intensity exercise may predispose an individual to the formation of intravascular thrombi.

Research suggests that an acute bout of strenuous exercise causes a rise in platelet count, platelet hyperactivity, and hypercoagulability (2, 3, 4). Platelet function and coagulatory changes resulting from exercise-induced heat stress (EIHS) have not been thoroughly investigated. Furthermore, the effect of short term passive heat stress (PHS) on platelet function and coagulation has not been documented.

Purpose

To investigate changes in platelet function and coagulation resulting from EIHS and PHS in apparently healthy active males.

Methods

Study Design

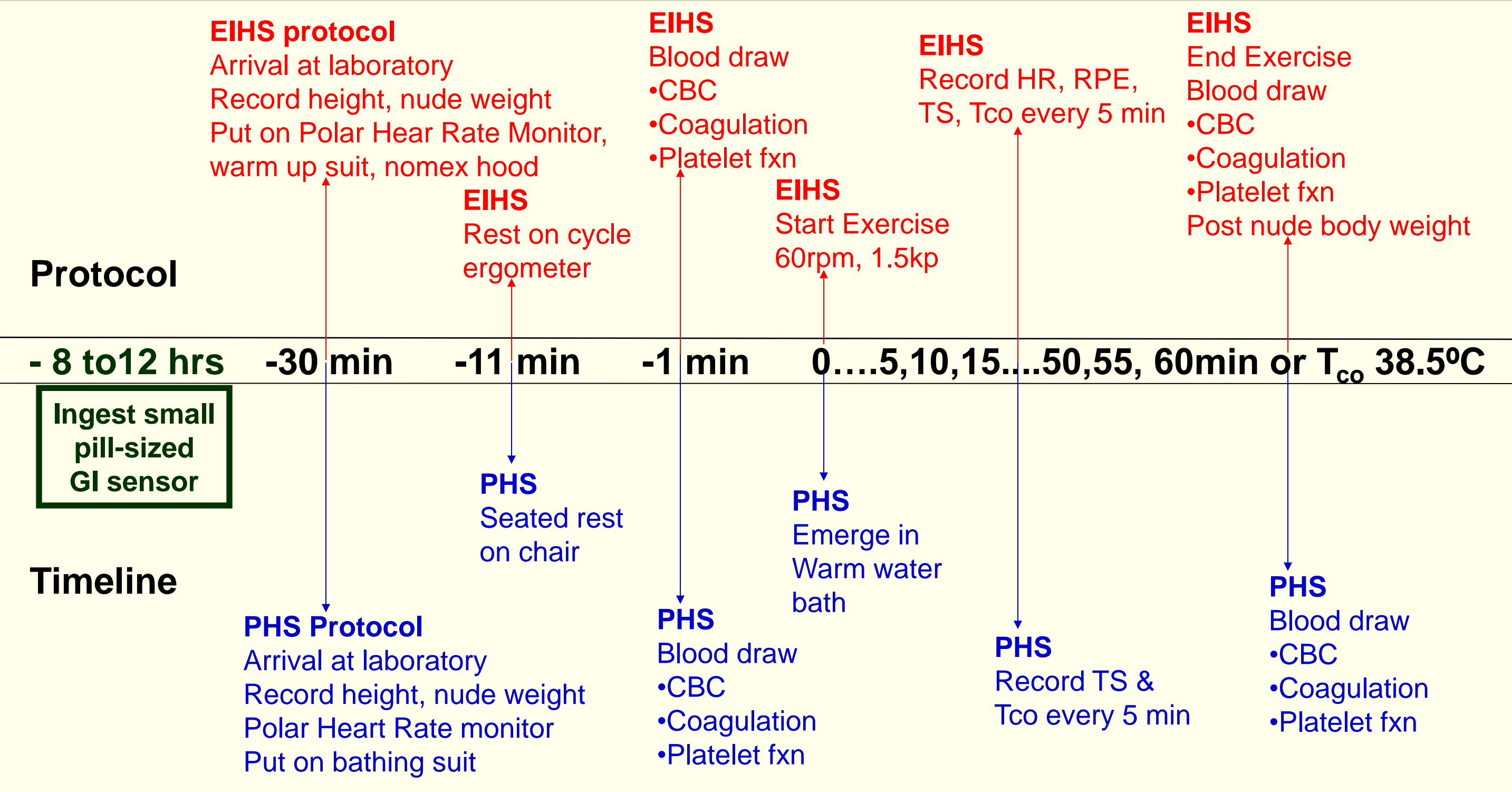
Repeated Measures Design:

On separate days subjects completed two trials:

Exercise Induced Heat Stress (EIHS)– cycle in warm-up gear until Tco reached 38.5°C or 60 min.

Passive Heat Stress PHS) – sit in tank of warm water (40°C) until Tco reached 38.5°C or 60 min.

Study Protocol



Instrumentation

•Blood samples containing no additives were analyzed for basic hematological variables using a Coulter LH750 (Beckman Coulter, Inc; Fullerton, CA, USA).

•Blood anticoagulated with EDTA was analyzed for PT and PTT using the Sysmex CA-1500 (Sysmex America, Inc; Mundlein, IL, USA).

•Epinephrine-induced and ADP-induced platelet aggregability was analyzed using a Platelet Function Analyzer (PFA-100, Dade Behring; Deerfield, IL, USA).

Results

Table 1. Effects of PHS and EIHS on core temperature, body weight, thermal sensation, and percent change in plasma volume; n=11

Selected Variables	EIHS			PHS		
	Pre	Post	Δ	Pre	Post	Δ
Temperature, °C	37.3 ± 0.4	38.4 ± 0.2	1.1 ± 0.3	37.3 ± 0.3	38.5 ± 0.1	1.2 ± 0.3
Body Weight, kg	79.6 ± 7.4	78.9 ± 7.6	0.7 ± 0.6	78.9 ± 7.4	78.2 ± 7.3	0.7 ± 0.4
Thermal Sensation	4.2 ± 0.4	7.0 ± 0.5	2.8 ± 0.5	4.0 ± 0.6	6.7 ± 0.8	2.7 ± 0.7
Time to Achieve, min	—	—	51.1 ± 8.8	—	—	46.7 ± 11.3
ΔPlasma volume, %	—	—	- 10.2 ± 3.9	—	—	- 6.1 ± 3.3

Values are expressed as the mean ± SD

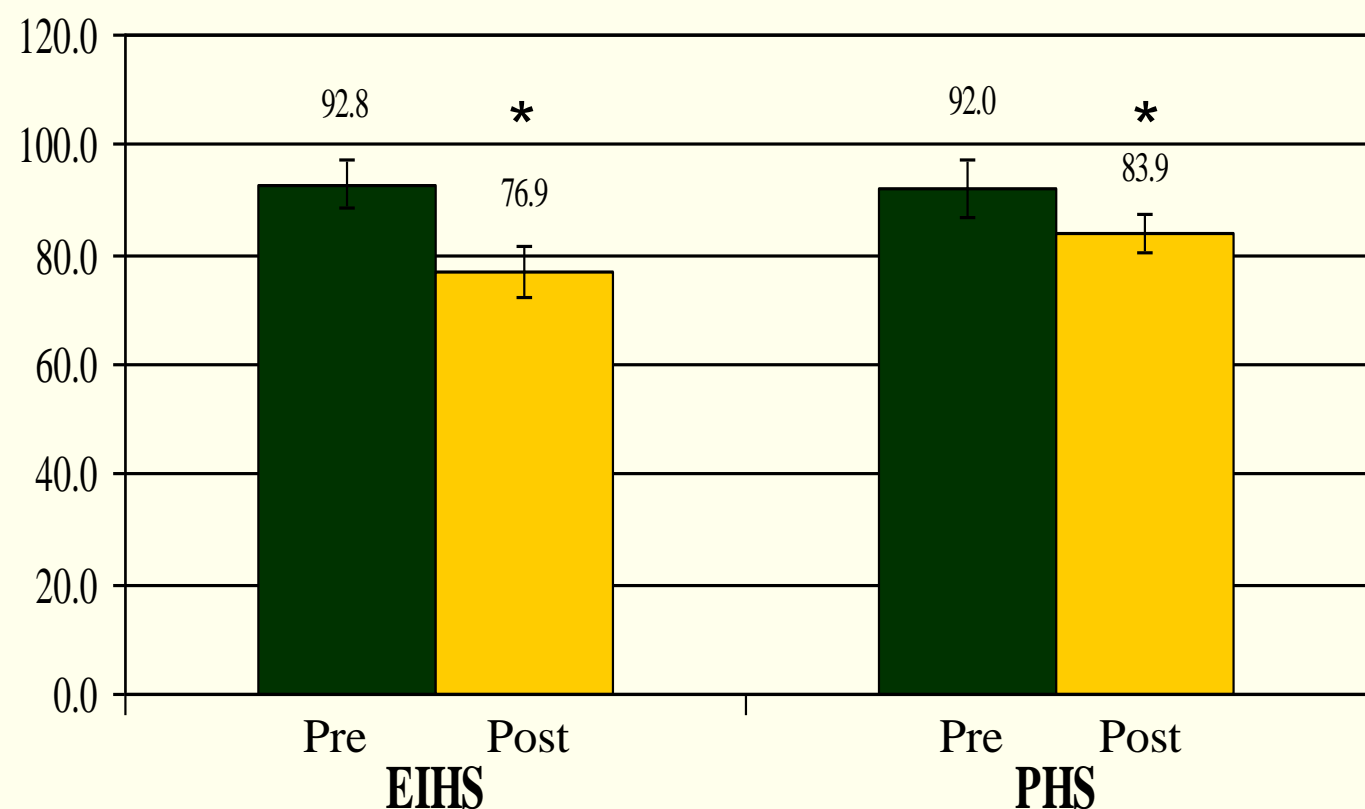


Fig. 1a. Effects of EIHS and PHS on platelet reactivity (collage-ADP time to occlusion). Values are expressed as the mean ± SE; * p ≤ 0.05

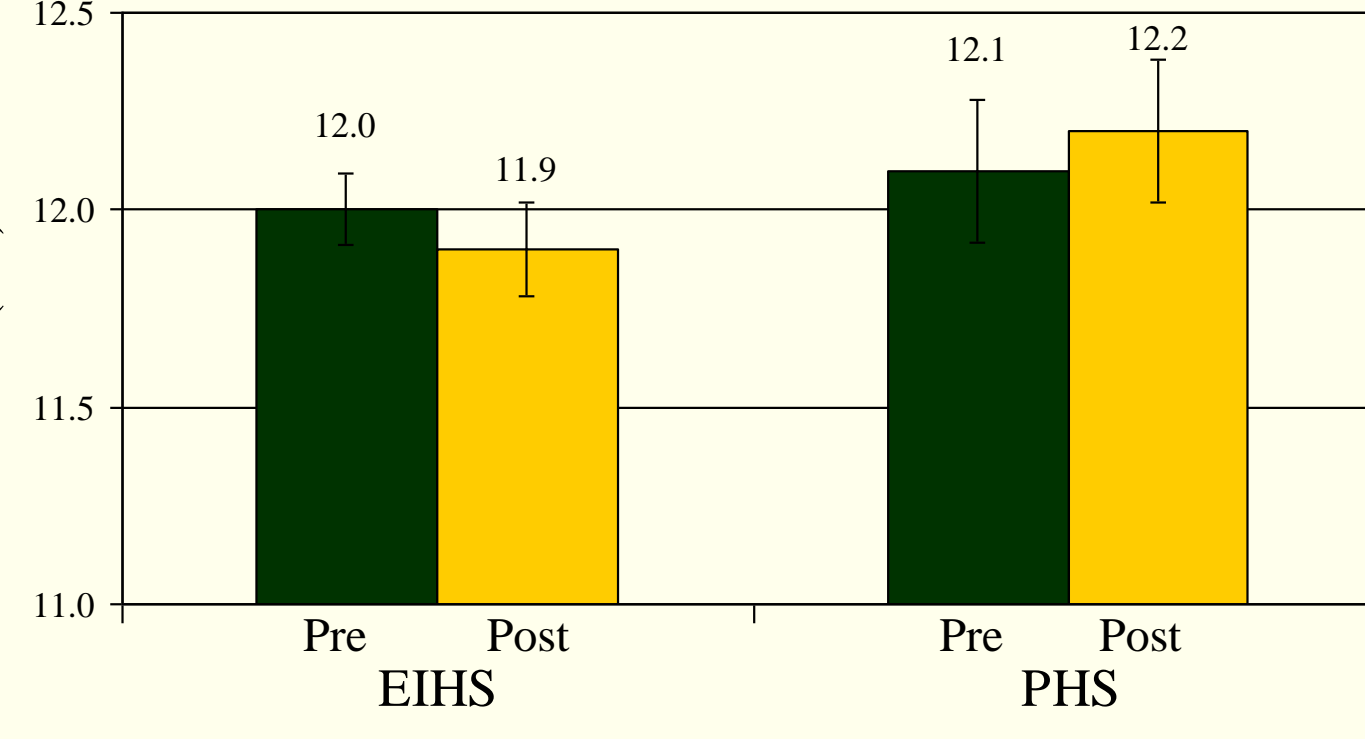


Fig. 2a Effects of EIHS and PHS on prothrombin time (expressed in seconds) Values are expressed as the mean ± SE. * p≤0.05

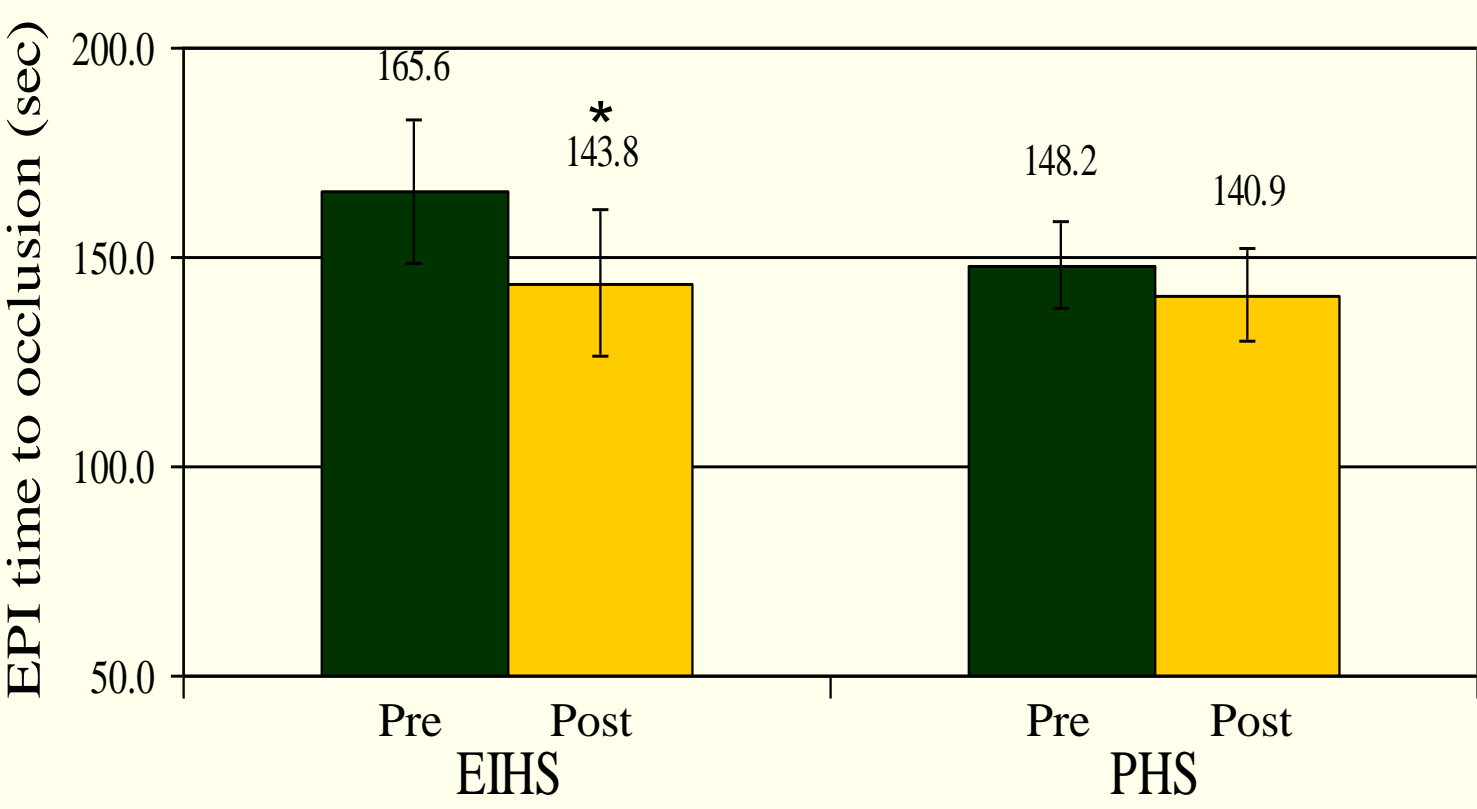


Fig. 1b Effects of EIHS and PHS on platelet reactivity (collage-EPI time to occlusion). Values are expressed as the mean ± SE; n = 10; * p ≤ 0.05

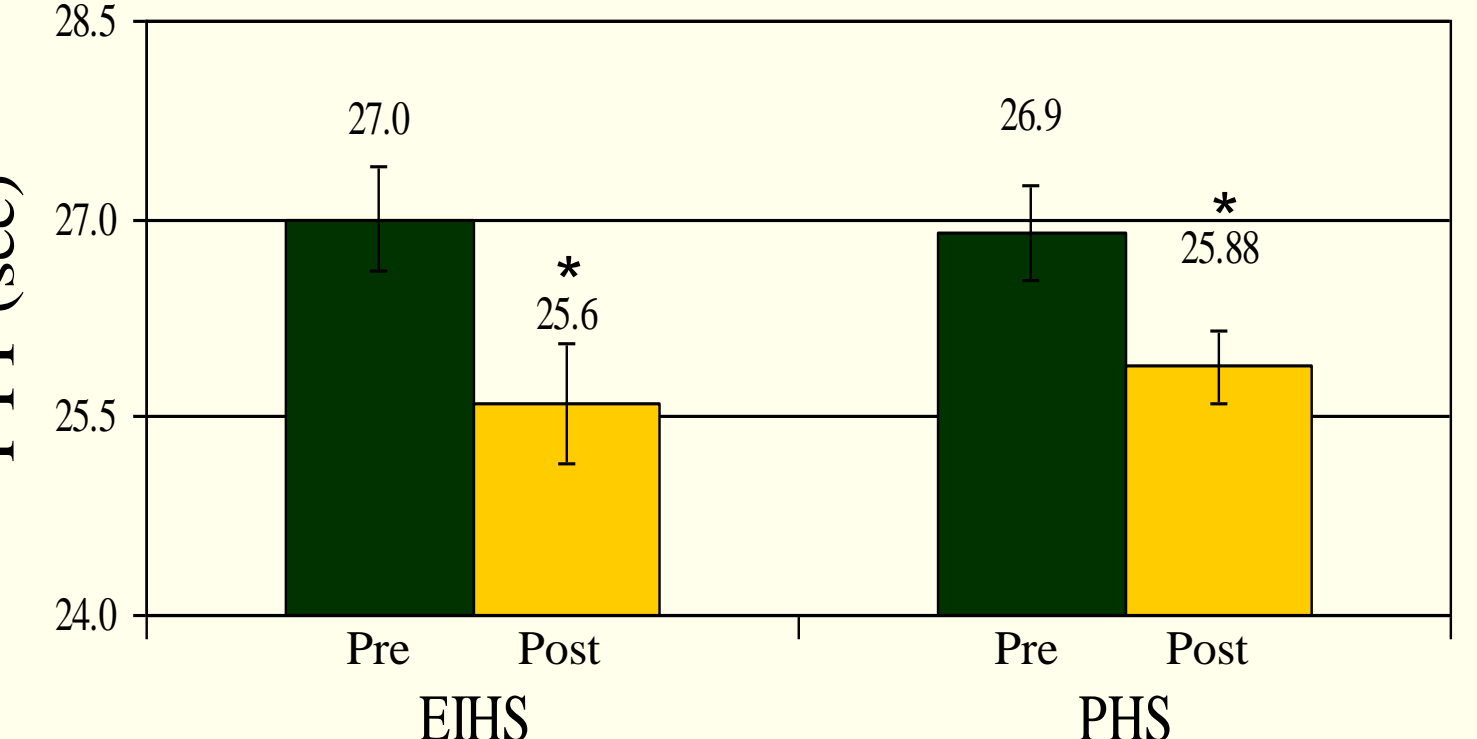


Fig. 2b Effects of EIHS and PHS on partial thromboplastin time (expressed in seconds) Values are expressed as the mean ± SE. * p≤0.05

Table 2. Effects of PHS and EIHS on Hematological Variables; n=11

Hematological Variables	Condition	Pre	Post	% Δ	P value, student t-test
RBC, ×10 ⁶ ul	EIHS	5.1 ± 0.4	5.4 ± 0.3***	6.2%	p<0.001
	PHS	5.1 ± 0.3	5.3 ± 0.3***	4.0%	p<0.001
WBC, ×10 ³ ul	EIHS	6.8 ± 1.6	8.4 ± 2.4**	23.0%	p<0.01
	PHS	6.6 ± 1.8	6.8 ± 2.2	3.2%	p=0.221
Platelet Number, ×10 ³ ul	EIHS	255.4 ± 46.0	311.6 ± 67.0***	22.0%	p<0.001
	PHS	251.2 ± 45.8	266.0 ± 53.7***	5.9%	p<0.001
Mean Platelet Volume, fl	EIHS	9.2 ± 0.8	9.1 ± 0.9	1.0%	p=0.220
	PHS	8.9 ± 0.7	9.0 ± 0.7	1.22%	p=0.108
Hematocrit, %	EIHS	44.7 ± 2.5	47.4 ± 2.5***	6.1%	p<0.001
	PHS	44.5 ± 2.4	46.1 ± 2.3***	3.4%	p<0.001
Hemoglobin, g/dl	EIHS	15.4 ± 0.8	16.3 ± 1.0***	6.0%	p<0.001
	PHS	15.3 ± 0.9	15.9 ± 0.9***	3.7%	p<0.001

Discussion/Conclusion

The purpose of this study was to investigate changes in platelet function and coagulation resulting from EIHS and PHS in healthy, active males. Both EIHS and PHS resulted in:

- increased potential for clotting as evidenced by increased platelet number,
- decreased closure time,
- decreased PTT.

Previous research suggests that moderate exercise suppresses platelet function (platelets take longer to aggregate) while strenuous exercise increases platelet function (platelets take less time to aggregate) (5,6). Sympathetic nervous system activation with exercise, and subsequent catecholamine release is thought to influence platelet aggregation (2). It is possible that the combined stress of moderate exercise and the thermal strain imposed by the insulating clothing had a cumulative effect on the sympathetic nervous system and hence on platelet function in our study.

The present study both PHS or EIHS (moderate activity) caused enhanced platelet function and a procoagulatory state. Thus, it appears likely that heat stress, or exercise in combination with heat stress, exacerbates the risk of an acute thrombotic event. Further research is needed to examine the hemostatic responses to heat stress, particularly EIHS.

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