The synergistic effects of concurrent stress on the inflammatory response in healthy individuals

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Introduction

- Certain occupations such as firefighting, emergency medical operations, and law enforcement expose workers to both physical and psychological stress. The stimuli from the dual stress that these individuals experience on a regular basis may put them at higher risk for cardiovascular disease, including atherosclerosis (Hessl, 2001).
- Pentraxin 3 has recently been discovered as a marker of vascular inflammation. It is produced by endothelial cells of the blood vessels and by monocytes and macrophages (Presta et al., 2007; Imamura et al., 2007) .
- Physical fitness has shown to increase cardiovascular efficiency (Hamer et al., 2002; DeSouza et al., 2000; Olive et al., 2002) and lower pro inflammatory cytokines in response to acute psychological stress (Hamer and Steptoe, 2007).
- While studies have shown that those who are physically fit may benefit from greater immune and stress protection, no studies have looked at the relationship of cardiorespiratory fitness on pentraxin 3 concentration during acute bouts of dual stress.
- The purpose of this study was to examine pentraxin 3 levels when subjects were exposed to both physical and psychological stress simultaneously. The study also looked at the effects of physical fitness on pentraxin 3 and catecholamine levels during the dual stress condition.

Method

Participants

- 14 healthy male subjects were recruited for the experiment.
- 7 subjects were placed in the fit group and seven were placed in the unfit group according to measurements of $VO_{2\,max}$.

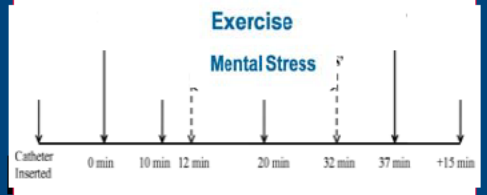
	Fit Group	Unfit Group	Combined Group
Number of Subjects	7	7	14
$VO_{2\,max}$ (ml/kg/min)	50.99 ± 2.19	36.27 ± 3.51	43.63 ± 8.14
Weight (kg)	68.23 ± 7.95	71.96 ± 8.38	70.09 ± 8.08
Height (cm)	174.57 ± 6.19	173.43 ± 5.06	174.00 ± 5.46
BMI (kg/m^2)	22.32 ± 1.40	23.92 ± 2.60	23.12 ± 2.17
Age (years)	22.29 ± 5.22	20.86 ± 2.19	21.57 ± 3.92

Materials

- Subjects cycled on a stationary cycle ergometer with the workload controlled by CompuTrainer Pro Cycle ergometer software.
- Psychological stress was provided by using the computer based Stroop Color Word (SCW) and mental arithmetic (MA) tasks.

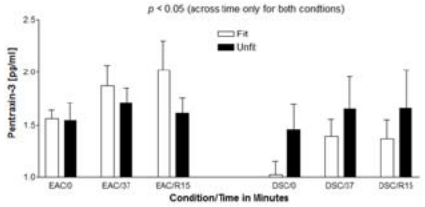
Procedure

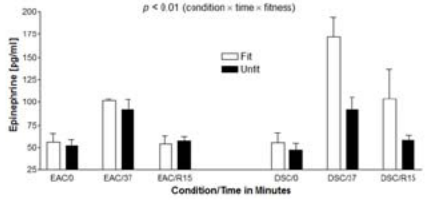
- Data was collected during three separate sessions.
- Session 1 consisted of a VO_{2max} test and a consent form.
- Session 2 required the subjects exercise for 37 minutes for the Exercise Alone Condition (EAC).
- Session 3 required the subjects to exercise for 37 minutes while receiving psychological stimuli for 20 minutes for the Dual Stress Condition (DSC).
- Blood was taken during sessions 2 and 3 at the intervals shown in the chart below.

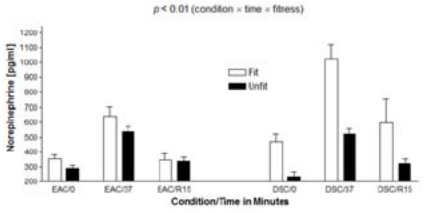


Results

- The data collected revealed that plasma pentraxin 3 concentrations increased significantly over time in both high fit and low fit groups for the EAC and DSC ($p < 0.02$).
- Results showed that there was no significant difference in pentraxin 3 levels between EAC and DSC.
- Additionally, significant time effect and time by fitness level interaction in plasma epinephrine (EPI) and norepinephrine (NE) levels were found in both EAC and DSC with greater levels in the high fit group ($p < 0.05$).
- Furthermore, plasma pentraxin 3 was not correlated with EPI and NE neither EAC nor DSC.







Discussion

- Pentraxin 3 was elevated following both EAC and DSC, although no difference was observed between both conditions or fit and unfit groups.
- These findings suggest that mental stress does not exacerbate elevation of pentraxin 3 levels during physical stress. Additionally, cardiovascular fitness may not affect the release of plasma pentraxin 3.
- In addition, higher EPI and NE in DSC may be associated with elevated mortality rates in some occupations such as firefighting, emergency medical operations, and law enforcement exposed to combined stress.
- Future investigation into the relationship between cardiovascular fitness and combined stress environments on the inflammatory response may help in finding strategies (e.g. exercise) to combat the adverse effects of concurrent stressors.

References

- Hessl SM. Police and corrections. Occup Med. 2001;16:39-49.
- Presta M, Camozzi M, Salvatori G, Rusnati M. J Cell Mol Med. 2007 Jul-Aug;11(4):723-38. Role of the soluble pattern recognition receptor PTX3 in vascular biology.
- Imamura M, et al. Lipopolysaccharide induced expression of pentraxin 3 in human neutrophils and monocyte-derived macrophages. Cell Immunol. 2007 Aug;248(2):86-94.
- Hamer, M, Boutcher Y, Boutcher SH. Cardiovascular and renal responses to mental challenge in highly and moderately active male with a family history of hypertension. J Hum Hypertens 2002; 16: 319-326.
- DeSouza CA, Shapiro LF, Clevenger CM, Dinenno FA, Monahan KD, Tanaka H, Seals DR. Regular aerobic exercise prevents and restores age-related declines in endothelium-dependent vasodilation in healthy men. Circulation 2000; 102: 1351-1357.
- Olive JL, DeVan AE, McCully KK. The effects of aging and activity on muscle blood flow. Dyn Med 2002; 1: 2.
- Hamer M, Steptoe A. Association between physical fitness, parasympathetic control, and proinflammatory responses to mental stress. Psychosom Med. 2007; 69: 660-666.

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