HORMONAL RESPONSES TO RESTING COLD EXPOSURE: INFLUENCE OF MENSTRUAL CYCLE PHASE AND GENDER

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INTRODUCTION

Gender differences in the metabolic response to cold stress have been reported. McArdle et al. (1) found that women exhibited a lower thermosensitivity of metabolic heat production than men during rest in cold water immersion. Graham et al. (2) observed that women demonstrated a reduced thermal responsiveness during 5°C air exposure; this alteration was unrelated to differences in body composition or size. In contrast, Mannino and Kaufinan (3) found a greater responsiveness to cold in women who were similar in body composition to the men studied.

The role of the reproductive hormones on thermoregulation in women has been well documented (4). Estrogens may also influence hormones involved in substrate metabolism (5) or those that could affect the thermogenic response to cold. Thus, we investigated whether the differences in thermal responses to cold between men and women are linked to the potential menstrual cycle alterations in thermogenic hormones.

MATERIAL AND METHODS

Seven men (21 ± 3 yrs; 1.88 ± 0.11 m^2; 10.0 ± 3.0 %fat; $\dot{V}_{O_2max}$, 47.4 ± 5.7 $ml \cdot kg^{-1} \cdot min^{-1}$) and 3 women (31 ± 10 yrs; 1.70 ± 0.13 m^2; 23.1 ± 2.9% fat; $\dot{V}_{O_2max}$, 46.6 ± 3.2 $ml \cdot kg^{-1} \cdot min^{-1}$) volunteered for the study. Women were eumenorrheic and were not using oral contraceptives. Menstrual status was confirmed by assessment of serum estradiol and progesterone.

Trials were conducted between April and mid-November to eliminate effects of cold acclimatization. Following a 30-min baseline period ($T_a = 25 \pm 0.5$°C, RH = 55 ± 2%) subjects rested in an environmental chamber at 5°C and 40% RH for 60 min. Women were evaluated during follicular (FOL, days 1-8) and luteal (LUT, days 19-24) phases of the menstrual cycle. Blood was collected immediately before and after the cold exposure from an antecubital vein. Heat production (HP) was determined indirectly from V02 and respiratory exchange ratio (RER). Core temperature was measured within the esophagus (T_{es}). Plasma norepinephrine (NOREPI) and epinephrine (EPI) were determined by high-pressure liquid chromatography (HPLC) (6). Total thyroxine (tT4), free triiodothyronine (fT3) and free thyroxine (fT4) were measured by radioimmunoassay as described previously (7).

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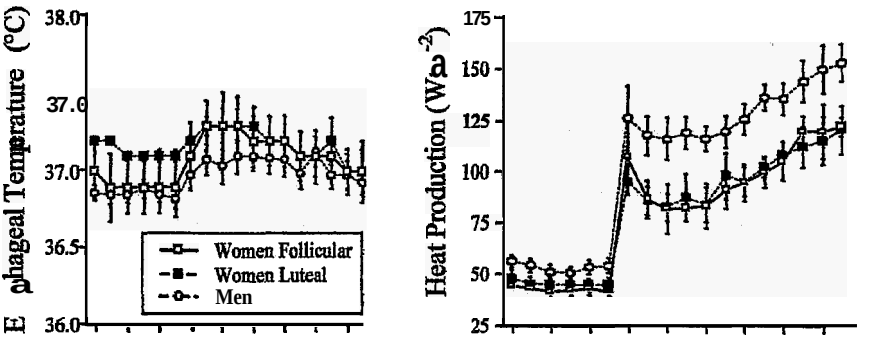
HP



LUT T_{es} at baseline was **0.2** to **0.3°C** higher compared with T_{es} during the FOL trial or T_{es} for the men. HP in the cold tended to be higher in the men compared with both FOL and LUT, although these differences were not statistically significant. Values for plasma catecholamines and thyroid hormones are shown in Table 1.

Table 1. Values for Plasma Catecholamines and Thyroid Hormones

Group	Time	NOREPI (pg·ml^{-1})	EPI (pg·ml^{-1})	tT4 (μg·dl^{-1})	fT4† (ng·dl^{-1})	fT3† (pg·ml^{-1})
Men	Omin	245 f 2 3	25.4± 4.7	5.2k0.2	2.6± 0.2	2.8 kO.l
	60 min	1324 ±1 66*	56.5 ± 14.6	5.6 ± 0.3*	2.6± 0.1	3.3 ± 0.3*
Women	Omin	262 ± 8 1	13.6292	5.1 ±0.1	2.220.1	2.0 ± 0.1
FOL	60 min	1448 ± 61*	16.4± 12.0	5.8 ± 0.1*	2.3 ± 0.1*	2.5 ± 0.3*
Women	0 min	272 ± 75	13.4k5.1	5.4 ± 0.3	2.3k0.1	2.3 ± 0.2
LUT	60 min	1132 f 4 15*	26.8 ± 7.1	6.5 ± 0.3*	2.6 ± 0.1*	2.6 ± 0.4*

*$P < 0.05$ vs min 0; †$P <$ 0.05, men vs. women.

NOREPI, but not EPI, was significantly increased by the cold exposure. Neither baseline values nor cold values were influenced by gender or menstrual

cycle phase. Total T4 responses were also similar between groups and were elevated by the 60 min of rest in the cold. At baseline, men had higher plasma values for fT4 and fT3 when compared with the women (FOL and LUT). During the cold fT3 increased in all groups, whereas, only the women exhibited a significant increase in fT4. No menstrual-phase differences were noted for any hormonal response.

DISCUSSION

This study investigated the effects of menstrual cycle phase and gender on the metabolic and hormonal responses to cold in healthy, young men and women, matched for aerobic fitness. Our findings in the small number of subjects studied indicated that resting exposure in 5°C induced similar catecholamine, HP and T_{es} responses in men and women, regardless of menstrual cycle phase. Men had higher fT3 and fT4 values at baseline, and the increase in fT4 during the cold was elevated only in the women, without an effect of menstrual cycle phase. The reason for these differences is unclear. The higher fT3 and fT4 values in men at baseline were not accompanied by a higher heat production. Although others have reported similar catecholamine responses to cold in men and women (8), this study is the first to compare .thyroid hormone responses between genders and menstrual cycle phases.

CONCLUSIONS

Although gender differences in fT4 and fT3 require further study, these differences did not alter cold metabolism in similarly trained men and women. Menstrual cycle phase did not alter resting metabolic responses during 60 min exposure in 5°C air.

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