Autonomic Function in Men and Women Throughout the Menstrual Cycle

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INTRODUCTION

Orthostatic intolerance is more common in women in comparison to age matched men. Many aspects of female physiology are known to be governed by the menstrual cycle, yet research specifically on the role of female sex hormones on autonomic function is limited and has provided mixed results. Guasti et al. investigated autonomic function in women by power spectral analysis of heat rate variability (HRV) and baroreflex sensitivity, finding greater sympathetic activity (Gausti et al. 1999). However, a study by Fuenmayor et al. investigated autonomic balance using the Valsalva maneuver and reported conflicting results. They also found a significant difference during two different phases of the menstrual cycle, where the change in heart rate was higher during the luteal stage compared to the follicular stage (Fuenmayor et al. 2000). This finding, unlike the previous finding, proposes that the luteal phase has elevated parasympathetic activity. This study is intended to use clinical autonomic testing methodology to help clarify these discrepancies.

PURPOSE

1) To investigate changes in heart rate during paced deep breathing in men and women throughout the menstrual cycle.
2) To investigate the Valsalva ratio and Sympathetic index based on heart rate and blood pressure changes during the Valsalva maneuver in men and women throughout the menstrual cycle.

METHODS

Healthy men and women (n=6 each) were recruited (age 18-30). Women came in twice, one during the low hormone phase (LH; day 2-5) and once during the high hormone phase (HH; day 18-24 of the menstrual cycle). A standard electrocardiogram was recorded while mean arterial blood pressure was continuously measured using a beat-by-beat non-invasive blood pressure device (Finometer, Finapres Medical Systems).

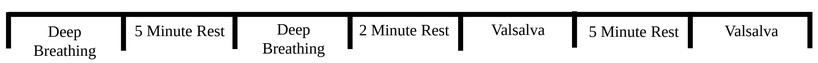

Figure 1: Timeline of Deep Breathing and Valsalva Trials

Paced Deep Breathing: Participants were instructed to breath at a rate of 6 breaths/min to measure parasympathetic control of heart rate at rest. The expiratory to inspiratory ratio (E:I) was calculated based on the ratio between maximum and minimum heart rate during a respiratory cycle.
Valsalva maneuver: Participants were instructed to exhale forcefully into a mouthpiece (40mmHg for 15 seconds). The Valsalva ratio is the ratio of maximal to minimal HR during the Valsalva maneuver, used as a tool to assess cardiovagal function. The Sympathetic index, [(Fall in blood pressure during phase 2 of Valsalva + 0.7*Magnitude of recovery of blood pressure in Valsalva)/Blood pressure recovery time](Novak,2011) was used to evaluate sympathetic function. Data was represented as means +/- SE. T-tests were conducted between men and women (unpaired) or between low hormone and high hormone phases (paired).

RESULTS

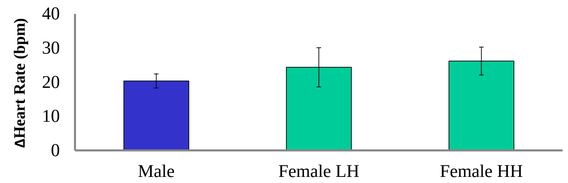

Figure 2. Change in heart rate during the deep breathing exercise of male, female low hormone (LH) phase, and female high hormone (HH) phase participants.

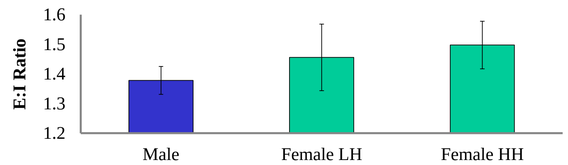

Figure 3. Expiratory to inspiratory ratio (E:I) during the deep breathing exercise of male, female low hormone (LH) phase, and female high hormone (HH) phase participants.

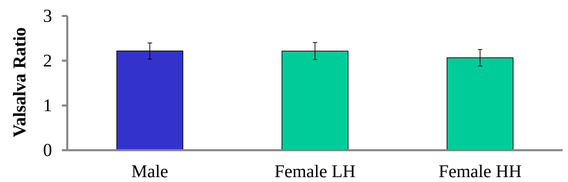

Figure 4. Valsalva ratio of male, female low hormone (LH) phase, and female high hormone (HH) phase participants based on the heart rate response to the Valsalva maneuver. Slight trend noted between female LH and HH groups (P = 0.14).

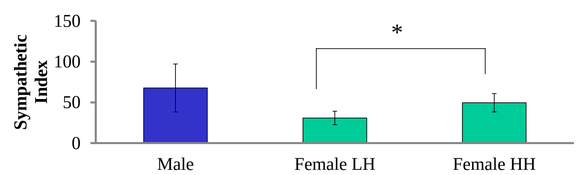

Figure 5. Sympathetic index of male, female low hormone (LH) phase, and female high hormone (HH) phase participants based on the blood pressure changes during the Valsalva maneuver. *There was a significant difference in the sympathetic index between female LH and HH groups (P = 0.0)1.

SUMMARY

1) There was a trend noted in the Valsalva ratio between the LH and HH phase females. LH phase females tended to have a greater Valsalva ratio (2.22 ± 0.19), than HH phase females (2.07 ± 0.19), however this was not statistically significant.

2) There was a significant difference found in the Sympathetic index between LH phase and HH phase females. The Sympathetic index was greater for females in the HH phase, at 49.5 ± 11.3 mmHg/s, in comparison to females in the LH phase, at 30.9 ± 8.3 mmHg/s. Although there was a significant difference in sympathetic drive between the two menstrual cycle phases, the same results were not seen between the two sexes.

CONCLUSIONS

Since females in the LH phase tended to have a greater Valsalva ratio than in the HH phase, this suggests a greater parasympathetic tone for the LH phase. This greater parasympathetic tone aligns with some studies which have found greater parasympathetic activity during the follicular phase (i.e. LH) but through measurements of HRV spectral analysis (Sato et al. 1995). Moreover, the significant difference in Sympathetic Index observed between LH phase and HH phase indicates that there is a greater sympathetic drive in the HH phase.

Future Directions: This study looked at young healthy individuals (males = 23.3 ± 1.7 years, females = 22.5 ± 1.2 years). Differences may have been subtle and not detectable with such a small sample size, therefore future studies will include older participants and a comparison of pre- and post-menopausal women. In this study, data from women using oral contraceptives and women not using oral contraceptives were combined. Similarly, oral contraceptive usage was not randomized and several types of oral contraceptives were used. This may have confounded the results as a distinction between exogenous and endogenous female sex hormones was not made. Thus, further research will be done to investigate the differences between women using oral contraceptives and those that are not.

REFERENCES

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