The Effect of Estrogen and Progesterone on Breathing during Exercise in Hypoxia and Normoxia

Thomas Farrell, Licy Li, Vicky Lin, Lily Xie

Department of Statistics, UBC Faculty of Science

Abstract

Using data from premenopausal and postmenopausal females, we examined how hormone levels[1], oxygen condition and other factors influence women's breathing during exercise. Through mixed-effects linear regression, results indicated that in older females, HRT was associated with a reduced ventilatory response to hypoxia. Hypoxia and higher general fitness led to higher ventilation in both groups.

Introduction

- Prior studies mostly focused on resting, with limited investigation during exercise
- This study explored how hormone levels affect breathing for premenopausal and postmenopausal women during exercise
- **Study Objectives**
  - To investigate effect of hormones on ventilation for younger females across menstrual phases
  - To investigate impact of hormone replacement therapy (HRT) on ventilation for older females
  - To compare ventilation levels between younger and older females

Methods

- **Uniform imputation** was used to address the missing data
- **Mixed-effects linear regression models** were fitted to account for wide individual variation between participants
- Model selection using **VIF** and **backward selection** for all three objectives

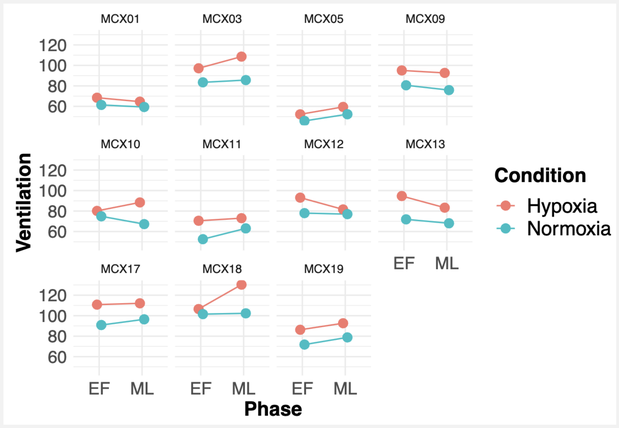

Figure 1. Interaction Plot on Phase and Condition for Ventilation for Younger Women

Results

- For **younger women**, **hypoxia**, **random effects** and **70% peak power**[2] significantly affected ventilation

Variable	Coefficient	P-value
Intercepts per Participant	SD: 12.99	<0.001
Hypoxia	13.17	<0.001
70% Peak Power	0.542	<0.05
Progesterone	9.48×10^{-2}	0.45
Estradiol	-2.99×10^{-3}	0.72
Progesterone × Estradiol	2.81×10^{-5}	0.90

Table 1. Model Results of Young Female

- For **older women**, **hypoxia**, **random effects**, the interaction of **hypoxia and HRT**, and **VO2max** were significant variables

Variable	Coefficient	P-value
Intercepts per Participant	SD: 12.29	<0.001
Hypoxia	15.65	<0.001
Hypoxia × HRT	-9.31	<0.01
VO2max	21.12	<0.05
HRT	4.93	0.56

Table 2. Model Results of Older Female

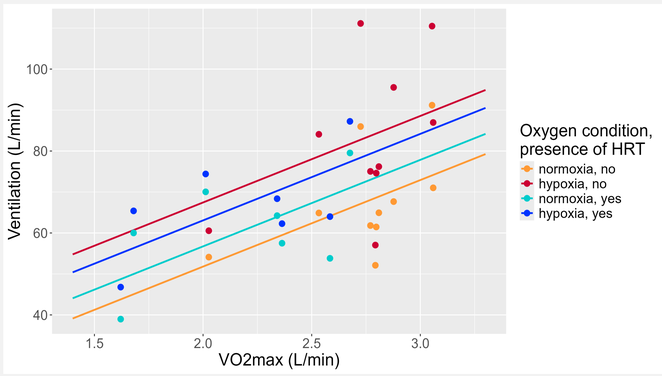

Figure 2. Predicted Mean Ventilation Levels for Older Women

Comparison of Younger and Older Women

- No new findings from fitting model to combined dataset:
  - **Oxygen condition** and **random intercepts** were still significant at $p < 0.001$
  - **70% peak power** was significantly associated with increased ventilation[2] ($p < 0.01$)
  - No significant association with age ($p = 0.58$) or grouped hormone levels ($p = 0.57$)

Conclusions

Both Groups

- Hypoxia significantly increased ventilation
- Higher general fitness associated with higher ventilation[2]
- Substantial individual variability not attributed to variables in the study

Younger Women

- No statistically significant effects of progesterone or estradiol or their interaction on ventilation

Older Women

- HRT associated with significantly lowered ventilatory response to hypoxia

Comparison of Younger and Older Women

- No new statistically significant findings, showing that any differences in ventilation between the two groups can be adequately explained by variables other than age

Limitations

- Biased sampling of participants with higher-than-average fitness levels limited generalizability
- Small sample size restricted ability to detect smaller effects on ventilation, making data splitting impractical
- Inability to precisely measure hormone levels in older women precluded direct modelling of effects on ventilation

References

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- (2) Vella, C. A., Robergs, R. A., & Yamada, P. (2008). Fitness, body size, ventilation, and the oxygen cost of breathing in adults. *Journal of Exercise Physiology Online, 11*(6), 67–76.

Acknowledgements

We give sincere thanks to:

- Our client, Sierra Arn, for providing valuable data and domain insights throughout this project
- Our mentor, Gian Carlo Diluvi, and the UBC STAT450 teaching team for their generous support and guidance throughout this project