Preclinical Modeling of Military Relevant Stressors: Effects of $PM_{2.5}$ & Psychosocial Stress

Brandon M. Gibson, PhD.

Dorothy M. Davis Heart and Lung Research Institute, The Ohio State University College of Medicine

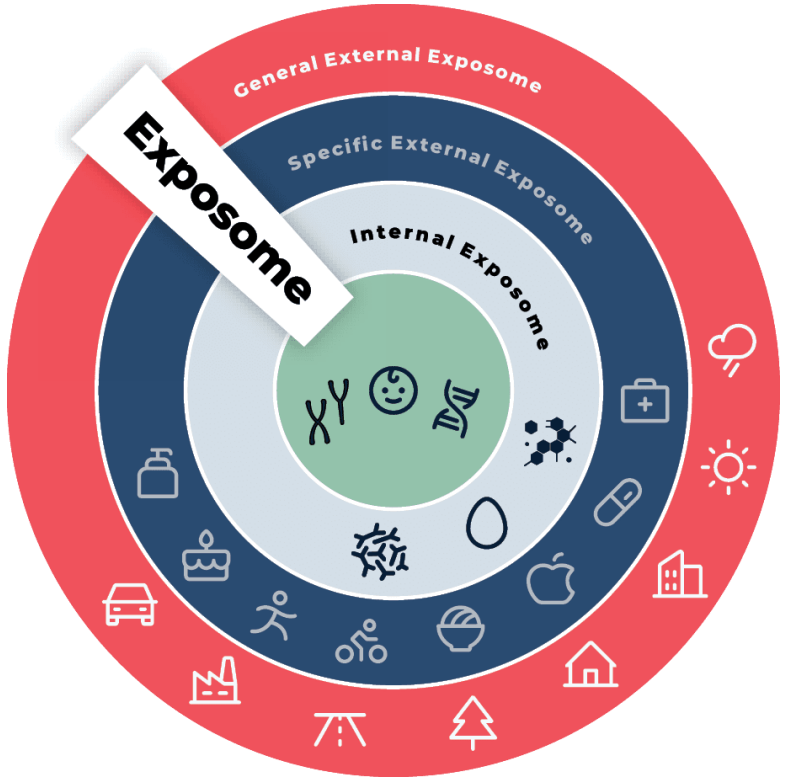
NON-DISCLOSURE

Brandon M. Gibson has no conflicts to report.

MHSRS 2026

BACKGROUND

Unique Warfighter Exposome



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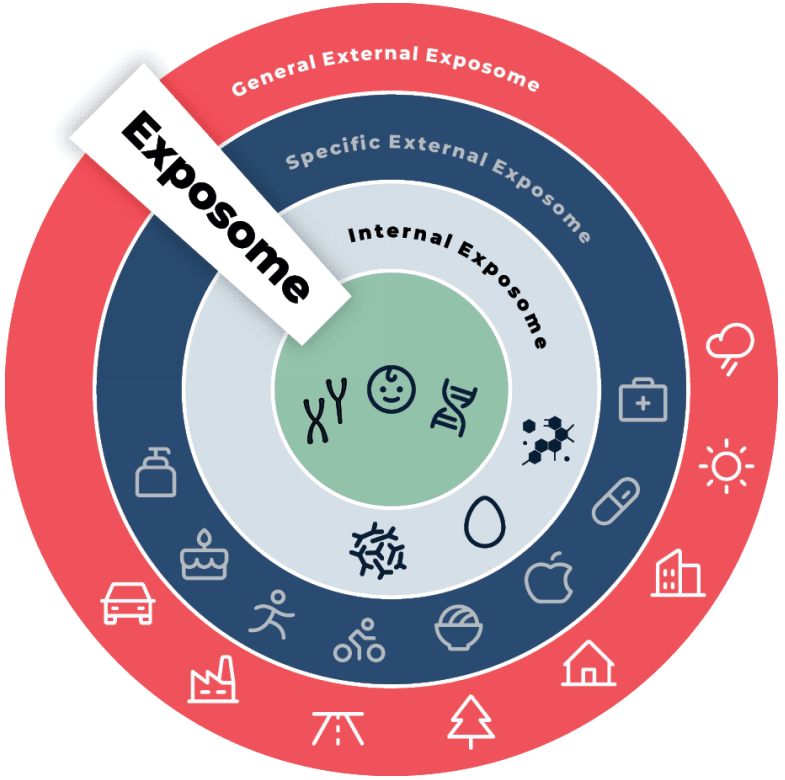
Open-air burn pits were used extensively across military campaigns — **Vietnam, the Gulf War, Iraq, and Afghanistan** — to dispose of solid waste in the outdoor air.



- **Heterogeneous fuel:** Plastics, fuels, electronics, treated wood, food waste, and medical waste were often burned together, a mixture more toxic than natural biomass combustion alone[6,13,14]
- **Massive scale:** Some installations reportedly burned as much as 227 metric tons of waste per day[15–18]
- **Complex emissions:** **Particulate matter**, volatile organic compounds, polycyclic aromatic hydrocarbons, dioxins, metals, and other combustion by-products[1–8]

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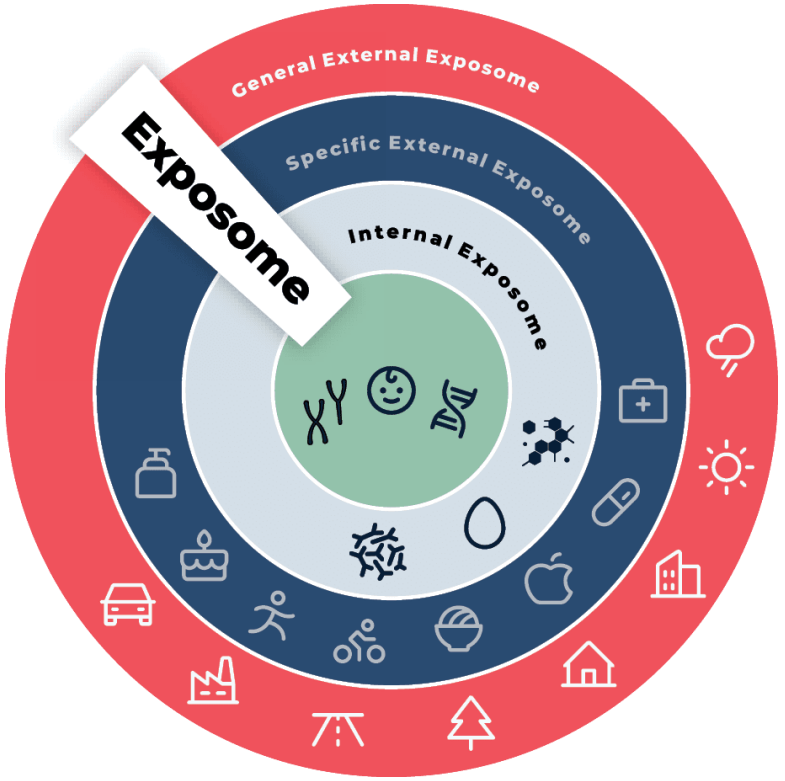

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- **Complex emissions:** **Particulate matter**, volatile organic compounds, polycyclic aromatic hydrocarbons, dioxins, metals, and other combustion by-products[1–8]
- **Incomplete phase-out:** Incinerators began replacing burn pits starting in 2009, but hundreds of sites were still active during peak deployment years[9]

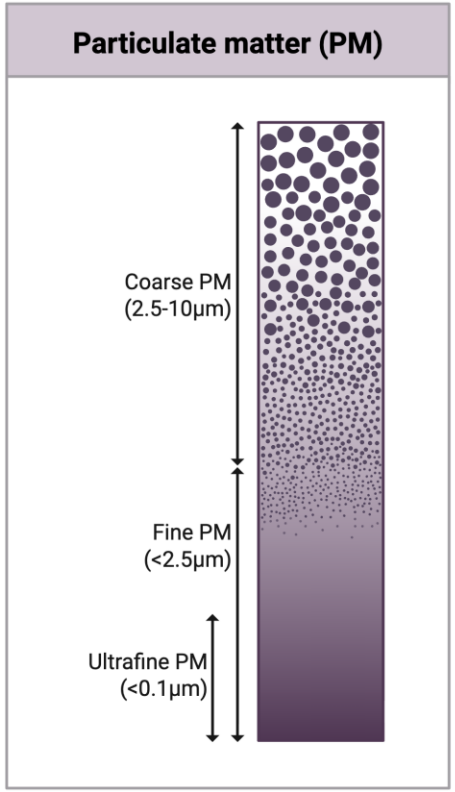
Deployment Footprint

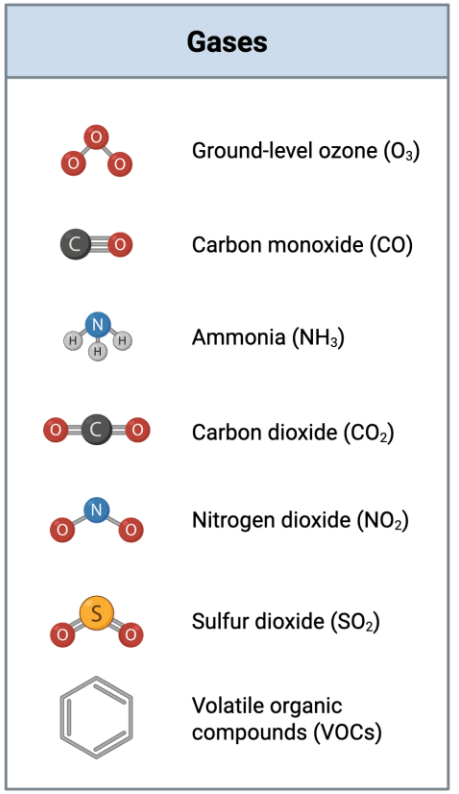
Over 4 million U.S. personnel were deployed to the Southwest Asia Theater and Middle East during OEF/OIF[11], with hundreds of thousands stationed at bases near active burn pit sites[5,12].

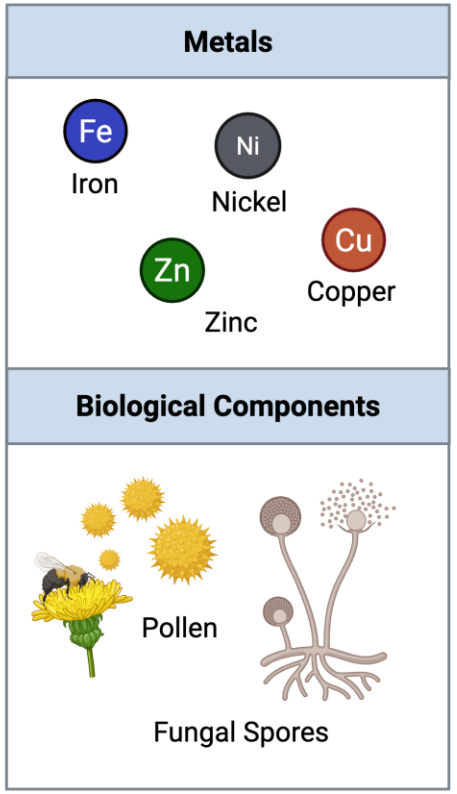
BACKGROUND

Burn Pit Emissions: What is Particulate Matter (PM)?

Particulate Matter (<2.5 µm)
Inflammation
Reactive Oxygen Species
Endothelial Dysfunction







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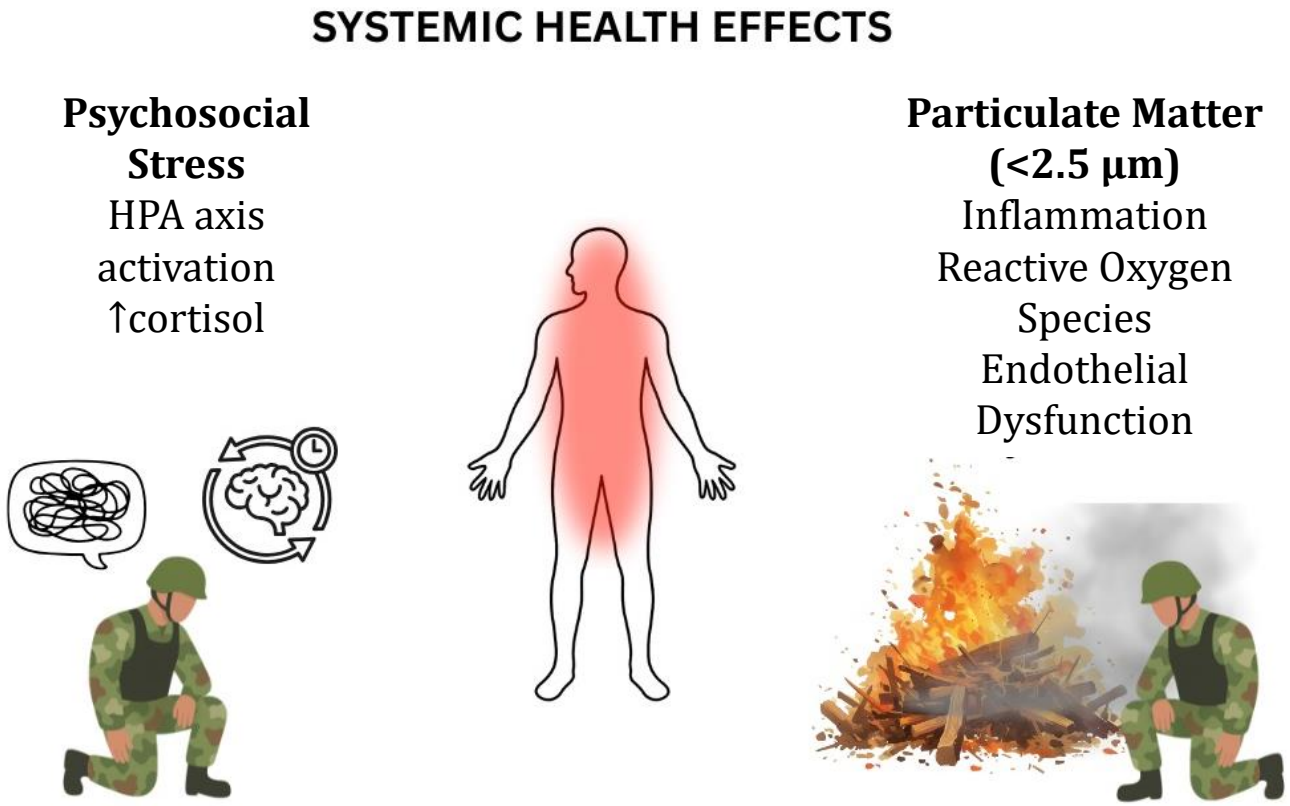
Key Gap: Combined Exposures are often unexplored



PURPOSE & HYPOTHESIS

Purpose: Demonstrate complexity of dual exposures experienced by warfighters

Hypothesis:

Mice exposed to psychosocial stress prior to or during particulate matter exposure will exhibit amplified cardiovascular effects

Acclimation

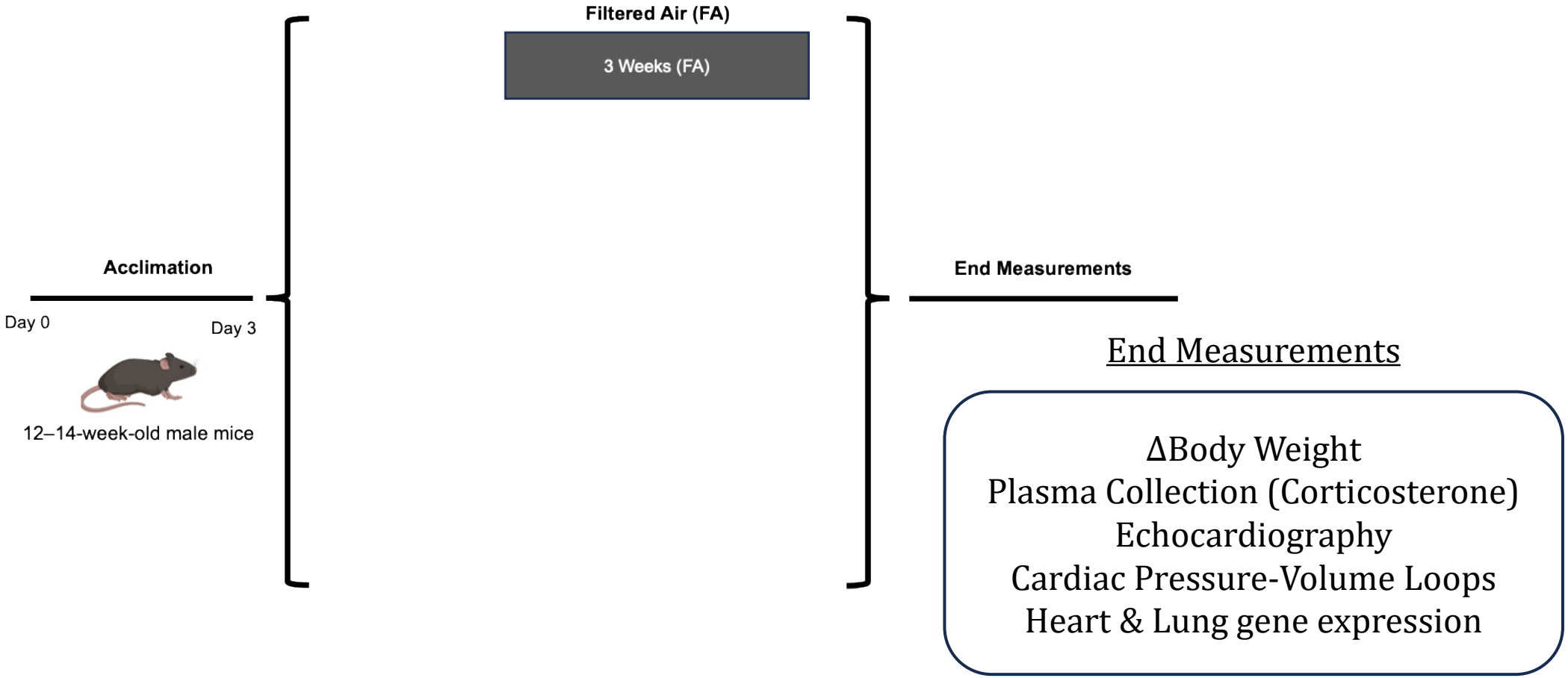
Day 0 — Day 3

12–14-week-old male mice

End Measurements

End Measurements

ΔBody Weight
Plasma Collection (Corticosterone)
Echocardiography
Cardiac Pressure-Volume Loops
Heart & Lung gene expression



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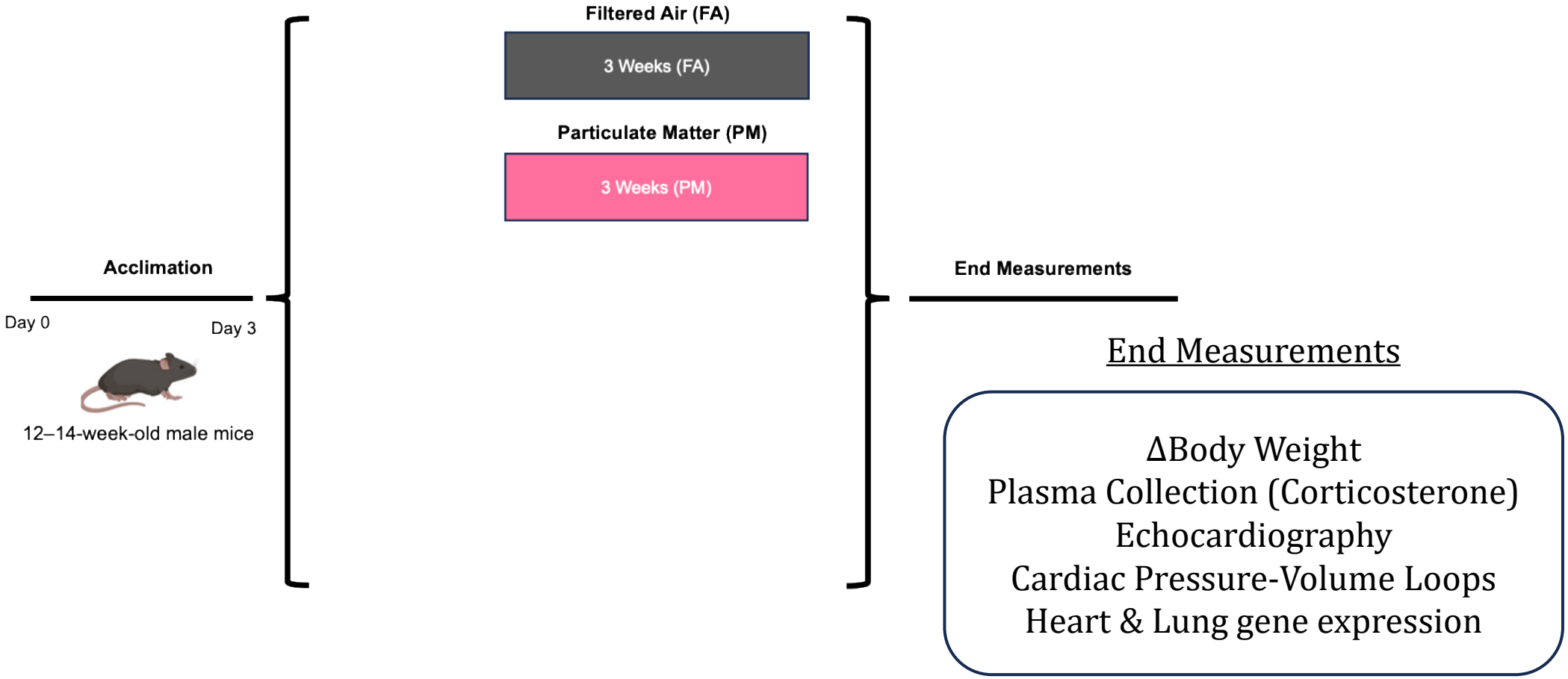

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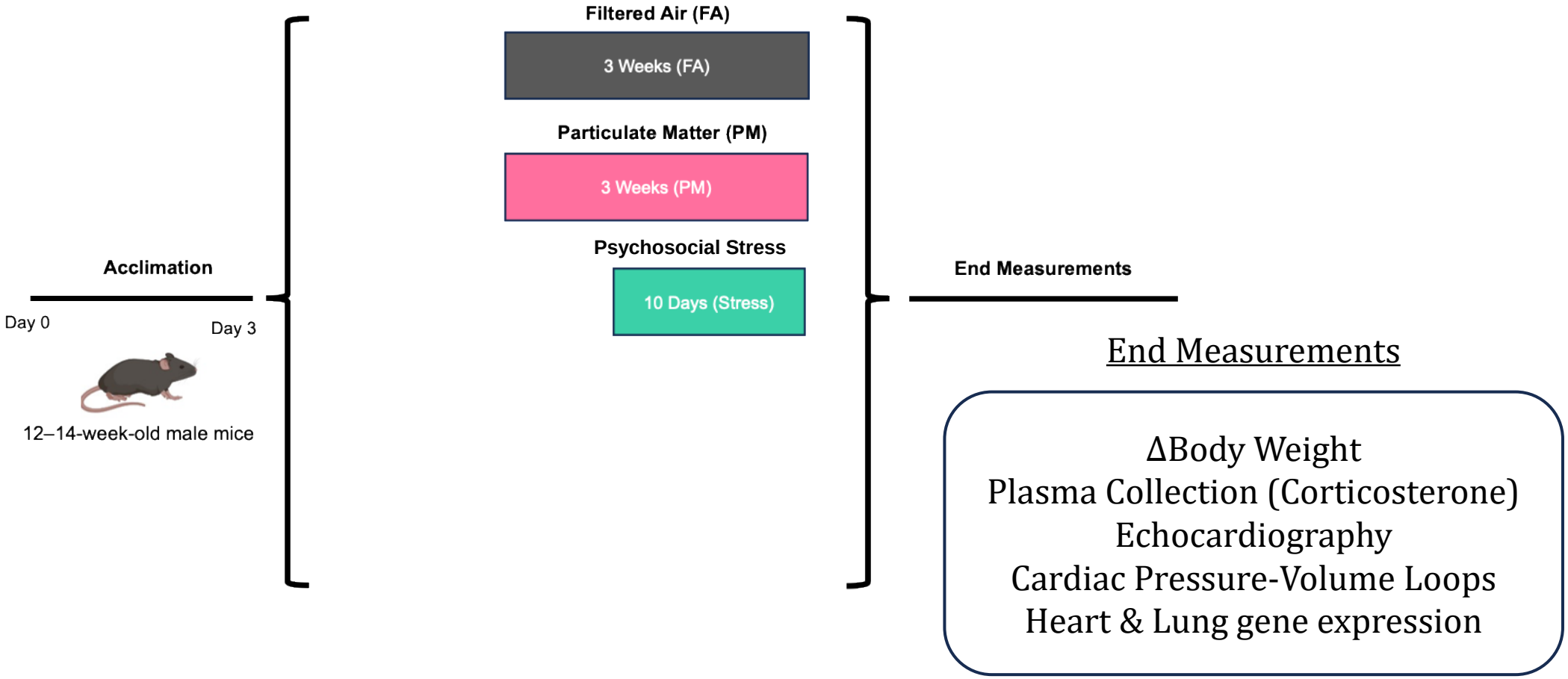

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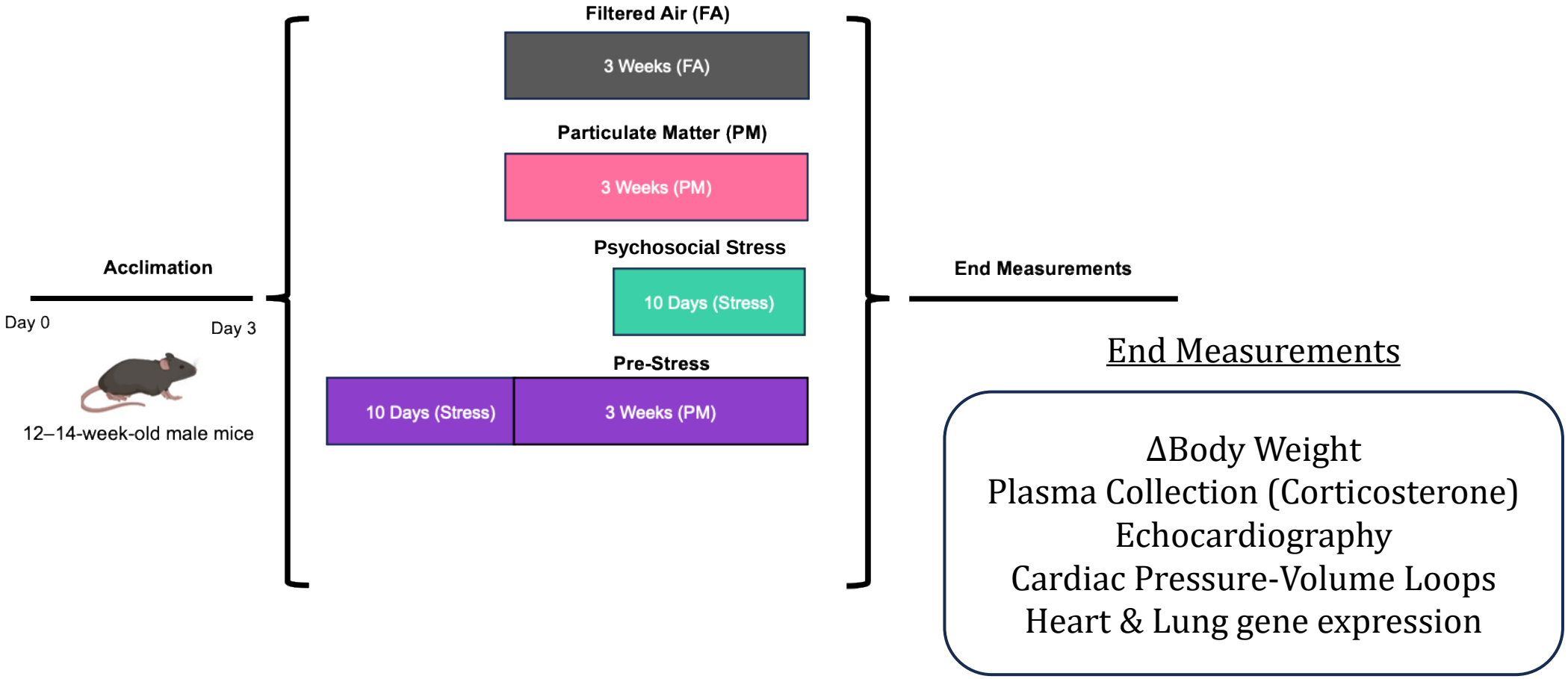

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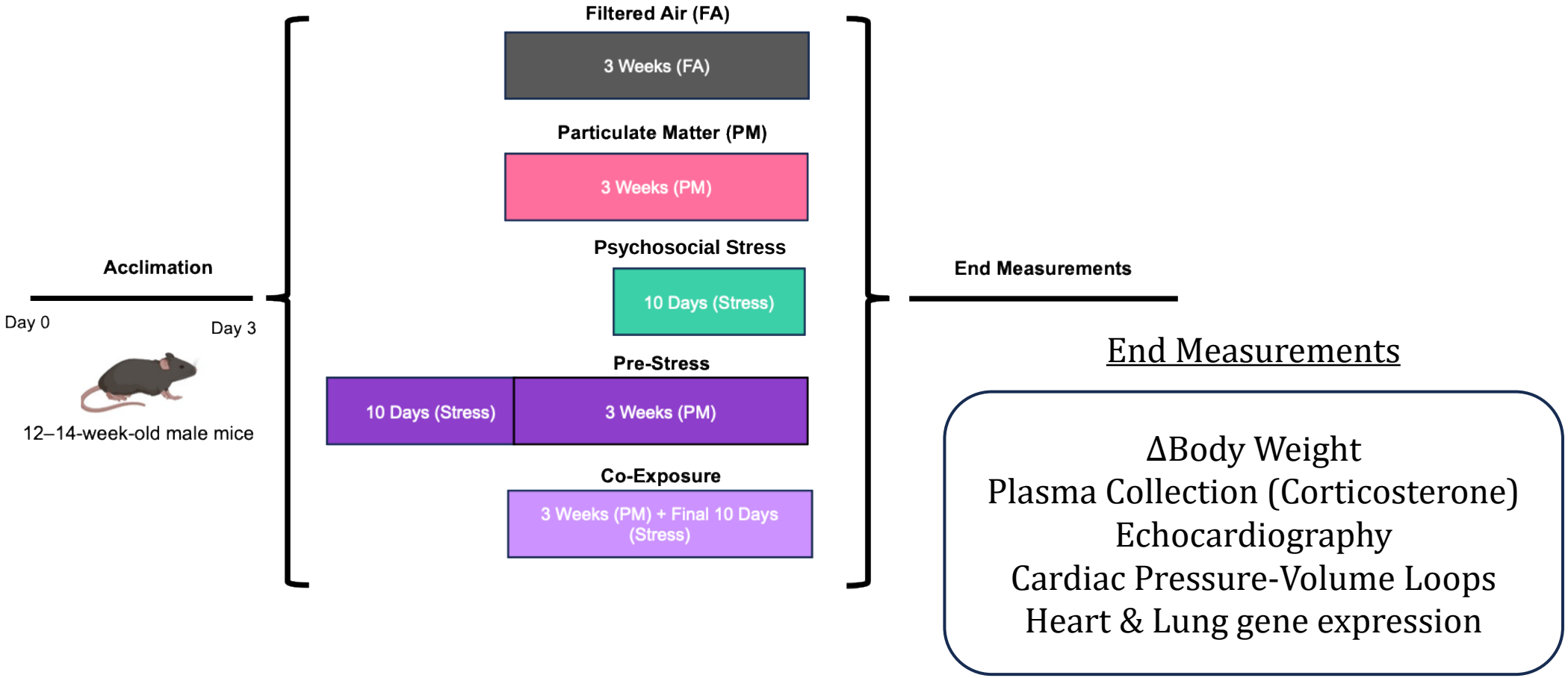

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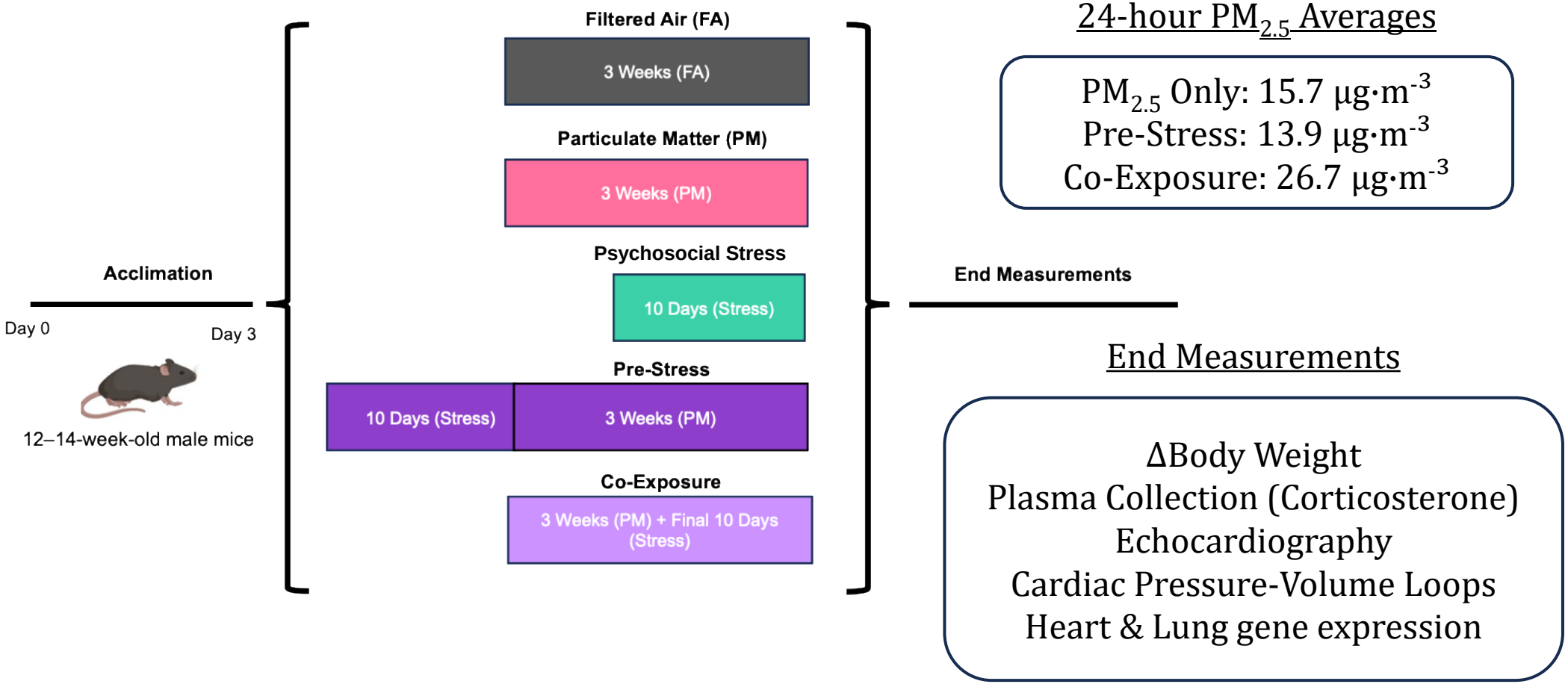

24-hour $PM_{2.5}$ Averages

$PM_{2.5}$ Only: 15.7 $\mu g \cdot m^{-3}$
Pre-Stress: 13.9 $\mu g \cdot m^{-3}$
Co-Exposure: 26.7 $\mu g \cdot m^{-3}$

End Measurements

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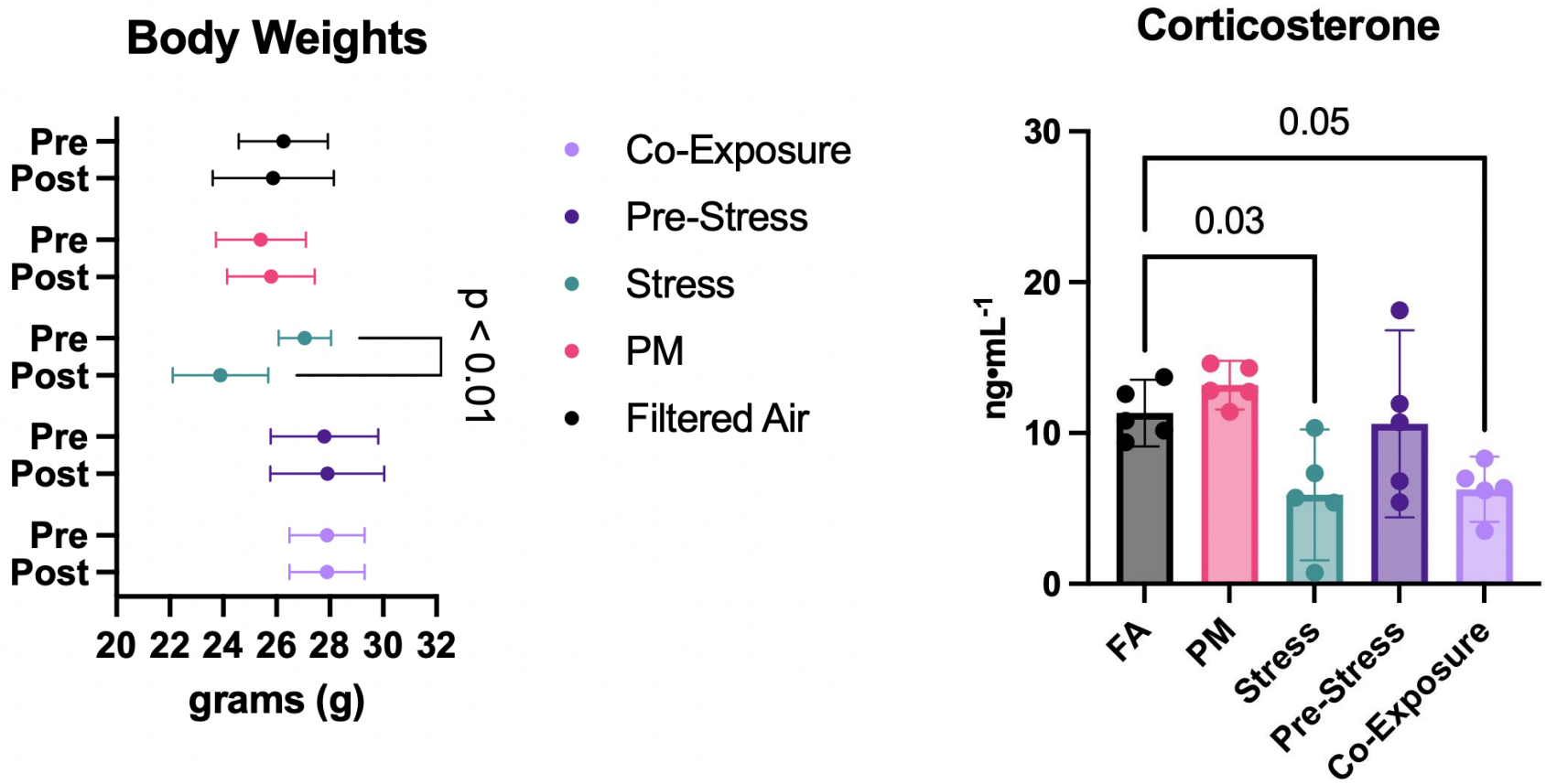
RESULTS

Response to Stress Models: Psychosocial Stress Reduces Bodyweight and Increases Corticosterone Release



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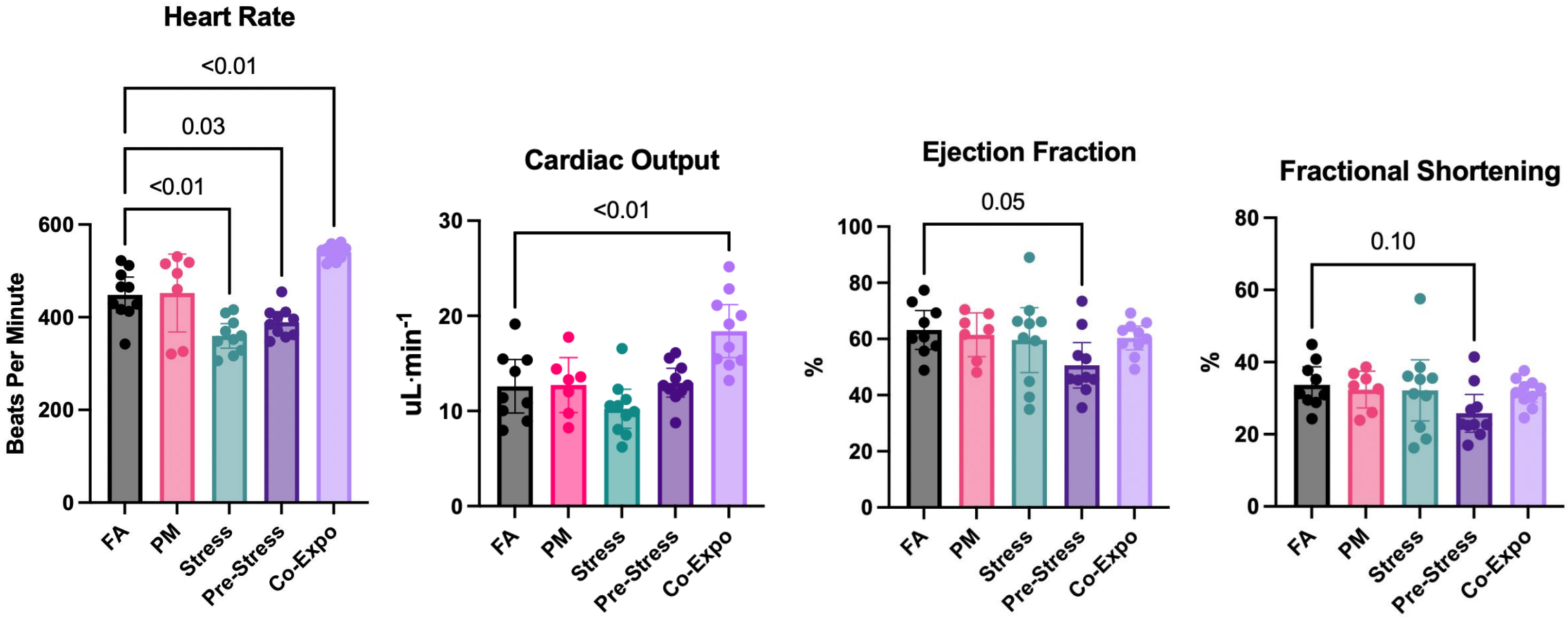
Echocardiography: Psychosocial Stress Reduces Function



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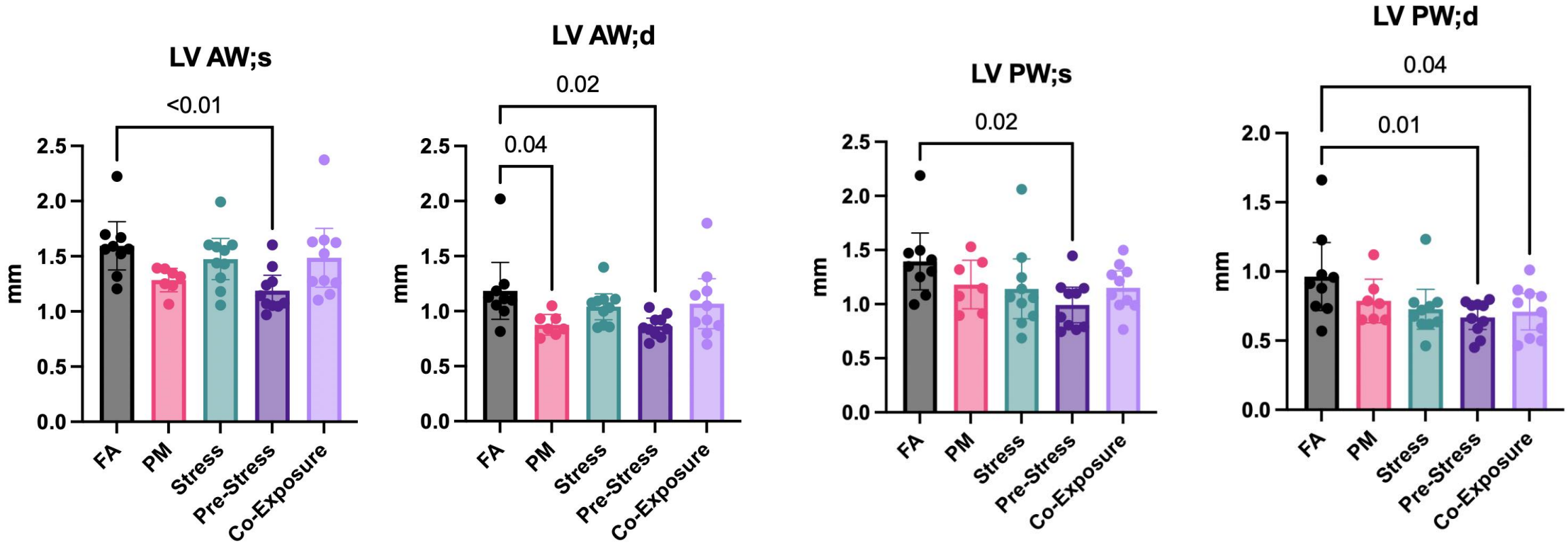

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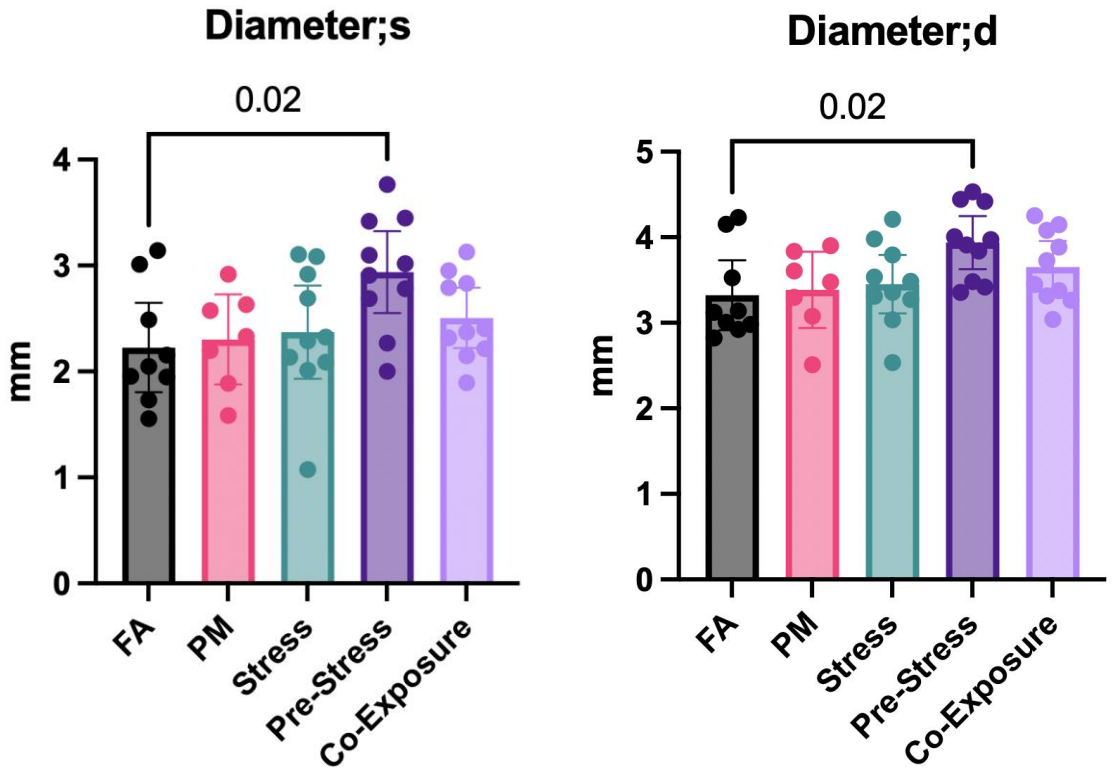

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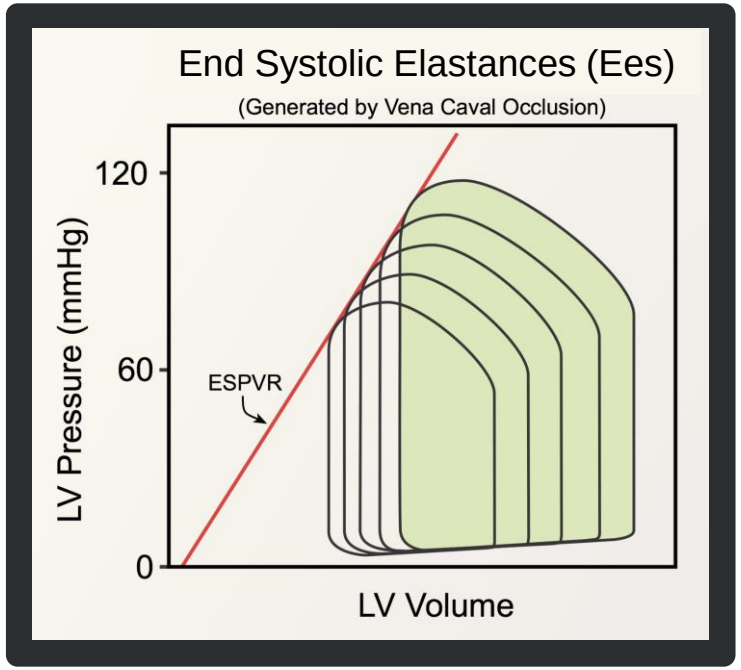
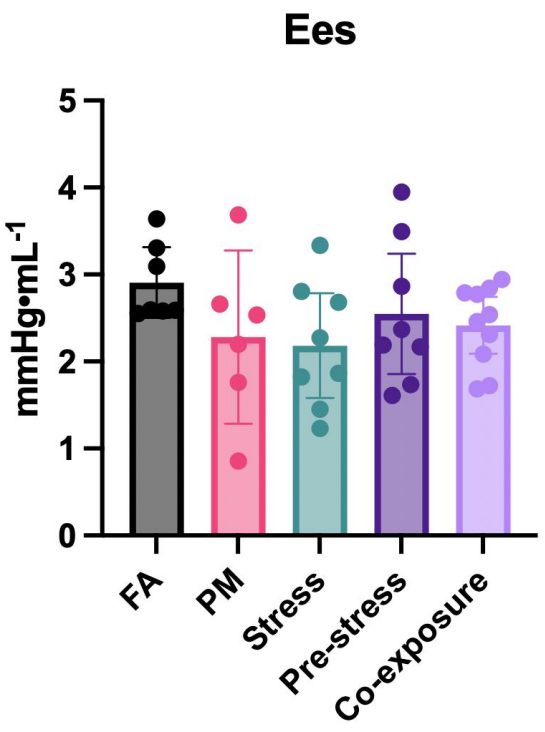
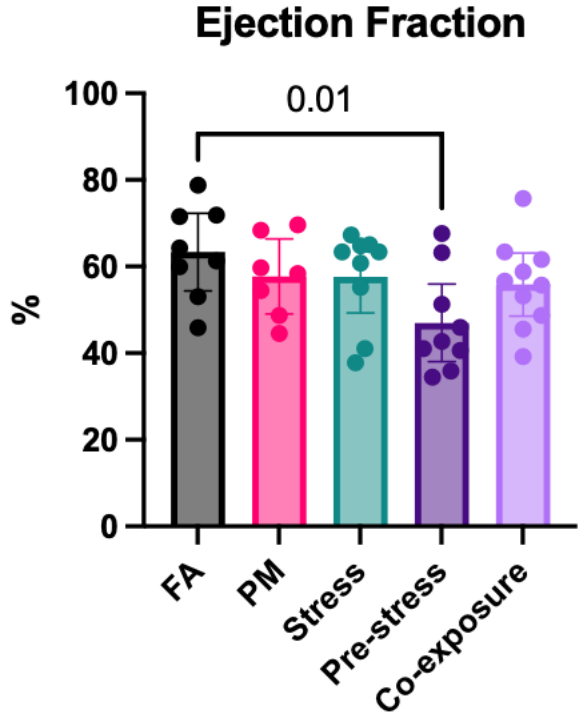
Pressure-Volume Loop: Left Ventricle Intrinsic Contractility Maintained







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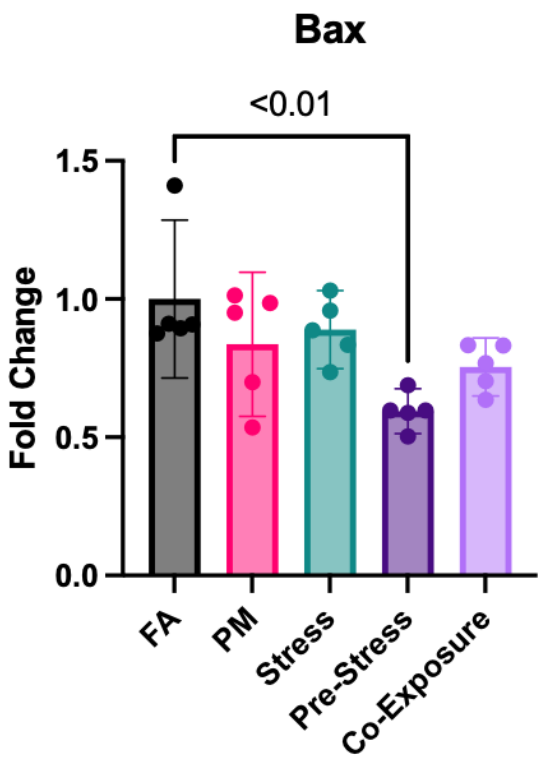
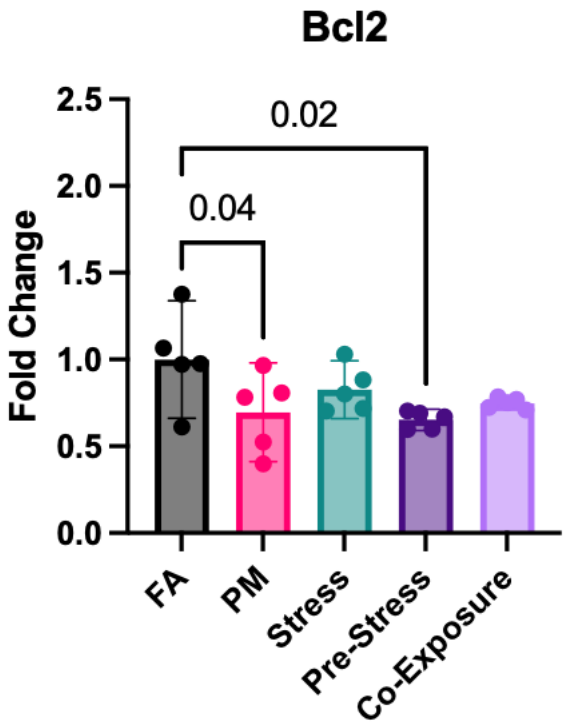
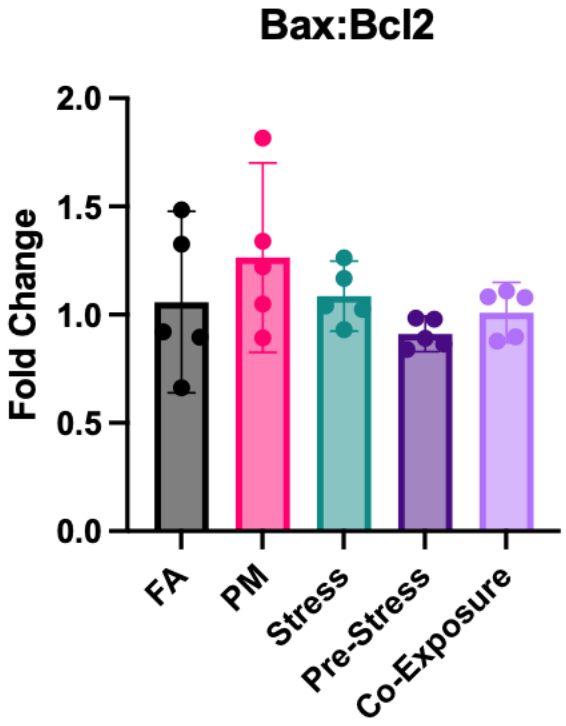
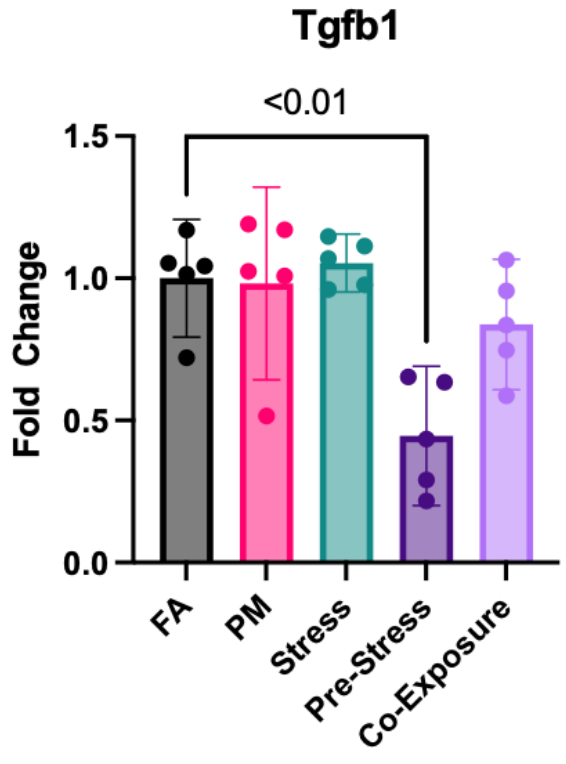
Lung Gene Expression: Psychosocial Stress prior to PM Exposure Suppresses Apoptotic and Fibrotic Signaling









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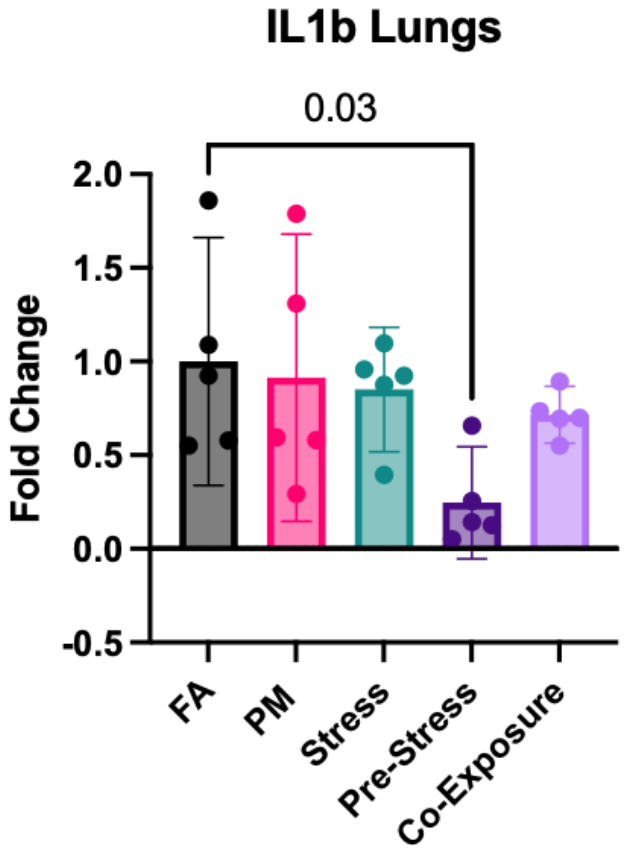

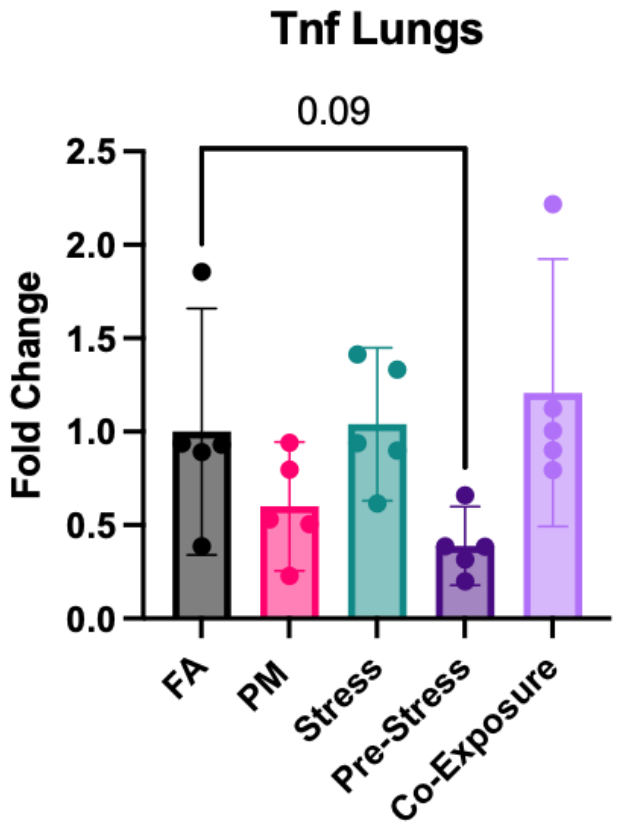

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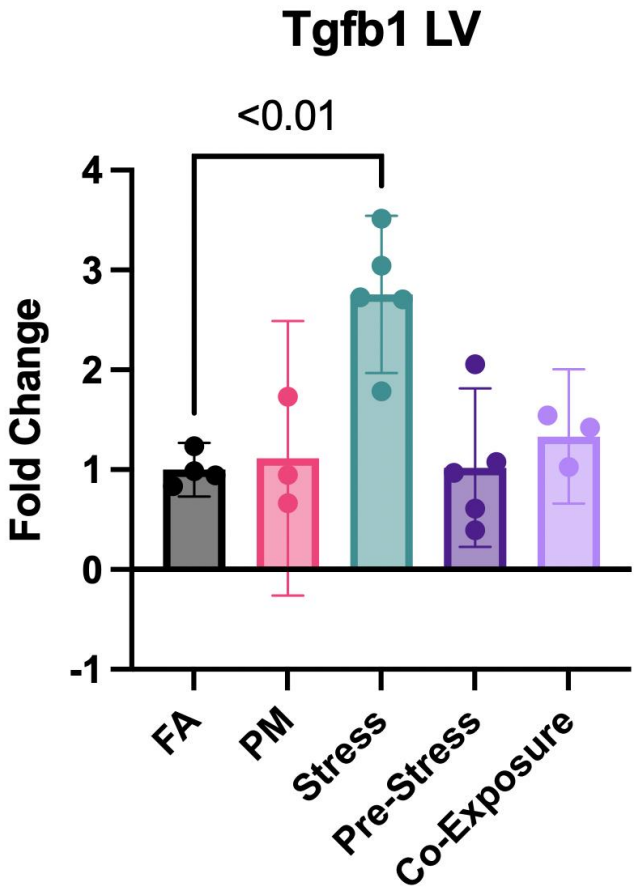
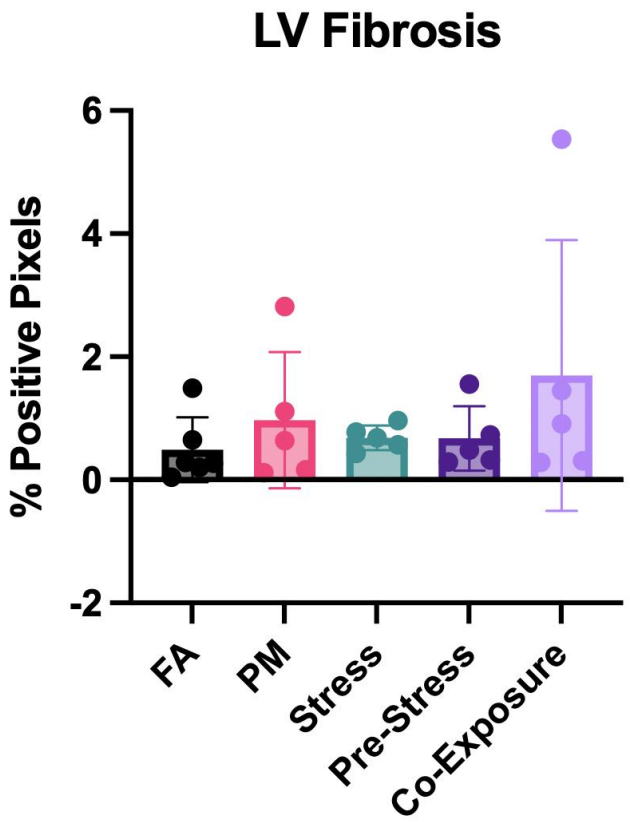
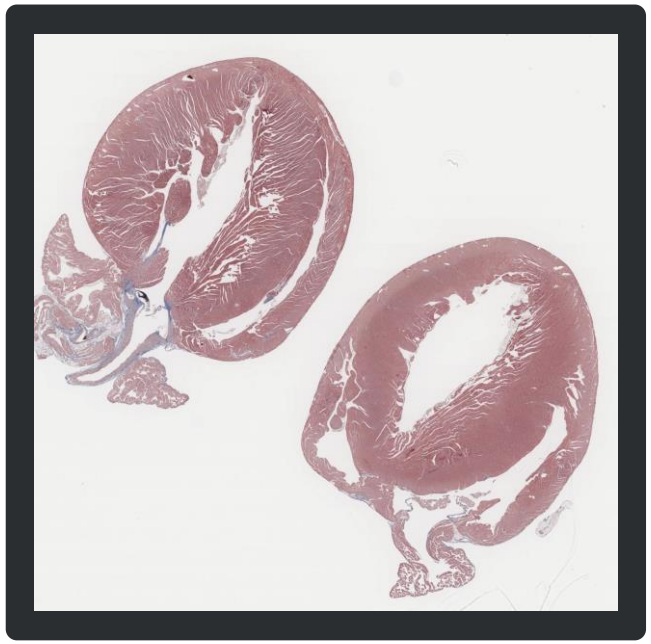
Heart Gene Expression: Psychosocial Stress Enhances Fibrotic Signaling but No Collagen Deposition







Representative Image from Stress Only Group

CONCLUSION

Key Takeaways

- **Psychosocial stress prior to $PM_{2.5}$ exposure**
  - LV structural remodeling (thinner walls, larger internal diameter) & reduced ejection fraction
  - Cardiac output remained preserved
  - No detection of fibrosis – time will tell
- **Consistent with early, compensated cardiac remodeling**

- **Demonstrates that combined, sequential stressors are necessary to capture deployment-relevant cardiovascular effects**, and reinforcing the case for multi-stressor preclinical models

Psychosocial Stress
HPA axis activation
↑cortisol

Particulate Matter (<2.5 µm)
Inflammation
Reactive Oxygen Species
Endothelial Dysfunction

Image generated using Biorender

Bottom line: *capturing the psychosocial dimension of deployment exposure is essential for preclinical models to reflect true warfighter cardiovascular risk.*

A FRAMEWORK FOR MODEL DESIGN

Five Translational Variables

1

Exposure Delivery

Instillation vs. inhalation

2

Material Composition

Dust, ambient PM, or simulated combustion

3

Duration & Proximity

Acute vs. chronic; distance to site

4

Biological Sex

Sex-balanced vs. male-only cohorts

5

Psychosocial Stress

A deployment-relevant co-exposure

Rather than cataloging studies in isolation, this review organizes the literature around how each modeling strategy captures — or omits — these deployment-relevant dimensions.

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Noah O. Citek
Colin A. Doss
Esha Ghadi
Brandon Fowler

Other Contributors:
Dr. Michael J. Falvo
Dr. Matthew W. Gorr

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Thank You

Questions & Discussion Welcome

Correspondence: Brandon M. Gibson • brandon.gibson@osumc.edu
The Ohio State University College of Medicine • 603 Dorothy M. Davis Heart and Lung Research Institute • 473 W. 12th Avenue, Columbus, OH 43210