

Association between perceived stress levels, PTSD symptom severity and gut microbiome among firefighters

Ji Youn Yoo¹, Anujit Sarkar¹, Samia Dutra², Usha Menon³, Maureen Groer¹

¹ College of Nursing, University of Tennessee, Knoxville. ² Nancy Atmospera-Walch School of Nursing, University of Hawaii. ³ College of Nursing, University of South Florida.

Contact: Ji Youn Yoo
University of Tennessee
jyoo14@utk.edu
+1) 813-362-7774

Background

- Firefighting is a high-stress occupation associated with an elevated risk of post-traumatic stress disorder (PTSD), with reported prevalence rates ranging from 6% to 20%^{1,2}.
- Emerging evidence highlights the gut microbiome as a key regulator of mental health through the gut-brain axis^{3,4}.
- This microbial community plays a critical role in both physical and psychological well-being and might be disrupted by traumatic stress, leading to gut dysbiosis, an imbalance in the normal composition of the gut microbiota.
- While interest in the microbiome–mental health connection continues to grow, limited research has explored the relationship between PTSD symptom severity and gut microbiome dysbiosis in high-risk populations such as firefighters.
- Given firefighters' repeated exposure to trauma and their increased risk for developing PTSD, investigating this relationship is essential for guiding microbiome-informed preventive and therapeutic interventions.

Research Questions

1. What are the differences in the prevalence of PTSD and perceived stress levels between firefighters and non-firefighter (control group)?
2. What is the association between perceived stress levels and PTSD symptom severity?
3. How does stress and PTSD symptom severity relate to gut microbiome composition and diversity?

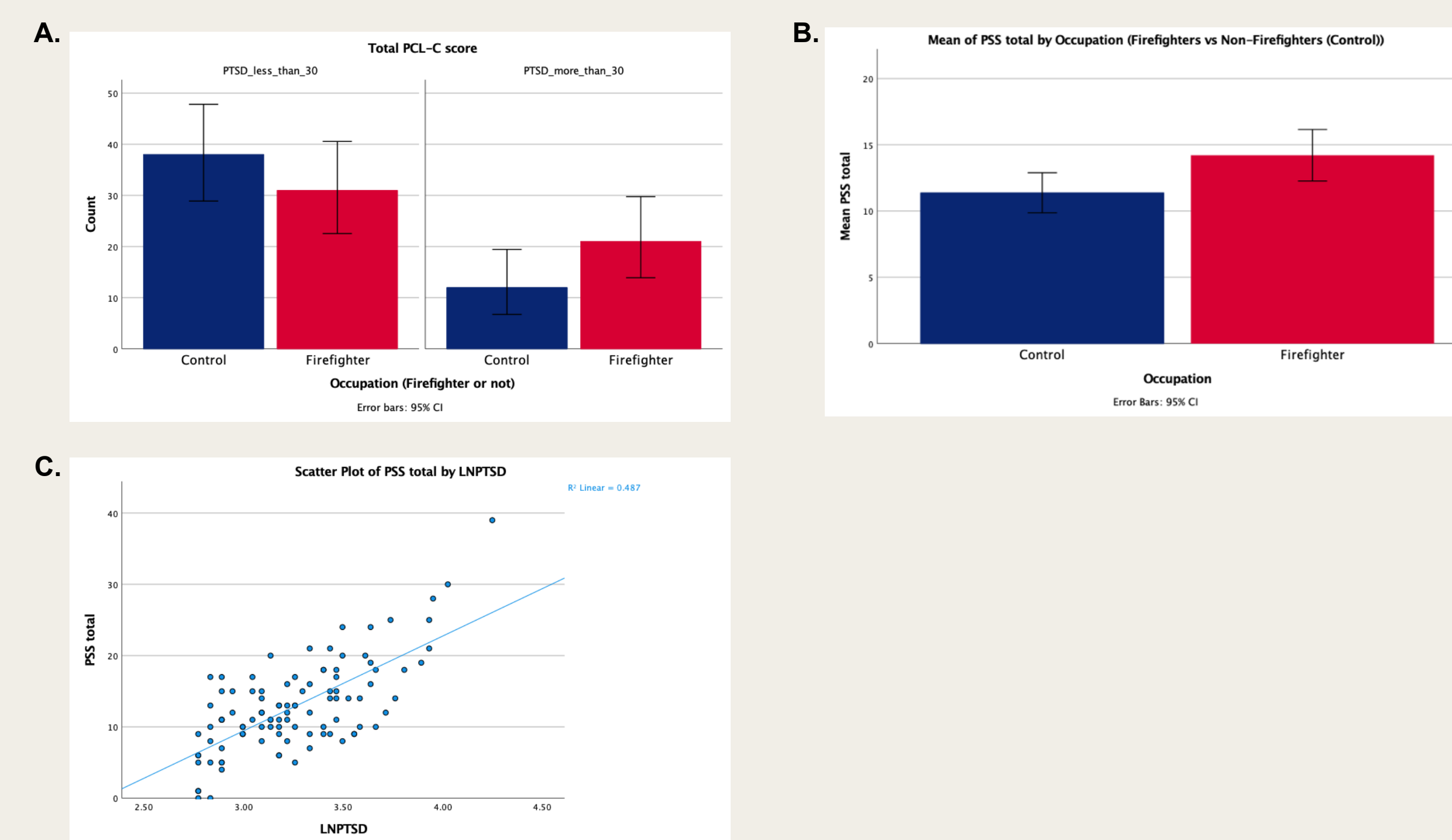
Methods

- We enrolled 102 healthy males (aged 21–50), including 52 firefighters and 50 controls from South Florida and East Tennessee.
- This subgroup was derived from the parent Firefighters Health Promotion Study, which initially recruited 102 American and 101 South Korean participants.
- Participants with medical conditions (e.g. cancer, IBD, DM), current smoking, or recent probiotic use were excluded.
- Gut microbiota profiles were assessed using 16S rRNA gene sequencing.
- PTSD symptoms were measured using the PCL-C (cutoff >30), and perceived stress using the Perceived Stress Scale (cutoff >13).
- The study was approved by the IRBs of the University of South Florida and the University of Tennessee, Knoxville.

Results

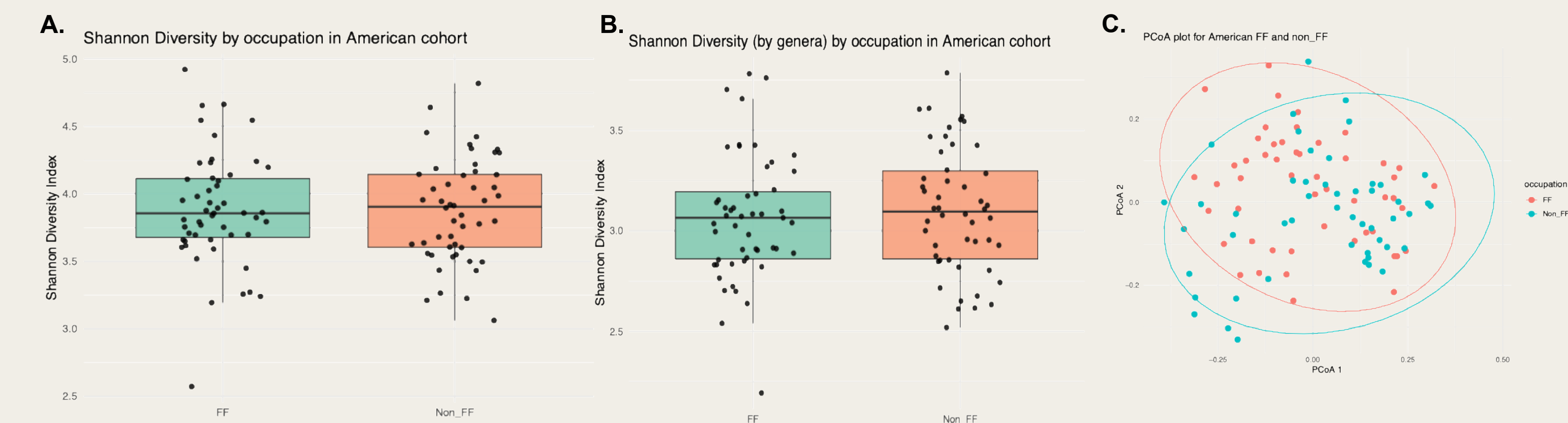
- Firefighters reported twice higher PTSD symptoms ($p = 0.022$) and perceived stress ($p=0.024$) than the control group. (Figure 1. A and B)
- 49% ($n = 25$) of firefighters reported moderate to severe PTSD symptoms.
- Individuals who report higher levels of stress tend to also report higher levels of PTSD-related symptoms ($r = .698$, $p < 0.001$). (Figure 1. C)
- Alpha diversity (ASV levels measured by the Shannon index) did not significantly differ between firefighters and the control group ($p = 0.05$). However, at the genus level, alpha diversity showed a statistically significant difference ($p = 0.048$). (Figure 2. A and B)
- Beta diversity (Bray-Curtis dissimilarity) was significantly different between the two groups ($p = 0.01$), indicating occupational differences in gut microbiome composition. (Figure 2. C)
- No significant differences in gut microbiome alpha or beta diversity were observed between individuals with high vs. low PTSD symptom scores or PSS scores. Despite the lack of global diversity changes, specific microbial taxa were found to be significantly associated with elevated PTSD symptom scores and perceived stress scores.
- Individuals with moderate to high perceived stress scores showed significantly higher abundance of *Ruminococcus torques* (ASV_85) while *Incertae Sedis_sp* (ASV_345) was higher in lower perceived stress scores group.
- Individuals with moderate to high PTSD scores showed significantly higher abundance of *Monoglobus_sp* (ASV_36) and *Oscillospirales* (ASV_404) compared to those with lower PTSD scores.

Figure 1. Prevalence PTSD Symptoms and Perceived Stress Levels (PSS)



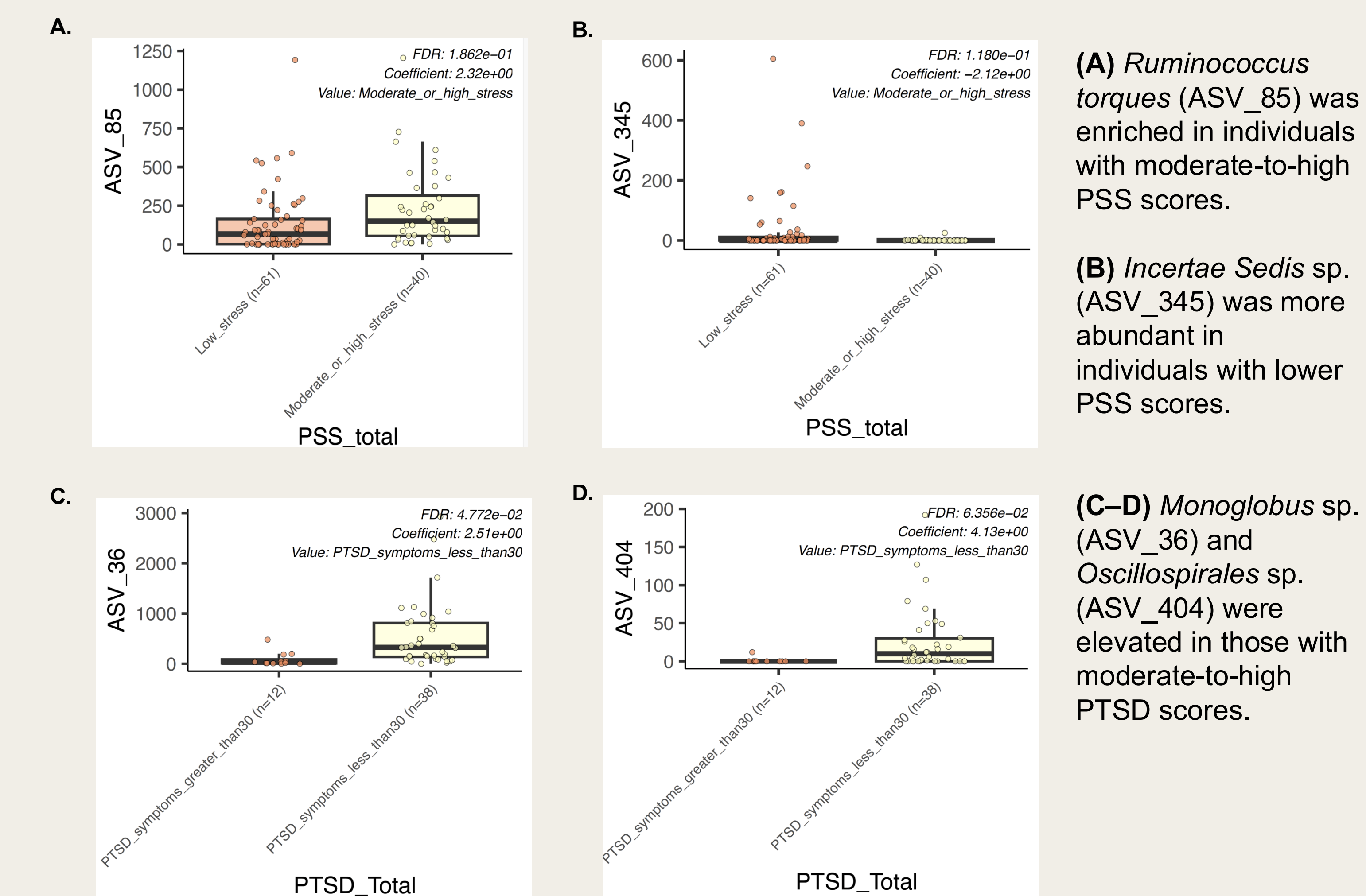
A. Prevalence of moderate to severe PTSD symptoms (PCL-C score >30) **B.** Prevalence of elevated perceived stress (PSS score >13) in the same cohort. **C.** Positive correlation between PTSD symptom severity and perceived stress total scores.

Figure 2. Alpha and Beta Diversities among Firefighters and Non-Firefighters



A. Shannon diversity at the ASV level shows no significant difference between firefighters and controls. **B.** Shannon diversity at the genus level indicates reduced diversity in firefighters. **C.** Principal Component Analysis (PCA) plot of beta diversity reveals distinct clustering of gut microbial composition between groups.

Figure 3. Comparison of gut microbial taxa between individuals with moderate-to-high versus low perceived stress and PTSD scores.



(A) *Ruminococcus torques* (ASV_85) was enriched in individuals with moderate-to-high PSS scores.

(B) *Incertae Sedis* sp. (ASV_345) was more abundant in individuals with lower PSS scores.

(C–D) *Monoglobus* sp. (ASV_36) and *Oscillospirales* sp. (ASV_404) were elevated in those with moderate-to-high PTSD scores.

Conclusions and Limitations

Firefighters exhibited significantly higher PTSD symptoms and perceived stress than controls, with a strong positive correlation between PSS and PTSD. Alpha diversity did not differ, but genus-level and beta diversity analyses revealed distinct gut microbial profiles. Specific taxa were associated with elevated PTSD and stress, suggesting a potential microbial signature of stress. However, the cross-sectional design limits causal interpretation. The all-male, healthy sample restricts generalizability, and unmeasured dietary intake may confound microbiome results.

References:

1. Oliveira, J., Aires Dias, J., Duarte, I. C., Caldeira, S., Marques, A. R., Rodrigues, V., ... & Castelo-Branco, M. (2023). Mental health and post-traumatic stress disorder in firefighters: an integrated analysis from an action research study. *Frontiers in Psychology*, 14, 1259388.
2. Obuobi-Donkor, G., Oluwasina, F., Nkire, N., & Agyapong, V. I. (2022). A scoping review on the prevalence and determinants of post-traumatic stress disorder among military personnel and firefighters: Implications for public policy and practice. *International journal of environmental research and public health*, 19(3), 1565.
3. Yoo, J. Y., Groer, M., Dutra, S. V. O., Sarkar, A., & McSkimming, D. I. (2020). Gut microbiota and immune system interactions. *Microorganisms*, 8(10), 1587.
4. Foster, J. A., Rinaman, L., & Cryan, J. F. (2017). Stress & the gut-brain axis: regulation by the microbiome. *Neurobiology of stress*, 7, 124-136.