

# 🔊 The mediating roles of gut microbiota in the associations of air pollution and meteorological factors with metabolic syndrome.

Yixiang Huang<sup>1, 2, 3#</sup>, Wei Wu<sup>4#</sup>, Yuan Zheng<sup>1, 2, 3</sup>, Hongwei Tu<sup>4</sup>,  
Yiping Duan<sup>1, 3</sup>, Qijiong Zhu<sup>1, 2, 3</sup>, Zhiqing Chen<sup>1, 2, 3</sup>, Siwen Yu<sup>1, 2, 3</sup>,  
Yayi Li<sup>1, 2, 3</sup>, Wan Peng<sup>1, 2, 3</sup>, Wenjun Ma<sup>2\*</sup>, Tao Liu<sup>1, 3\*</sup>

<sup>1</sup>Department of Public Health and Preventive Medicine, School of Medicine,  
Jinan University, Guangzhou, China

<sup>2</sup>China Greater Bay Area Research Center of Environmental Health, School of Medicine,  
Jinan University, Guangzhou, China

<sup>3</sup>Key Laboratory of Viral Pathogenesis & Infection Prevention and Control,  
Jinan University, Ministry of Education, Guangzhou, China

<sup>4</sup>Guangdong Provincial Institute of Public Health, Guangdong Provincial Center  
for Disease Control and Prevention, Guangzhou 511430, China



Yixiang Huang, Wei Wu, Yuan Zheng, Hongwei Tu, Yiping Duan, Qijiong Zhu, Zhiqing Chen, et al. 2026. The mediating roles of gut microbiota in the associations of air pollution and meteorological factors with metabolic syndrome. *iMetaOmics* 3: e70099. <https://doi.org/10.1002/imo2.70099>

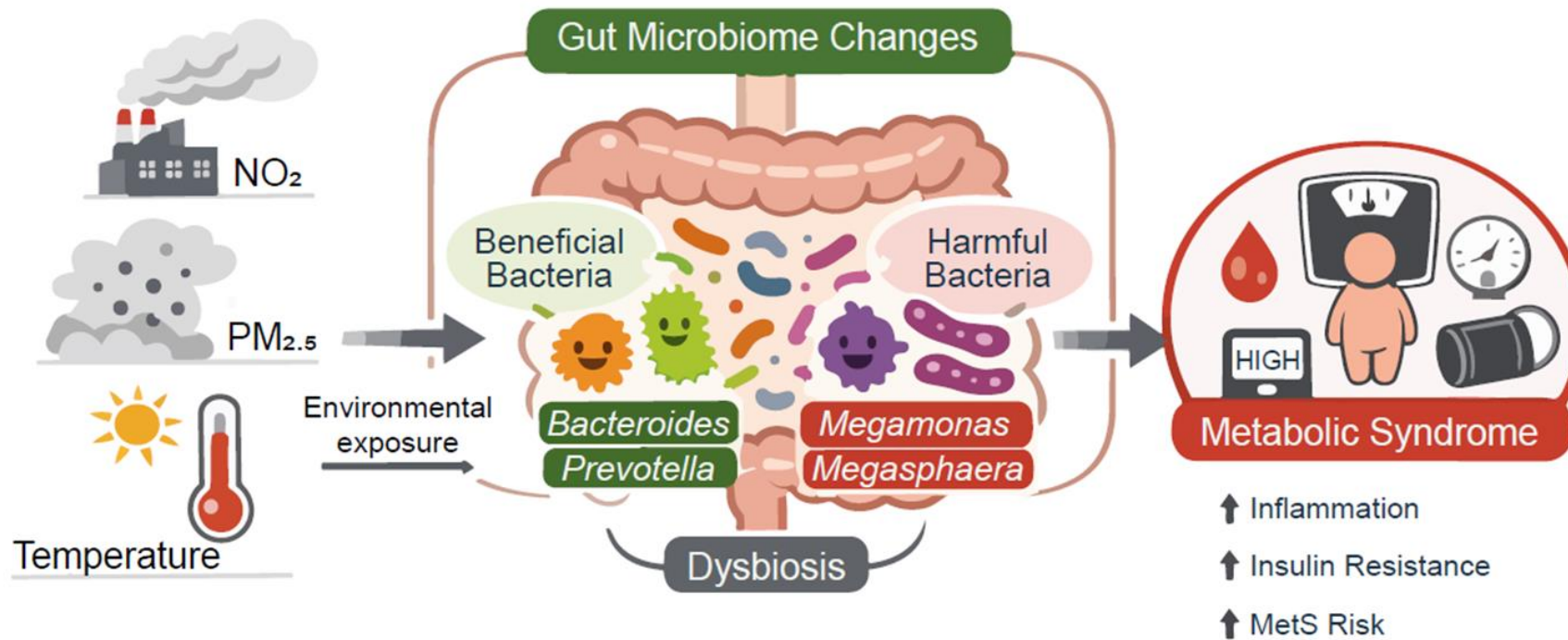


# Introduction

1. Metabolic syndrome (MetS) is a major global public health problem and is associated with increased risks of cardiovascular disease, type 2 diabetes, and all-cause mortality. Increasing evidence suggests that environmental factors, including fine particulate matter (PM<sub>2.5</sub>), nitrogen dioxide (NO<sub>2</sub>), and ambient temperature, may contribute to MetS.
2. The gut microbiota is a key regulator of metabolic homeostasis, environmental factors may disrupt gut microbial composition and function, thereby promoting inflammation and metabolic disturbances related to MetS. However, it remains unclear whether environmentally induced alterations in the gut microbiota contribute to the development of MetS.
3. This study aimed to examine the associations of long-term exposure to PM<sub>2.5</sub>, NO<sub>2</sub>, and ambient temperature with MetS, and performed exploratory mediation analyses to assess potential indirect associations through the gut microbiota.



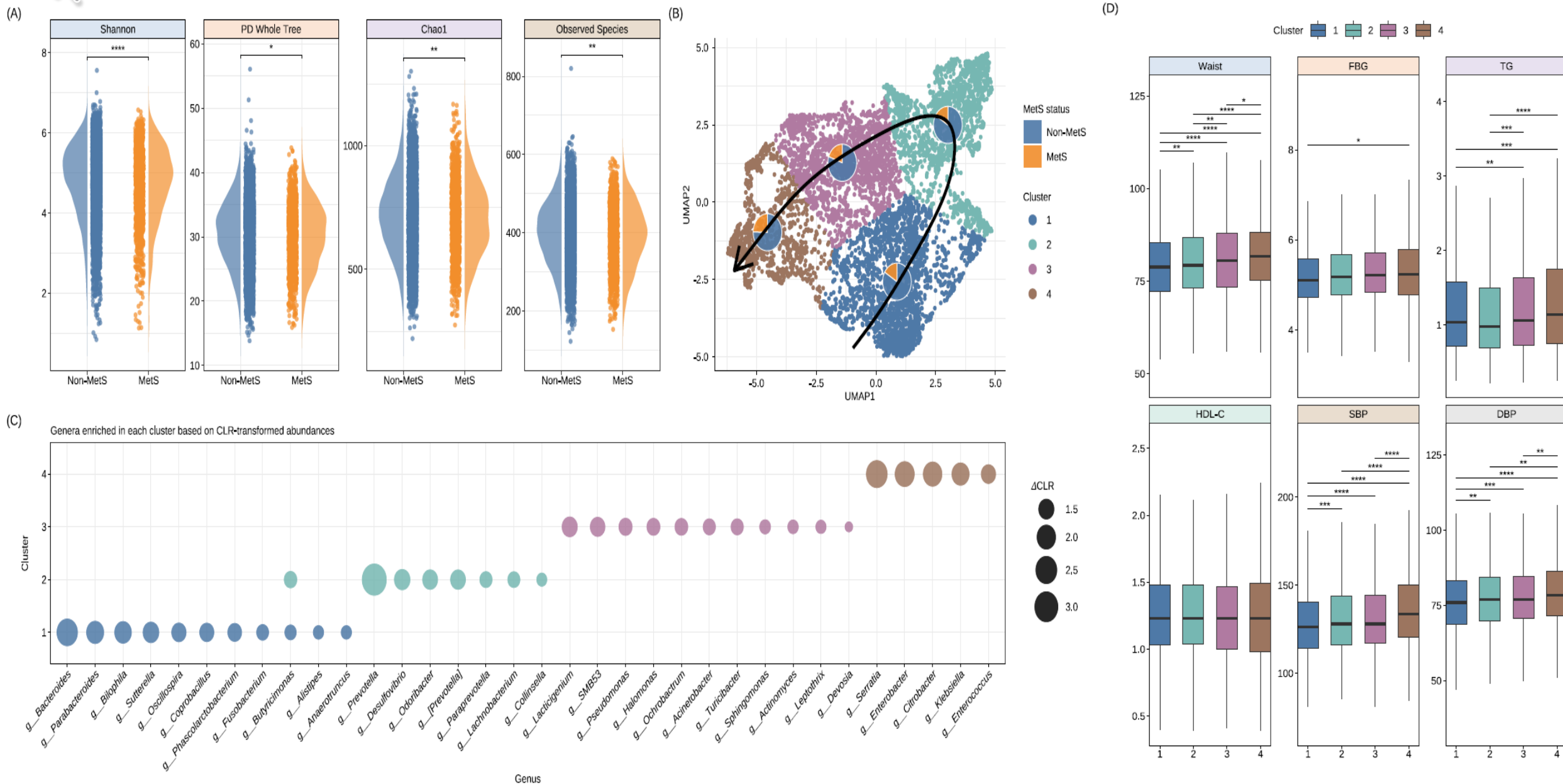
# Highlights



- Based on gut microbial composition, participants were classified into four distinct community clusters. Cluster 1 was characterized by the enrichment of *Bacteroides*, whereas cluster 2 was characterized by the enrichment of *Prevotella*. Participants in these two clusters showed lower waist circumference, fasting blood glucose, triglycerides, and blood pressure levels, as well as higher high-density lipoprotein cholesterol levels.
- Long-term exposure to higher levels of  $\text{NO}_2$  and  $\text{PM}_{2.5}$ , as well as lower ambient temperature, was associated with an increased risk of MetS.
- Specific gut microbial genera, particularly *Megamonas* and *Megasphaera*, may play mediating roles in the associations of  $\text{NO}_2$ ,  $\text{PM}_{2.5}$ , and ambient temperature with MetS risk.



# Gut microbial diversity and community structure differ by MetS status



**Figure 1. Gut microbial diversity, community structure, key genera, and clinical phenotypes in relation to MetS.**



# Microbial co-variation patterns in relation to MetS

(E)

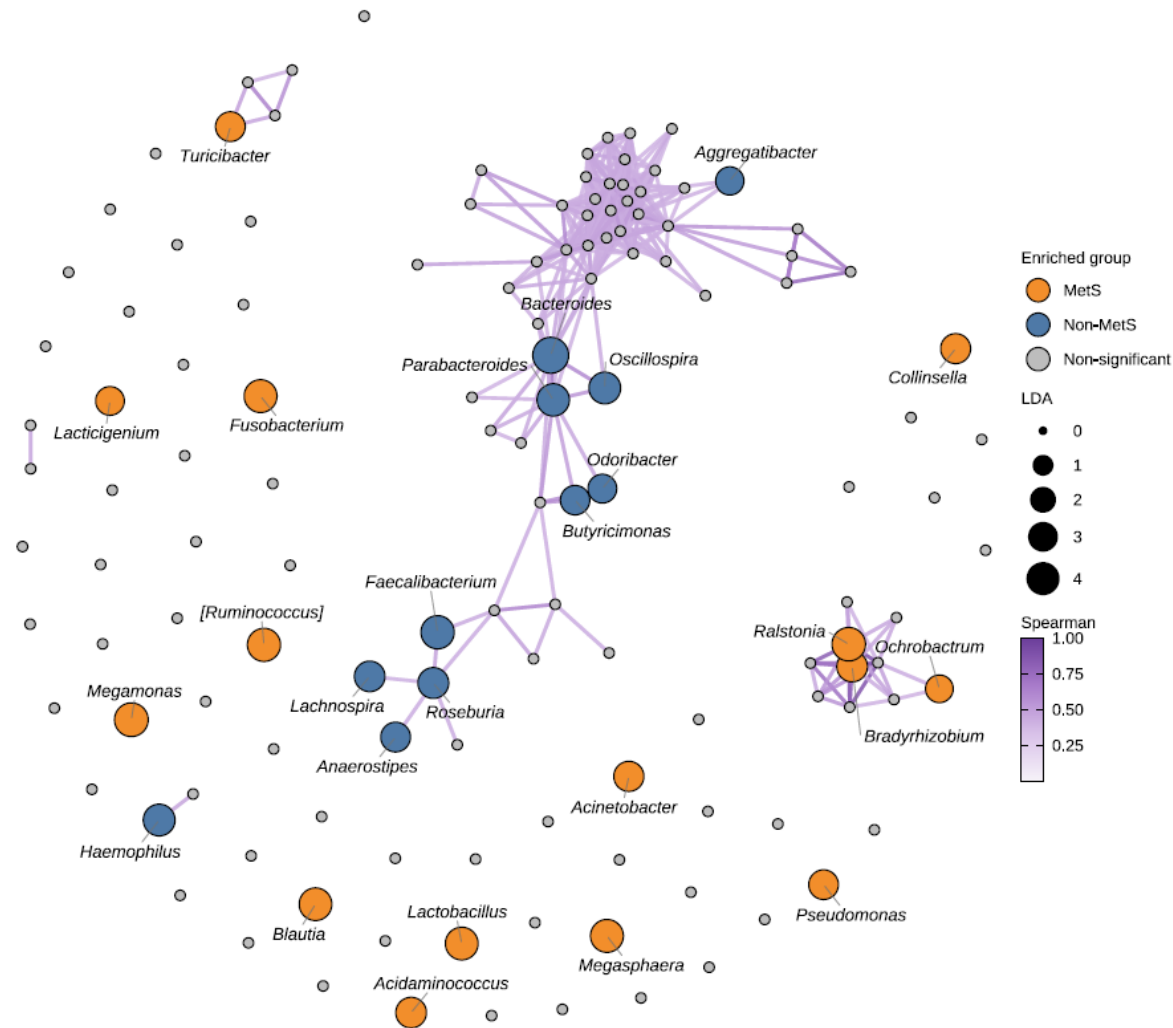


Figure 1. Gut microbial diversity, community structure, key genera, and clinical phenotypes in relation to MetS.



# Environmental exposures are important correlates of gut microbiota composition

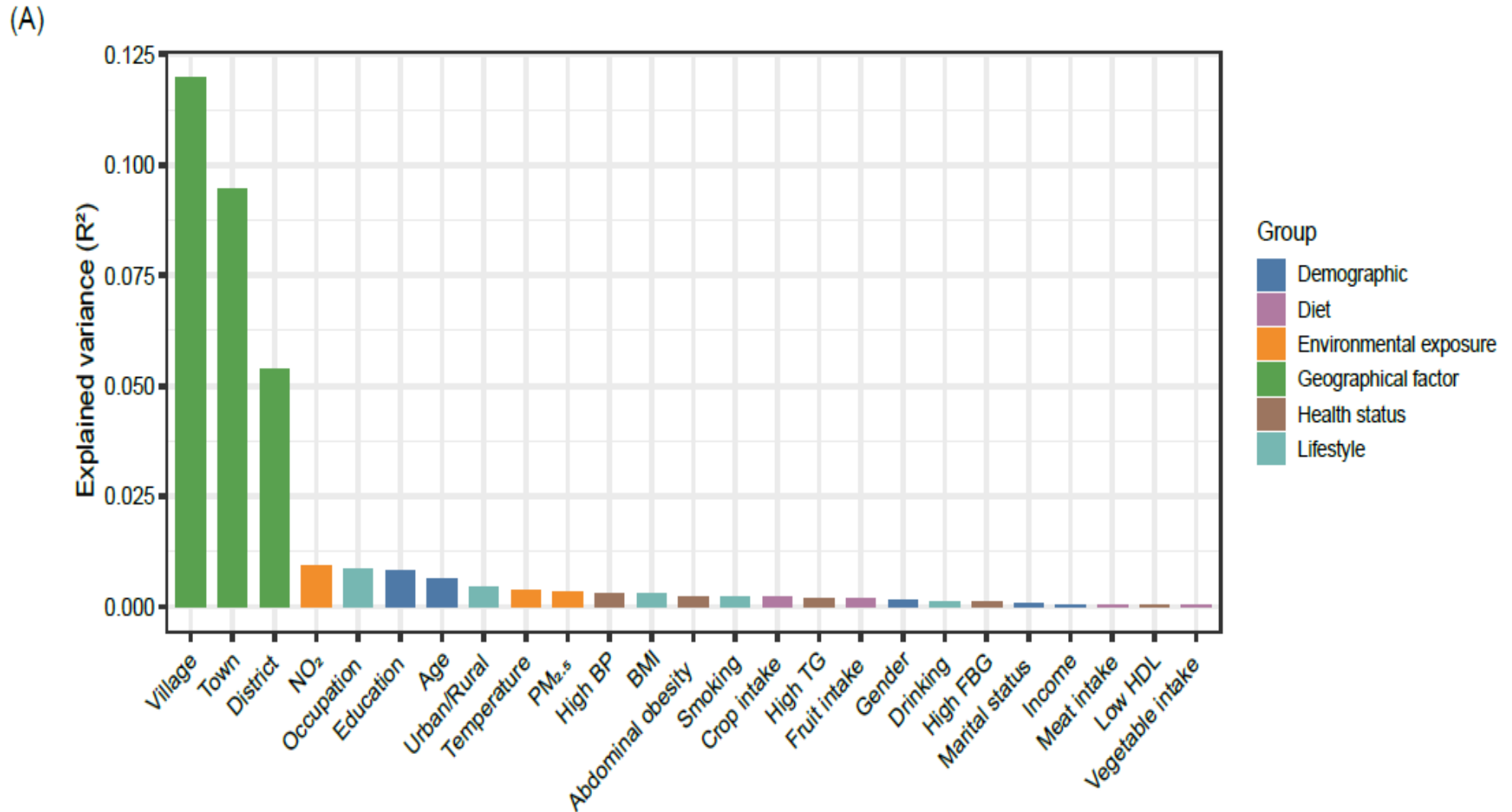


Figure 2. Environmental drivers of gut microbiota and their associations with metabolic syndrome through mediation by key gut microbial genera.



# Mediating roles of gut microbiota in the associations between environmental factors and MetS

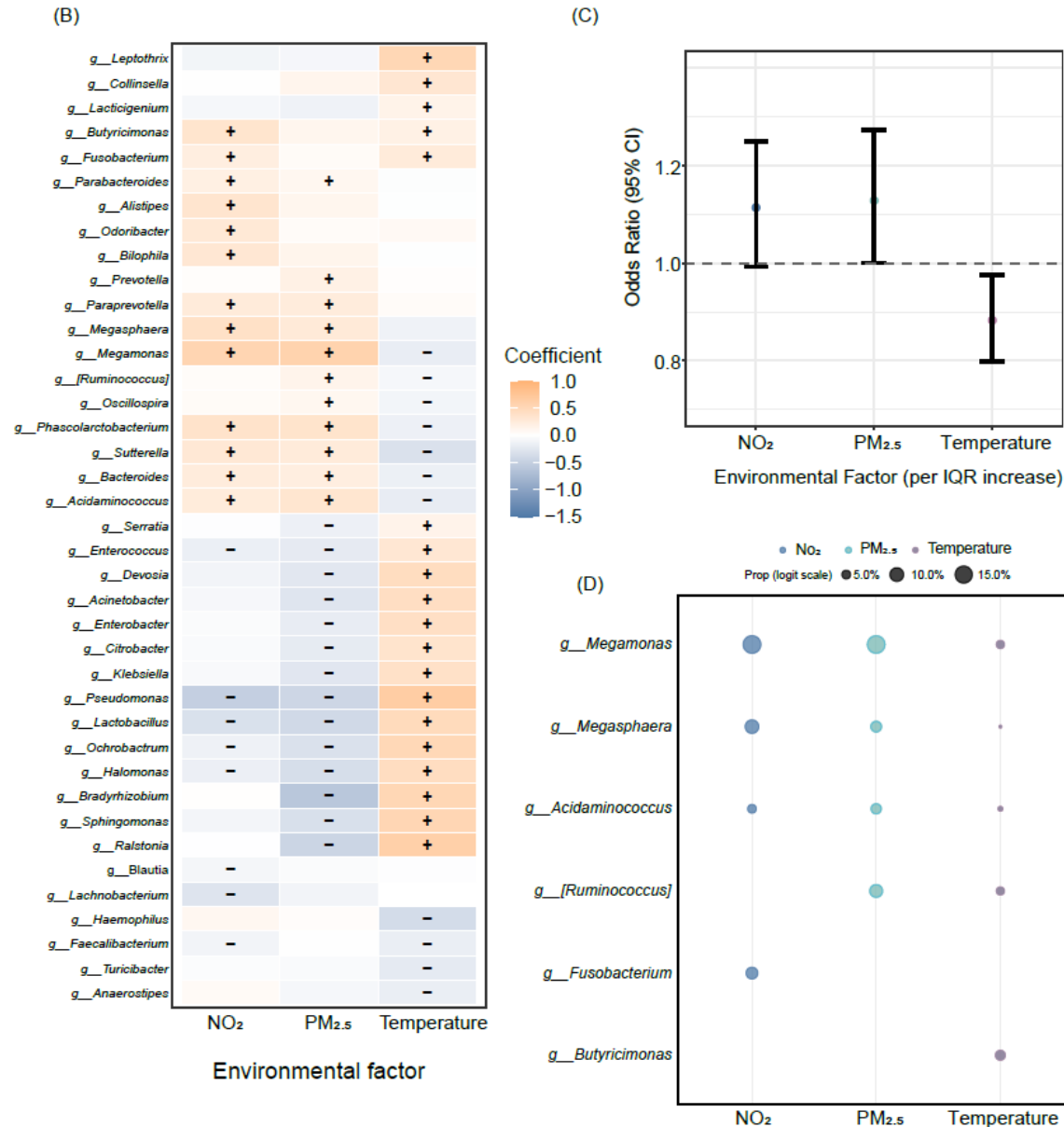


Figure 2. Environmental drivers of gut microbiota and their associations with metabolic syndrome through mediation by key gut microbial genera.



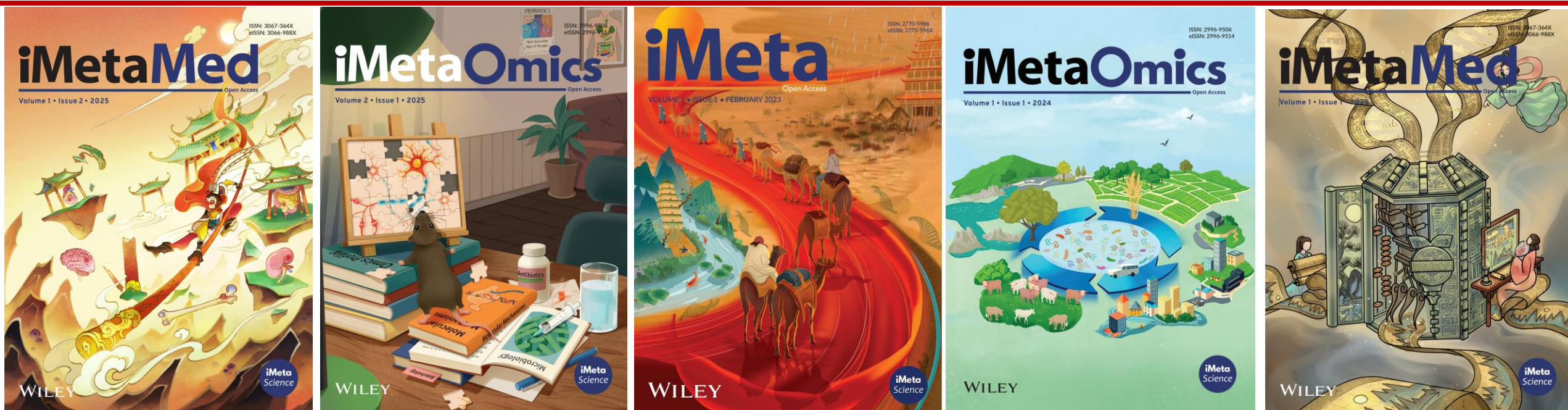
# Summary

- ❑ MetS was associated with lower gut microbial  $\alpha$ -diversity, distinct community clusters, and differences in key genera, including enrichment of several potentially pathogenic genera.
- ❑ Higher long-term exposure to NO<sub>2</sub> and PM<sub>2.5</sub> and lower ambient temperature was associated with increased MetS risk.
- ❑ Several genera, including Megamonas, Megasphaera, Acidaminococcus, and Ruminococcus, may play Mediating roles in linking environmental factors to MetS risk, highlighting the gut microbiota as a possible biological pathway.

Yixiang Huang, Wei Wu, Yuan Zheng, Hongwei Tu, Yiping Duan, Qijiong Zhu, Zhiqing Chen, et al. 2026. The mediating roles of gut microbiota in the associations of air pollution and meteorological factors with metabolic syndrome. *iMetaOmics* 3: e70099. <https://doi.org/10.1002/imo2.70099>

# iMeta: To be top journals in biology and medicine

# WILEY



“**iMeta**” launched in 2022 by iMeta Science Society, **impact factor (IF) 33.2**, ranking **top 65/22249 in world and 2/161 in the microbiology**. It aims to publish innovative and high-quality papers with broad and diverse audiences. **Its scope is similar to Cell, Nature Biotechnology/Methods/Microbiology/Medicine/Food**. Its unique features include video abstract, bilingual publication, and social media with 600,000 followers. Indexed by **SCIE/ESI, PubMed, Google Scholar** etc.

“**iMetaOmics**” launched in 2024, with a **target IF>10**, and its scope is similar to **Nature Communications, Cell Reports, Microbiome, ISME J, Nucleic Acids Research, Briefings in Bioinformatics**, etc.

“**iMetaMed**” launched in 2025, with a **target IF>15**, similar to **Med, Cell Reports Medicine, eBioMedicine, eClinicalMedicine** etc.



Society: <http://www.imeta.science>

Publisher: <https://wileyonlinelibrary.com/journal/imeta>

iMeta: <https://wiley.atyponrex.com/journal/IMT2>

Submission: iMetaOmics: <https://wiley.atyponrex.com/journal/IMO2>

iMetaMed: <https://wiley.atyponrex.com/journal/IMM3>



[iMetaScience](#)



[iMetaScience](#)



[office@imeta.science](mailto:office@imeta.science)  
[imetaomics@imeta.science](mailto:imetaomics@imeta.science)



[Promotion Video](#)

Update  
2025/7/6