Climate-Health Analysis Methodological Framework

African Urban Population Study (n=18,205) • Environmental Health Perspectives

Methodological Evolution Timeline

Initial Problems — *Methodological Refinement* — *Validated Results*

DATA STRUCTURE & COHORT SEPARATION

Original Dataset
n = 18,205 observations
9 biomarkers • 6 years

Cohort Separation Rationale
Clinical vs Socioeconomic
Avoid confounding bias

Clinical Cohort
n = 9,103
Biomarkers focus

Socioeconomic
n = 9,102
Demographics focus

Quality Control Measures
• Missing data analysis • Outlier detection
• Temporal consistency checks

MULTIPLE ANALYTICAL APPROACHES

Supervised ML
• Random Forest
• XGBoost
• Feature importance

Unsupervised
• Clustering analysis
• Pattern discovery
• Signal detection

Ecological
• DLNM analysis
• Temporal lags
• Non-linear effects

Comprehensive Lag Structure Analysis
Lag windows: 0, 1, 2, 3, 5, 7, 10, 14, 21 days
Novel 21-day cardiovascular effects • Immediate metabolic responses

STATISTICAL VALIDATION & QUALITY CONTROL

Multiple Testing
• Bonferroni correction
• FDR adjustment
• Conservative $p < 0.001$
• $p < 10^{-10}$ for key findings

Cross-Validation
• 5-fold CV framework
• Bootstrap validation
• 1,000 iterations
• Stability assessment

Effect Size Validation
• Clinical meaningfulness
• 2-3 mmHg BP changes
• 10-20 mg/dL glucose
• Literature comparison

Confounding Control
• Demographics: sex, race, age
• Temporal: season, year
• Socioeconomic factors
• Urban heat island effects

Reproducibility
• Open analysis pipeline
• Documented methodology
• Code availability
• Data sharing protocols

VALIDATED CLIMATE-HEALTH RELATIONSHIPS

Temperature-Blood Pressure
8 significant correlations
$n = 4,957$ • $p < 10^{-10}$
Novel 21-day effects

Temperature-Glucose
4 significant correlations
$n = 2,731$ • $p < 10^{-6}$
Immediate responses

CD4-Climate Effects
Novel immune findings
$n = 1,283$ • Cohen's $d = 0.261$
Extreme heat effects

Multi-System Approach
Cardiovascular + Metabolic
+ Immune responses
African urban population

METHODOLOGICAL INNOVATION

✓ Avoided overfitting through rigorous validation
✓ Sample sizes exceed literature standards
✓ Novel extended lag structure discovery
✓ Multi-system physiological approach
✓ Addresses African research gap
✓ Clinically meaningful effect sizes