

Supplementary Material 1. Supplementary methods and results

S1. Sensitivity analysis excluding the second follow-up visit

To evaluate the robustness of the time-varying temperature–blood pressure associations and address concerns that the findings might be driven by a single influential follow-up visit, we conducted sensitivity analyses excluding the second follow-up visit (index = 2). This visit exhibited the largest visit-specific coefficient in the primary generalized estimating equation (GEE) models.

All GEE models were re-estimated using the same analytical specifications as in the primary analysis, including identical covariate adjustment, interaction terms, and working correlation structure. Only observations corresponding to the second follow-up visit were excluded; all participants remained in the analysis through their remaining visits.

Excluding the second follow-up visit did not materially alter the global time effects or the overall pattern of temperature–time interactions for either systolic blood pressure (SBP) or diastolic blood pressure (DBP). The direction and temporal heterogeneity of the temperature–blood pressure associations were preserved, indicating that the main findings were not driven by a single influential visit.

S2. Evaluation of working correlation structures

Because the choice of working correlation structure can influence efficiency in GEE models with repeated measures, we formally compared alternative correlation structures to justify the selection of an unstructured matrix in the primary analyses. Four commonly used working correlation structures were evaluated for both SBP and DBP outcomes: independent, exchangeable, first-order autoregressive [AR(1)], and unstructured.

Model fit was assessed using the quasi likelihood under the independence model criterion (QIC) and its small-sample correction (QICC), with lower values indicating better fit. All models were otherwise identical in terms of covariates, interaction terms, and estimation settings.

S3. Model stability, convergence, and influence assessment

All GEE models converged successfully without numerical warnings. Robust (sandwich) variance estimators were applied to account for potential misspecification of the working correlation structure. Coefficient estimates and standard errors were stable across alternative correlation structures and sensitivity analyses.

The sensitivity analysis excluding the second follow-up visit further supports model stability and suggests that the observed time-varying temperature–blood pressure associations were not driven by a single influential visit or outlying observation. No additional evidence of undue influence from individual participants or visits was identified.

Supplementary Results

S4. Full GEE model estimates

S5. Net temperature effects across follow-up visits

To facilitate interpretation of the time-varying associations between ambient temperature and blood pressure, net temperature effects at each follow-up visit were derived as the sum of the main temperature coefficient and the corresponding visit-specific interaction term. These net effects represent the overall association between temperature and blood pressure at each visit.

The net temperature effects demonstrated substantial temporal heterogeneity for both SBP and DBP, with inverse associations observed at several follow-up visits. This pattern is consistent with the marginal effects plots and the global Wald tests presented in the main Results section and highlights the dynamic nature of temperature–blood pressure relationships over time rather than a single monotonic effect.

Supplementary Summary

Together, these supplementary analyses confirm that the primary findings of the study are robust to alternative modeling assumptions and sensitivity checks. The observed time-varying associations between ambient temperature and blood pressure persist after excluding a potentially influential follow-up visit and are not sensitive to the choice of working correlation structure. These results strengthen confidence in the validity and interpretability of the main analyses presented in the manuscript.