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Thermal indicators and headache-related hospitalizations in São Paulo: an ecological time-series analysis (2016–2025)

João Pedro Mesquita Gumes Vieira[1], Sofia Chapermann Araújo[1], Fabrício Pitanga Teles[1], Iago da Silva Costa Almeida[1], João Bruno Pereira Leite[1], Myllena Maria Santos Santana[1], Thais Cristina de Souza Melo[2]

[1]Federal University of Sergipe, Aracaju, Sergipe, Brazil
[2]Surgical Hospital, Aracaju, Sergipe, Brazil

João Pedro Mesquita Gumes Vieira
jpmgvieira2006@gmail.com

Introduction
The literature suggests that meteorological variables may act as triggers for primary headache attacks. However, the impact of these factors on population-level hospital utilization indicators remains uncertain, particularly in large urban centers, where healthcare, behavioral, and systemic factors can influence the decision to seek medical care.

Objective
To analyze the association between the monthly mean temperature and the monthly mean daily temperature range with the number of hospitalizations for migraine and other headaches in the city of São Paulo between 2016 and 2025, evaluating possible seasonal patterns and their impact on hospital burden.

Methods
This is an ecological time-series study using data from the Brazilian Public Health System's Hospital Information System (SIH/DATASUS). Hospitalizations classified as "Migraine and other headache syndromes" (ICD-10: G43 and G44) in the city of São Paulo were included, using monthly data from January 2016 to December 2025. Meteorological data were obtained from the Meteorological Database for Teaching and Research (BDMEP/INMET), using station A701 as the reference. The monthly mean temperature and the monthly mean daily temperature range were analyzed. Spearman's correlation test was used to assess the association between thermal variables and the number of hospitalizations, and the Kruskal-Wallis test was applied to investigate seasonal variability. A subgroup analysis was performed excluding the years 2020 and 2021 to minimize potential interference from the COVID-19 pandemic. A significance level of 5% was adopted.

Results
A total of 3,927 hospitalizations were recorded during the analyzed period, amounting to 3,318 after excluding the pandemic biennium. In the adjusted historical series, there was no statistically significant correlation between the monthly mean temperature and the number of hospitalizations (=0.088; p=0.390), nor between the temperature range and hospitalizations (=-0.084; p=0.417). There was also no significant monthly seasonality in the distribution of hospitalizations (p=0.548), indicating a relatively homogeneous behavior throughout the year. Conversely, significant interannual variability in the number of hospitalizations was identified (p<0.001), suggesting the influence of temporal factors not directly related to local thermal dynamics.

Conclusion
Despite previous evidence linking elevated ambient temperatures to an increase in headache-related medical visits, the analyzed thermal indicators did not prove to be robust predictors of headache hospitalizations in the city of São Paulo. Potential acute meteorological associations may have been attenuated by the monthly aggregation of data. Furthermore, hospital admissions represent only the most severe fraction of headache episodes, which may also reflect healthcare, behavioral, and systemic factors associated with seeking medical attention in large urban centers.

Keywords:
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