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Temporal patterns of air pollution and hospitalizations for migraine and other headache syndromes in the metropolitan region of São Paulo (2021–2024)

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Introduction
Atmospheric pollution in the Metropolitan Region of São Paulo, particularly fine particulate matter (PM2.5), has been suggested as a potential trigger for migraine episodes. These particles are hypothesized to promote neuroinflammation and the activation of the trigeminovascular system, potentially contributing to acute headache episodes.

Objective
To describe temporal patterns between PM2.5 levels and the number of hospital admissions for migraines and other headache syndromes (ICD-10 G43 and G44) in the Metropolitan Region of São Paulo from 2021 to 2024.

Methods
A descriptive ecological study was conducted using annual hospitalization counts from the SUS Hospital Information System (SIH/SUS/DATASUS) and air quality reports from the Environmental Company of the State of São Paulo (CETESB) and IQAir indicators. Atmospheric data prioritized concentrations of PM2.5. As a descriptive analysis, causal inference cannot be established.

Results
A total of 1,760 hospitalizations for migraines and headache syndromes were recorded in the analyzed period. The annual distribution of cases in the capital was: 318 (2021), 384 (2022), 367 (2023), and 383 (2024). Air quality indicators fluctuated, with PM2.5 annual averages of 16 µg/m³ (2021), 14 µg/m³ (2022), 15 µg/m³ (2023), and 18 µg/m³ (2024). The number of days exceeding daily standards was 9, 9, 5, and 34, respectively. According to IQAir, São Paulo exceeded WHO guidelines by 2 to 3 times in 2021 (index 14.8), 2022 (13.5), and 2023 (14.3), while the 2024 index (15.9) reached the 3-to-5-times threshold. Admissions remained elevated in years with high hospitalization burden, while the lowest volume occurred in 2021 during pandemic-related mobility restrictions.

Conclusion
These findings demonstrate a temporal coexistence between elevated PM2.5 levels and high hospitalization rates for migraine and headache syndromes in the Metropolitan Region of São Paulo. The results suggest a possible association and indicate the need for future analytical studies to further investigate these environmental determinants.

Keywords:
Migraine disorders
Air pollution
Particulate matter
Ecological studies

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