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Review

# Hospitalizations by headache disorders in Brazil: temporal trends, age and sex disparities (2010-2023)

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**Abstract**

**Introduction**
In 2019, migraine affected an estimated 1.1 billion people worldwide. Despite its prevalence, epidemiological trends and demographic disparities in Brazil remain unclear, particularly regarding hospitalizations for migraine and other headache syndromes (MAOHS).

**Objectives**
To analyze temporal trends in hospitalization rates for MAOHS across different age groups and sexes in Brazil from 2010 to 2023.

**Methods**
This ecological time-series study (2010-2023) utilized data from the Hospital Information System (ICD-10: G43 and G44) and the Brazilian Institute of Geography and Statistics (IBGE). Hospitalization rates were calculated per 100,000 inhabitants and analyzed across five age groups and by sex. Python was used for statistical analysis.

**Results**
During the study period, 120,306 hospitalizations due to MAOHS were recorded. A significant increasing trend was found in total hospitalizations (APC=5%; CI: 2.9–7.2). All age groups showed rising trends ($p<0.01$), notably the advanced elderly (APC=7.4%; CI: 5.2–9.7). All groups satisfied the normality assumption. ANOVA indicated differences among age groups ($p<0.001$); Tukey's post-hoc showed children had significantly lower rates ($p<0.001$). Both sexes showed a similar APC (~5%) in hospitalization rates. Normality and homogeneity of variances was confirmed. The Student's t-test revealed a significant difference between sexes ($p<0.001$; $t=6.22$), with females exhibiting a higher mean hospitalization rate than males (mean difference=2.45).

**Conclusion**
MAOHS hospitalizations are increasing in Brazil, especially among elderly and female populations, highlighting the need for targeted healthcare strategies.

**Keywords:**
Primary headaches,
Migraine,
Epidemiology

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## Introduction

Headaches are among the main reasons for seeking neurologists and one of the most frequently reported symptoms to primary care physicians, characterized by pain in the head region that varies in intensity, duration, and associated manifestations (1). They can be classified into two major groups: primary headaches, which do not have an identifiable structural cause, and secondary headaches, which are related to other underlying medical conditions (2,3). Among primary headaches, migraine, tension-type headache and cluster headache (2).

Migraine is a complex neurological disorder characterized by episodes of throbbing, recurrent, and disabling headache, usually unilateral, which can range from moderate to severe intensity, and is associated with various symptoms such as photophobia, phonophobia, vomiting, and nausea (4). In 2009, Migraine, the most prevalent headache disorder in Brazil (5). In 2019, migraine affected more than one billion people worldwide, with an average annual prevalence of 15.8% in the Brazilian population, being more common among women aged 35 to 40 years (1,4). Furthermore, migraine was the second leading cause of years lived with disability in 2016, surpassing other neurological conditions (6).

Despite its prevalence, epidemiological trends and demographic disparities related to hospitalizations for migraine and other headache syndromes (MAOHS) in Brazil remain poorly explored. Understanding these trends and the patient profile is essential for the development of public health strategies aimed at prevention, early diagnosis, and management of these conditions, especially among more susceptible populations. Then, this study aims to analyze temporal trends in hospitalization rates for MAOHS in Brazil between 2010 and 2023.

## Methods

*Study Design*

This ecological time-series study analyzed data from 2010 to 2023. The temporal dimension was examined by year, with additional stratification by age groups and sex.

*Data source and definitions*

Data were obtained from the Hospital Information System of the Brazilian Unified Health System (SUS) for hospitalizations related to migraine (ICD-10: G43) and other headache syndromes (ICD-10: G44), through the identifier: "Enxaqueca e outras síndromes de algias cefálicos" on TABNET. Population estimates were acquired from the Brazilian Institute of Geography and Statistics (IBGE) to calculate hospitalization rates.

To estimate the Hospitalization rates related to MAOHS, we divided the number of hospitalizations by the resident population. The values are presented in terms of cases per 100,000 people.

Analyses were conducted at three levels: a) national aggregate totals; b) rates stratified across five age groups: children (≤19 years), young adults (20-39 years), middle-aged adults (40-59 years), elderly (60-79 years), and advanced elderly (≥80 years); and c) rates stratified by sex (male and female) without age grouping.

*Statistical Analysis*

We conducted multiple statistical analyses to comprehensively evaluate temporal trends and demographic patterns.

To analyze trends in hospitalization rates over the 14-year study period, were employed the calculus of Annual Percentage Change (APC) (7,8) with 95% confidence intervals, from the linear regression model, to quantify the magnitude and direction of trends for each age group and sex category. The APC approach was selected to enable equitable comparison of relative trends across strata with varying baseline rates. Unlike absolute measures from linear regression, APC employs a log-linear model where the exponential transformation of the slope coefficient yields the annual percentage change, providing a standardized metric particularly suitable for comparing trends across age groups with different hospitalization rates. Additionally, the overall percent change was calculated to quantify the total percentage variation over the entire 14-year period.

For demographic comparisons, we first verified data normality using the Shapiro-Wilk test (9) and assessed homogeneity of variances with Levene's (10) test before applying Student's t-test (11) to compare hospitalization rates between males and females. Age group analysis involved One-way Analysis of Variance (ANOVA) (12) with post-hoc Tukey's test to identify significant differences in hospitalization rates among the five age groups, after confirming the assumption of normality. In addition, box plots were constructed to illustrate the distribution of results across different age groups and between sexes.

The Python version 3.12.3 was used for statistical analysis, with the libraries stats models (13), scipy (14), scikit-posthocs (15). All statistical tests were considered significant $p<0.05$.

## Results

One hundred and twenty thousand three hundred and six hospitalizations attributable to MAOHS in Brazil were documented between 2010 and 2023. As illustrated in Figure 1, age-stratified hospitalization rates exhibited distinct temporal trajectories, with increasing observed across all demographic cohorts.

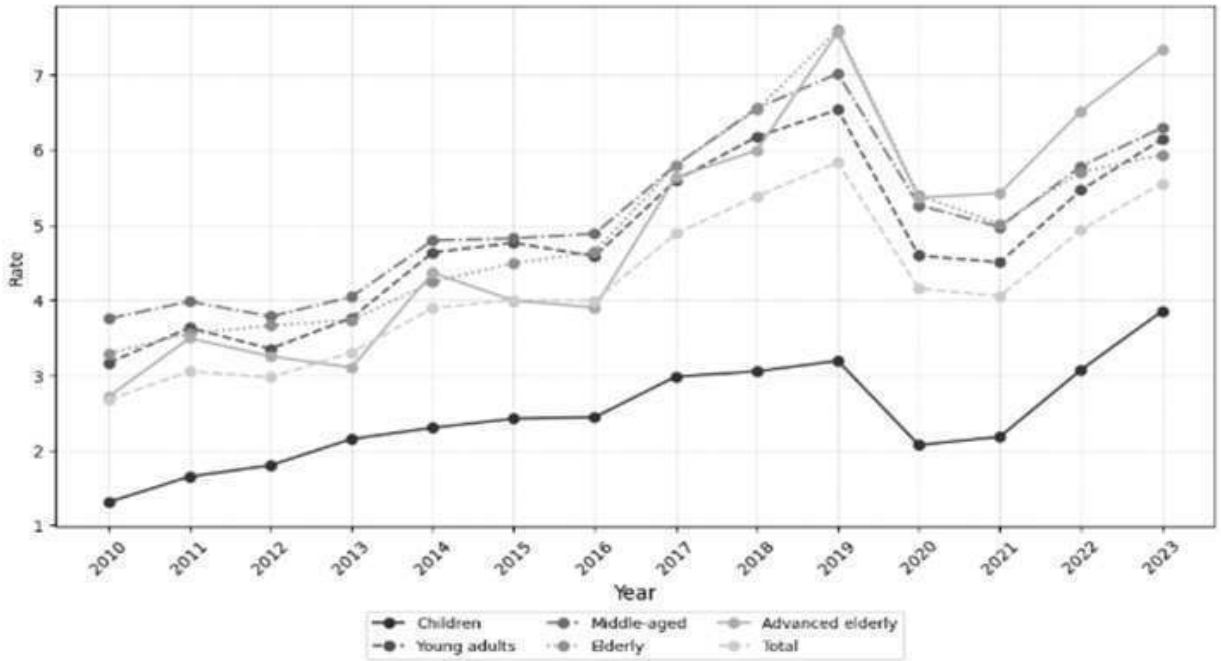


Figure 1. Temporal Evolution of Hospitalization rates related to MAOHS in Brazil, 2010–2023.

Nationally, the overall hospitalization rate demonstrated a significant upward trajectory, with an APC of 5.0% (95% CI: 2.9–7.2%; p<0.001). Stratified analyses are shown in Table 1. What stands out in the table is the heterogeneous yet statistically significant increases in all age groups (p<0.01), with the most pronounced escalation occurring among the advanced elderly population (APC=7.4%; CI: 5.2–9.7%). Younger age groups exhibited comparatively moderate growth, including children (APC=5.6%; CI: 2.8–8.5%) and young adults (APC=4.5%; CI: 2.3–6.7%).

Table 1. Trend of Hospitalization Rates for MAOHS (2010–2023) in Brazil by age groups

| | Rate per 100,00 | | APC results | | | | Change (%) |
|---|---|---|---|---|---|---|---|
| | 2010 | 2023 | APC | APC CI95% | $R^2$ | p-value | |
| Total | 2.7 | 5.6 | 5.0 | 2.9 – 7.2 | 0.7 | <0.001 | 107.9 |
| Children | 1.3 | 3.8 | 5.6 | 2.8 – 8.5 | 0.61 | <0.001 | 193.9 |
| Young adults | 3.2 | 6.1 | 4.5 | 2.2 – 6.7 | 0.62 | <0.001 | 94.3 |
| Middle-aged | 3.8 | 6.3 | 4.1 | 2.2 – 6.0 | 0.66 | <0.001 | 67.7 |
| Elderly | 3.3 | 5.9 | 5.1 | 2.8 – 7.4 | 0.68 | <0.001 | 80.2 |
| Advanced elderly | 2.7 | 7.3 | 7.4 | 5.2 – 9.7 | 0.82 | <0.001 | 170.5 |

APC: Annual Percentage Change. CI: confidence interval

Normality assumptions for parametric testing were validated across all cohorts (Shapiro-Wilk p>0.4), and homogeneity of variances was confirmed via Levene's test (p>0.05). The distribution of hospitalization rates across age groups is further visualized in Figure 2, which presents a box plot of MAOHS rates, highlighting central tendencies and variability within each cohort. Subsequent one-way ANOVA identified significant disparities in hospitalization rates among age groups (p<0.001). Tukey post hoc showed Pediatric hospitalization rates were significantly lower than those of all adult cohorts (p<0.001).

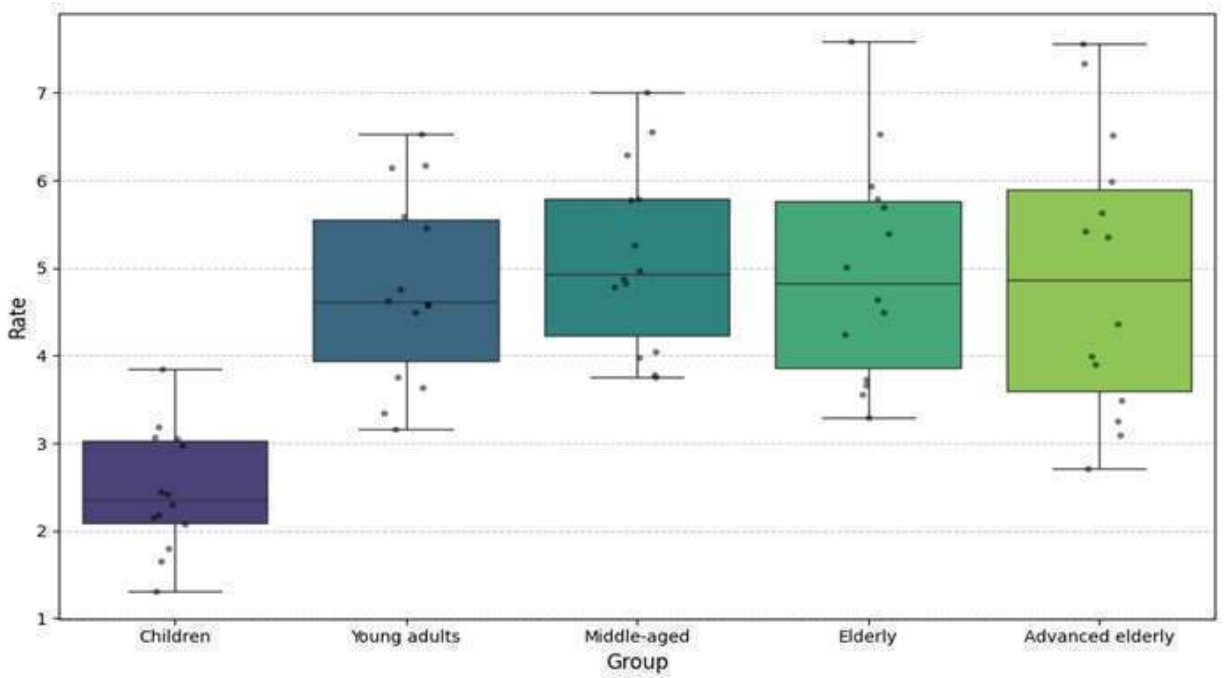


Figure 2. Box Plot of MAOHS Hospitalization Rates by age groups.

Both sexes showed a similar APC (~5%) in hospitalization rates. Normality was confirmed for sex-based analysis (p>0.4). Levene's test indicated homogeneity of variances (p=0.08). The Student's t-test revealed a significant difference between sexes (p<0.001; t=6.22), with females exhibiting a higher mean hospitalization rate than males (mean difference=2.45) (Figure 3).

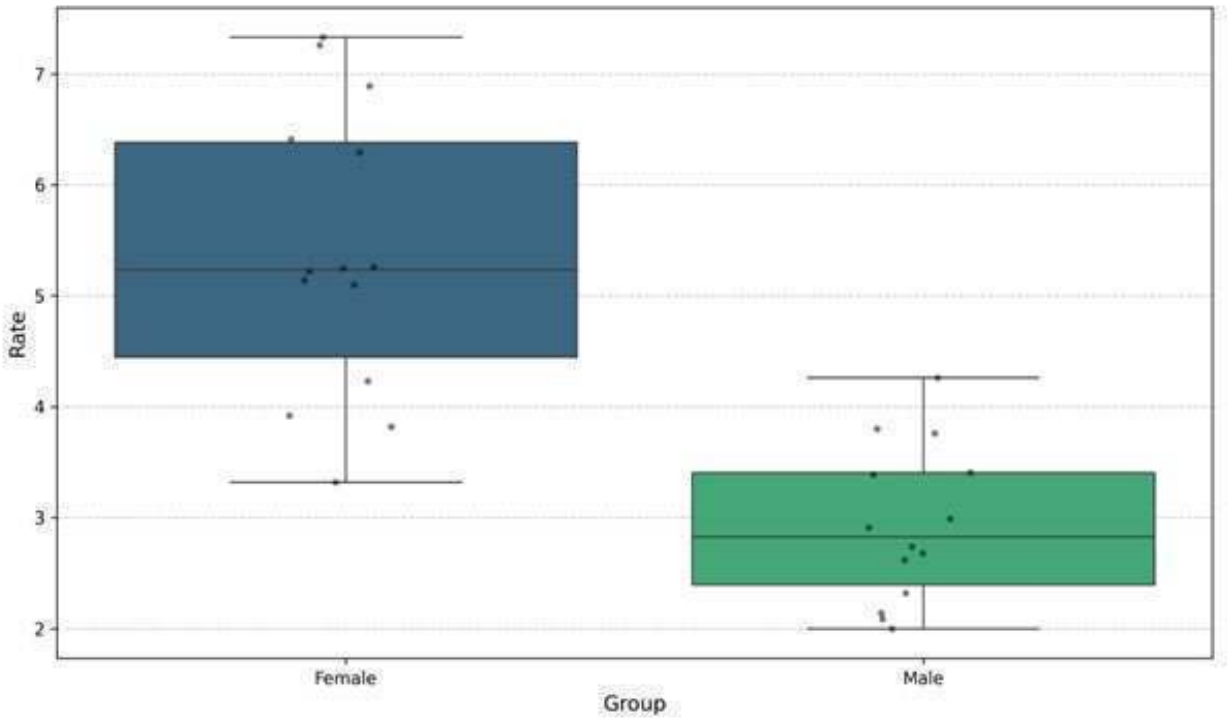


Figure 3. Box Plot of MAOHS Hospitalization Rates by sex.

## Discussion

Our study revealed a significant and sustained increase in hospitalization rates due to MAOHS in Brazil from 2010 to 2023, with relevant disparities across age and sex. These findings reinforce the growing public health impact of MAOHS and align with global trends, while also exposing particularities within the Brazilian context.

These findings are consistent with global estimates indicating the increasing burden of headache disorders. According to the Global Burden of Disease (GBD) study 2021, headache disorders affected approximately 2.81 billion people globally in 2021, a 57.2% increase from 1990, with both age-standardized prevalence and DALY rates showing gradual increases and remaining highly prevalent across all regions (16). Studies in high-income countries, such as the United States and United Kingdom, have also reported stable or increasing healthcare utilization due to headaches, particularly among women and middle-aged adults. In contrast, low- and middle-income countries often report underutilization of healthcare services for headache, reflecting barriers in access, diagnosis, and treatment (17,18). Within this global context, our results demonstrate that Brazil may be experiencing both rising prevalence and increased recognition of headache disorders, as evidenced by the sharp increase in hospitalizations for MAOHS, especially among vulnerable groups.

Comparative analyses indicate that the increase in hospitalization rates for MAOHS in Brazil may outpace trends observed in other countries. In the United States, for instance, data from the Nationwide Inpatient Sample suggest a relatively stable or modest rise in migraine-related admissions from the early 2000s to the 2010s, with outpatient management becoming more common (19). Similarly, in Europe, studies from England and Germany have reported gradual increases in healthcare utilization for headache, though not necessarily in hospitalizations (20). In contrast, Brazil showed a markedly sharper increase in hospitalizations between 2010 and 2023, particularly among vulnerable groups, suggesting either more severe clinical presentations or systemic differences in healthcare access and delivery. This pattern aligns with GBD 2021 findings showing that middle-income regions, which would include Brazil as part of Tropical Latin America, experienced the fastest growth in headache disorder burden globally, significantly outpacing high-income regions like North America and suggesting that the burden of headache disorders is shifting toward middle-income countries (16). These disparities may be influenced by differences in health infrastructure, diagnostic coding practices, and awareness levels across regions.

In line with previous international research, our study confirmed sex-based differences, with women showing significantly higher hospitalization rates. This aligns with findings from Lipton et al. (2001), who noted that migraine is 2–3 times more prevalent in females, possibly due to hormonal fluctuations, psychosocial stressors, and pain processing mechanisms (21).

One of the most striking findings in our study was the sharp increase in hospitalization rates among the advanced elderly (≥80 years) with a 170% growth from 2010 to 2023 and the highest annual percentage change (APC = 7.42%). This substantial increase is particularly noteworthy given that headache disorders are underdiagnosed and undertreated in older populations, where symptoms may be attributed to other comorbidities or dismissed by clinicians (22), suggesting that the true burden in this age group may be even greater than observed. Additionally, the higher rates in elderly populations may be driven by the increasing complexity of chronic conditions, polypharmacy, and reduced outpatient care, leading to more frequent hospitalizations (23).

While children exhibited the lowest absolute hospitalization rates, they also experienced a relative increase of 194%, the largest overall percent change among all groups. This may reflect a growing awareness of headache disorders among younger populations among caregivers and clinicians, improved access to diagnostic services, or changes in the pattern of health service use. Global data indicate that headache disorders show distinct age patterns, with prevalence increasing markedly from adolescence (16), suggesting that early recognition and intervention are crucial. However, the overall low rate suggests that many cases may still be managed in outpatient settings or underdiagnosed, underscoring the need for educational initiatives in primary care.

Our study presents some limitations that must be considered. First, the aggregated nature of our data on headache disorders (ICD-10 G43-G44) prevented disaggregation of trends by specific subtypes. Consequently, we could not distinguish the individual contribution of migraine (G43) from other syndromes, such as tension-type headache and medication-overuse headache (G44). Therefore, the observed trends reflect the composite burden of multiple headache disorders rather than any specific subtype. Also, the absence of stratified analyses by Brazilian macro-regions and spatial distribution patterns limited our ability to inform geographically targeted public health strategies.

Furthermore, we used secondary administrative data from the Brazilian public health system, which, although valuable for large-scale analyses, may suffer from misclassification and underreporting. Diagnoses are not always made by neurologists, which can lead to variability in diagnostic accuracy. Additionally, not all cases of MAOHS result in hospitalization. Many are treated in outpatient settings, especially among younger individuals, limiting the generalizability of hospitalization data as a proxy for disease prevalence.

The APC was estimated using linear regression, a method that assumes a constant trend over time. This may not capture inflection points or nonlinear patterns. However, the statistical robustness of our results evidenced by significant p-values, normality, and homoscedasticity supports the validity of the findings.

## Conclusion

MAOHS-related hospitalizations in Brazil have increased significantly from 2010 to 2023, with notable disparities by age and sex. The sharpest rise was observed among the advanced elderly, while children also showed a substantial relative increase. Females consistently exhibited higher hospitalization rates than males, despite both sexes showing similar annual percentage growth. These trends likely reflect a combination of biological, behavioral, and healthcare system factors, with interpretations requiring caution due to the inherent limitations of secondary data. Nonetheless, the findings underscore a growing public health concern and highlight the need for targeted strategies focused on vulnerable groups—particularly elderly and female populations—to manage and mitigate the burden of MAOHS in Brazil.

## References


1. Queiroz LP, Silva Junior AA. The Prevalence and Impact of Headache in Brazil. Headache: The Journal of Head and Face Pain 2015;55:32–8. Doi:10.1111/head.12511.
2. Baraness L, Baker A. Acute Headache. StatPearls [Internet], Treasure Island (FL): StatPearls Publishing; 2025.
3. Robbins MS. Diagnosis and Management of Headache. JAMA 2021;325:1874. Doi:10.1001/jama.2021.1640.
4. Amiri P, Kazeminasab S, Nejadghaderi SA, Mohammadinasab R, Pourfathi H, Araj-Khodaei M, et al. Migraine: A Review on Its History, Global Epidemiology, Risk Factors, and Comorbidities. Front Neurol 2022;12. Doi:10.3389/fneur.2021.800605.
5. Queiroz L, Peres M, Piovesan E, Kowacs F, Ciciarelli M, Souza J, et al. A Nationwide Population-Based Study of Migraine in Brazil. Cephalalgia 2009;29:642–9. Doi:10.1111/j.1468-2982.2008.01782.x.
6. Stovner LJ, Nichols E, Steiner TJ, Abd-Allah F, Abdelalim A, Al-Raddadi RM, et al. Global, regional, and national burden of migraine and tension-type headache, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Neurol 2018;17:954–76. Doi:10.1016/S1474-4422(18)30322-3.
7. National Cancer Institute. Annual Percent Change (APC) and Confidence Interval n.d. https://surveillance.cancer.gov/help/joinpoint/setting-parameters/method-and-parameters-tab/apc-aapc-tau-confidence-intervals/estimate-average-percent-change-apc-and-confidence-interval (accessed September 27, 2025).
8. Clegg LX, Hankey BF, Tiwari R, Feuer EJ, Edwards BK. Estimating average annual per cent change in trend analysis. Stat Med 2009;28:3670–82. Doi:10.1002/sim.3733.

9. Shapiro SS, Wilk MB. An analysis of variance test for normality (complete samples). Biometrika 1965;52:591–611. Doi:10.1093/biomet/52.3-4.591.
10. Brown MB, Forsythe AB. Robust Tests for the Equality of Variances. J Am Stat Assoc 1974;69:364. Doi:10.2307/2285659.
11. Student. The Probable Error of a Mean. Biometrika 1908;6:1. Doi:10.2307/2331554.
12. Girden E. ANOVA: Repeated measures. New York: Sage; 1992.
13. Seabold S, Perktold J. Statsmodels: Econometric and Statistical Modeling with Python, 2010, p. 92–6. Doi:10.25080/Majora-92bf1922-011.
14. Virtanen P, Gommers R, Oliphant TE, Haberland M, Reddy T, Cournapeau D, et al. SciPy 1.0: fundamental algorithms for scientific computing in Python. Nat Methods 2020;17:261–72. Doi:10.1038/s41592-019-0686-2.
15. Terpilowski M. scikit-posthocs: Pairwise multiple comparison tests in Python. J Open Source Softw 2019;4:1169. Doi:10.21105/joss.01169.
16. Rui Y, Wu B, Li Q, Zhang K. Global trends and regional disparities in the burden of headache disorders, 1990–2021: a comprehensive analysis of the global burden of disease study. Front Neurol 2025;16. Doi:10.3389/fneur.2025.1575705.
17. Stovner LJ, Hagen K, Linde M, Steiner TJ. The global prevalence of headache: an update, with analysis of the influences of methodological factors on prevalence estimates. J Headache Pain 2022;23:34. Doi:10.1186/s10194-022-01402-2.
18. Mortel D, Kawatu N, Steiner TJ, Saylor D. Barriers to headache care in low- and middle-income countries. ENeurologicalSci 2022;29:100427. Doi:10.1016/j.ensci.2022.100427.
19. Smitherman TA, Burch R, Sheikh H, Loder E. The Prevalence, Impact, and Treatment of Migraine and Severe Headaches in the United States: A Review of Statistics From National Surveillance Studies. Headache: The Journal of Head and Face Pain 2013;53:427–36. Doi:10.1111/head.12074.
20. Steiner TJ, Stovner LJ, Jensen R, Uluduz D, Katsarava Z. Migraine remains second among the world's causes of disability, and first among young women: findings from GBD2019. J Headache Pain 2020;21:137. Doi:10.1186/s10194-020-01208-0.
21. Lipton RB, Stewart WF, Diamond S, Diamond ML, Reed M. Prevalence and Burden of Migraine in the United States: Data From the American Migraine Study II. Headache: The Journal of Head and Face Pain 2001;41:646–57. Doi:10.1046/j.1526-4610.2001.041007646.x.
22. Pascual J, Berciano J. Experience in the diagnosis of headaches that start in elderly people. J Neurol Neurosurg Psychiatry 1994;57:1255–7. Doi:10.1136/jnnp.57.10.1255.
23. Maher RL, Hanlon J, Hajjar ER. Clinical consequences of polypharmacy in elderly. Expert Opin Drug Saf 2014;13:57–65. Doi:10.1517/14740338.2013.827660.



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