



Racial Differences in Neuroimaging Utilization and Secondary Headache Diagnosis in the Emergency Department

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BACKGROUND

- Headache is among the most common reasons for patients to seek evaluation in the Emergency Department (ED).
- While most patients harbor benign primary headache disorders, a **small proportion are found to have serious secondary causes that warrant urgent medical imaging investigation**[1].
- To help identify patients at risk for secondary headache, various “red flag” criteria, collectively summarized in the SNOOP10 framework [2], have been established.
- However, growing evidence suggests that neuroimaging decisions may differ across racial and ethnic groups due to systemic and implicit biases in emergency care.**
- Minority patients have been shown to receive fewer diagnostic tests and less advanced imaging compared to White patients, even when presenting with similar symptoms.
- Whether neuroimaging is utilized equitably across racial and ethnic groups remains unclear. **This study aimed to evaluate racial differences in neuroimaging utilization by modality among adults presenting to the ED with chief complaints of headache.**

METHODS

- Using the Medical Information Mart for Intensive Care IV (MIMIC-IV) database [3,4,5] we conducted a **retrospective review of 13,814 adult patients** presenting to the Beth Israel Deaconess Medical Center Emergency Department from 2008-2019 with chief complaints of headache.
- Encounters were **stratified by self-identified race** (White, Black, Hispanic, Asian, Other). Imaging utilization was categorized as no imaging, MRI, CT without contrast, CT with contrast, or CT angiography (CTA).
- Diagnoses were classified as primary or secondary headaches.** Secondary headache was defined operationally as headache attributed to an identifiable underlying disorder per clinical diagnosis. Diagnoses containing the terms “migraine,” “tension,” “cluster,” or diagnoses limited to the word “headache” were categorized as primary.
- We compared imaging patterns and diagnostic outcomes by race using **Chi-square analysis, with standardized residuals calculated to determine which groups contributed most to observed differences.** Standardized residuals exceeding |1.96| correspond to $p < 0.05$ and were considered statistically significant.

RESULTS

	Imaging Type by Race				
	No imaging	MRI	CT w/o Contrast	CT w/ Contrast	CTA
White	3728 (55.34%)	286 (4.25%)	1361 (20.20%)	17 (0.25%)	1344 (19.95%)
Hispanic	1023 (63.70%)	32 (1.99%)	311 (19.36%)	3 (0.19%)	237 (14.76%)
Black	2320 (62.94%)	102 (2.77%)	741 (20.10%)	3 (0.08%)	520 (14.11%)
Asian	351 (58.02%)	16 (2.64%)	130 (21.49%)	2 (0.33%)	106 (17.52%)
Other	549 (62.60%)	32 (3.65%)	165 (18.81%)	2 (0.23%)	129 (14.71%)

Table 1. Imaging type distribution by race (counts and percentages).

	Standardized Residuals				
	No imaging	MRI	CT w/o contrast	CT w/ contrast	CTA
White	-3.91	+3.45	+0.29	+0.96	+5.25
Hispanic	+2.45	-3.17	-0.61	-0.12	-2.44
Black	+3.11	-2.27	+0.08	-1.61	-4.65
Asian	-0.32	-1.08	+0.79	+0.72	+0.14
Other	+1.39	+0.29	-0.81	+0.19	-1.84

Table 2. Standardized residuals of imaging utilization by race. Values with an absolute standardized residual > 1.96 are considered statistically significant.

	Headache Diagnosis by Race			
	Primary Headache	Secondary Headache	% Secondary	P value
White	3630	3106	46.11%	0.3830
Hispanic	903	703	43.77%	0.1458
Black	2064	1622	44.00%	0.0546
Asian	265	340	56.20%	< 0.0001
Other	490	387	44.13%	0.3875

Table 3. Chi-Square analysis of headache diagnosis by race.

RESULTS CONT.

- Significant racial variation was observed in both neuroimaging modality and headache diagnosis between races.**
- MRI and CTA imaging was performed at higher rates in white patients (standardized residual +3.45 and +5.25, respectively), who were less likely to receive no imaging (-3.91) compared to other races.
- In contrast, Black (+3.11) and Hispanic (+2.45) patients were significantly more likely to undergo no imaging and less likely to receive MRI (-2.27 and -3.17, respectively) or CTA (-4.65 and -2.44).** Asian and “Other” race patients showed no significant difference in imaging rates across modalities.
- When evaluating outcomes, 46.1 % of White, 43.8 % of Hispanic, 44.0 % of Black, 56.2 % of Asian, and 44.1 % of “Other” patients were diagnosed with a secondary cause of headache.
- The higher rate among Asian patients ($P < 0.0001$) persisted independent of imaging type, suggesting possible influences of variation in clinical presentation, underlying comorbidities, or implicit bias in diagnostic decision-making.

CONCLUSION

Significant racial differences were observed in both neuroimaging utilization and diagnoses of secondary headache among ED patients. White patients more often underwent MRI or CTA, whereas Black and Hispanic patients were imaged less frequently despite similar diagnostic yield. Asian patients exhibited the highest rate of secondary headache diagnoses, a difference that persisted across imaging types. **Further exploring these disparities can promote equity in neuroimaging decisions in the ED.**

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