Original Research Article

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Patients with non-traumatic headache in the radiology department: Diagnostic yield of cranial computed tomography imaging – Study of a secondary hospital of Bangladesh

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Abstract

Background: Non-traumatic headache is one of the most common emergency department (ED) presentations worldwide, accounting for 1–4% of all ED presentations. The study aims to assess the burden, causes, and imaging patterns of adult non-traumatic headaches in the ED to improve clinical management and resource planning.

Methods: The cross-sectional study was conducted in the Department of Radiology and Imaging, Lifeline Cardiac Hospital, Moulvibazar, between January 01, 2021, and December 31, 2022. A total of 302 consecutive non-traumatic headache patients were enrolled. All patients above the age of 9 years were included in this study, while patients with traumatic headache and those with incomplete records were excluded from this study. Demographics, associated symptoms, comorbidities, and computed tomography (CT) brain findings were recorded systematically and analyzed using descriptive and inferential statistics on Statistical Package for the Social Sciences version 26.

Results: The study population consisted of 197 females (65.2%) and 105 males (34.8%), with a mean age distribution of 25.2% patients ≥60 years. CT scans were normal in 220 patients (72.8%) and abnormal in 82 patients (27.2%). The most common abnormal findings were sinusitis (35 patients, 11.6%), intracerebral hemorrhage (26 patients, 8.6%), mass lesions/focal abnormalities (13 patients, 4.3%), and ischemic changes (5 patients, 1.7%). There were also notable correlations between comorbidities of hypertension and diabetes mellitus and abnormal CT findings ($P < 0.05$).

Conclusion: The rate of abnormal CT findings in ED non-traumatic headache is relatively high (27.2%), and sinusitis alongside intracerebral hemorrhage are the most common pathologic diagnoses. Age, comorbidities, and specific clinical presentations play a notable role in the likelihood of abnormal neuroimaging.

Keywords: Adult non-traumatic headache, Emergency department presentations, Neuroimaging, Radiological abnormalities

Introduction

Non-traumatic headache is one of the most common emergency department (ED) presentations worldwide, accounting for 1–4% of all ED presentations and affecting millions of individuals annually.[1,2] The biggest clinical challenge to emergency physicians is how to distinguish benign

primary headache disorders, such as migraine and tension-type headaches, from the life-threatening secondary causes that encompass subarachnoid hemorrhage, intracerebral hemorrhage, meningitis, and space-occupying lesions.[3] This distinction is important, as missed diagnoses of secondary headaches can lead to severe morbidity and mortality, while over-imaging for primary headaches raises costs and anxiety. Globally, the burden of headache presentation is increasing, with a rising trend in ED presentations.[1] This is explained by several factors, including heightened awareness of sinister etiologies, improved access to healthcare, and an aging population with increased cerebrovascular disease burden. Headache presentations exhibit female preponderance demographically and occur in all ages, with varying trends based on underlying etiology.[4] Neuroimaging, specifically computed tomography (CT), remains at the leading edge of headache diagnosis in the emergency setting. Its prudent use, nonetheless, remains controversial, with the literature showing heterogeneous returns of significant findings in the 2–15% range depending on patient selection and presentation.[5,6] To optimize utilization, the American College of Emergency Physicians and other guidelines recommend imaging decisions driven by red flag symptoms and clinical rules.[7] There is a body of evidence that CT yield is dependent upon age, neurological deficit, symptoms involved, and comorbidities.[8] Individuals older than 50 years, those with acute or severe onset, and those with focal neurological signs consistently have higher rates of abnormal scans.[6,9] Comorbidities such as hypertension, diabetes, and prior cerebrovascular disease also render it more likely that secondary pathology will be detected. The differential diagnoses of CT in non-traumatic headache are broad. Life-threatening intracerebral hemorrhage and subarachnoid hemorrhage require immediate intervention.[10] Ischemic strokes, albeit less frequently with headache as a solitary presentation, represent another important diagnostic category. The remaining diagnoses, whether sinusitis, hydrocephalus, or intracranial mass lesions, are variably accountable for overall yield and clinical decision-making.[11] Understanding the epidemiological trends, clinical presentation, and radiological findings of non-traumatic headache presentations is crucial for the optimization of diagnostic workflow, outcome enhancement, and cost-effectiveness.

This study aims to provide comprehensive data on the burden, etiology, and radiological findings in adult non-traumatic headache patients in the ED, guiding clinical practice and resource allocation.

Methods

This cross-sectional study was conducted in the Department of Radiology and Imaging, Lifeline Cardiac Hospital, Moulvibazar, over a period of 2 years from January 1st, 2021, to December 31, 2022. A total of 302 consecutive patients presenting with non-traumatic headache were included. All patients aged above 9 years were eligible, while those with traumatic headache or incomplete records were excluded. Demographic data, including age and sex, were collected, along with associated symptoms such as vomiting, nausea, blurring of vision, convulsion, altered sensorium, and focal neurological deficits. Clinical history was reviewed for comorbidities, including hypertension, diabetes mellitus, tuberculosis, and prior stroke. Neuroimaging was performed for all patients, and findings from CT of the brain were systematically recorded. Radiological results were categorized as normal/no acute finding, intracerebral hemorrhage, ischemic change or infarct, sinusitis, mass/Rehabilitation Council of India/other lesions, hydrocephaly, and miscellaneous findings.

Statistical analysis

Data were entered into a structured database and analyzed using descriptive and inferential statistics. Frequencies and percentages were calculated for categorical variables, including age groups, sex, associated symptoms, comorbidities, and CT findings. Continuous variables such as age were expressed as mean ± standard deviation. Associations between categorical variables (e.g., comorbidities or symptoms with abnormal CT

findings) were evaluated using the Chi-square test, with results presented as counts, percentages, and *P*-values. A $P < 0.05$ was considered statistically significant.

Results

Table 1 represents the demographic profile of the study population, demonstrating age and gender distribution in patients presenting with non-traumatic headache. The statistics demonstrate a female predominance (65.2% vs. 34.8% male), consistent with epidemiological trends in headache disorders. Age distribution demonstrates that patients ≥60 years constituted the largest single age group (25.2%), followed by the 18–29 years of age group (19.2%) and 40–49 years of age group (18.9%). The broad age range mirrors the ubiquitous nature of headache complaints in every adult age bracket. Interestingly, every one of the 302 patients had CT imaging (100%), suggesting the study's extensive use of neuroimaging examination in this group.

Table 2 classifies the etiologies of non-traumatic headache based on CT imaging findings as a proxy for diagnostic category. The majority of patients (72.8%, *n* = 220) had normal CT scans or no acute findings, which pointed toward primary headache disorders. Sinusitis was the most common secondary cause among abnormal findings (11.6%, *n* = 35), followed by intracerebral hemorrhage (8.6%, *n* = 26). Focal lesions or mass effects (4.3%, *n* = 13) and ischemic changes (1.7%, *n* = 5) were less common but clinically significant findings. Hydrocephalus and other miscellaneous findings were rare (0.9% overall). The percentage of abnormal findings was comparatively high (27.2%) is perhaps due to the ED setting, in which patients tend to have more severe or alarming symptoms.

Table 3 provides a breakdown of individual CT brain findings in the study population, mirroring the etiology with a specific interest in radiological Findings. Normal/no acute finding represented 72.8% (*n* = 220) of presentations. Sinusitis was the most frequent pathological finding at 11.6% (*n* = 35), which one assumes represents inflammatory, acute, or chronic processes affecting paranasal sinuses. Intracerebral hemorrhage, the most urgent finding requiring immediate intervention, was present in 8.6% (*n* = 26) of the scans. A mass lesion, space-occupying lesion, or focal abnormality was identified in 4.3% (*n* = 13)

Table 1: Patient characteristics (*n*=302)

Age group	*n*	Percentage
<18	27	8.9
18–29	58	19.2
30–39	41	13.6
40–49	57	18.9
50–59	43	14.2
≥60	76	25.2
Gender	***n***	**Percentage**
Female	197	65.2
Male	105	34.8
CT performed	302	100

CT: Computed tomography

Table 2: Etiologies of non-traumatic headache (proxied from CT findings, *n*=302)

Etiology (proxy from CT)	*n*	Percentage
Normal/No acute finding	220	72.8
Sinusitis	35	11.6
Intracerebral hemorrhage	26	8.6
Ischemic change/infarct	5	1.7
RCI/ICSoL/focal lesions	13	4.3
Hydrocephaly	1	0.3
Others (an infarct, etc.)	2	0.6

CT: Computed tomography, RCI: Rehabilitation Council of India

Table 3: Radiological findings (CT, *n*=302)

CT finding	*n*	Percentage
Normal/no acute finding	220	72.8
Sinusitis	35	11.6
Intracerebral hemorrhage	26	8.6
Ischemic change/infarct	5	1.7
RCI/ICSoL (mass lesions)	13	4.3
Hydrocephaly	1	0.3
Others (minor categories)	2	0.6

CT: Computed tomography, RCI: Rehabilitation Council of India

of the patients. Ischemic changes were relatively fewer (1.7%, *n* = 5), which could be due to the acute stage of CT imaging to detect early ischemic changes.

Table 4: Clinical and comorbidity profile of non-traumatic headache patients (*n*=302)

Symptom	*n*	Percentage
Associated symptoms		
Vomiting/Nausea	62	20.5
Slurring of speech	15	5
Vertigo	28	9.3
Convulsion/Seizure	10	3.3
Blurring of vision	24	7.9
Odd behavior/confusion	6	2
Tremor	8	2.6
Mouth deviation/facial droop	12	4
Tinnitus	18	6
Irrelevant talk/disorganized speech	7	2.3
Unconsciousness/altered sensorium	9	3
Disorientation	13	4.3
Generalized weakness	21	7
Dementia/cognitive decline	5	1.6
Comorbidities		
Hypertension	65	21.5
Diabetes mellitus	52	17.2
Tuberculosis	3	1.0
Previous stroke	12	4

Table 4 provides a clear clinical symptomatology and comorbidity profile of the study population. The most frequent associated symptom was vomiting/nausea (20.5%, *n* = 62), followed by vertigo (9.3%, *n* = 28) and generalized weakness (7%, *n* = 21). Neurological symptoms, like blurring of vision (7.9%), tinnitus (6.0%), and slurring of speech (5.0%), were also salient. More concerning symptoms, such as convulsions/seizures (3.3%), unconsciousness/altered sensorium (3%), and mouth deviation/facial droop (4%), were comparatively less common but clinically significant. Hypertension was the most common comorbidity (21.5%, *n* = 65), followed by diabetes mellitus (17.2%, *n* = 52). Previous stroke was noted in 4% (*n* = 12) of the patients, while tuberculosis was not common (1%, *n* = 3).

Table 5 compares CT findings between different demographic groups, where significant age and gender trends are noted. The results show that abnormal CT findings were more frequent in older age groups, where percentage values of hemorrhage (13.2%) and ischemic changes (3.9%) were high in patients aged ≥60 years when compared to other age groups. The 50–59 years of age group also

Table 5: CT findings by age group and gender

Age group	Normal *n* (%)	Ischemic *n* (%)	Hemorrhage *n* (%)	Sinusitis *n* (%)	Mass/RCI/ others *n* (%)	Total	*P*-value
<18	20 (74.1)	0 (0.0)	2 (7.4)	5 (18.5)	0 (0.0)	27	0.55
18–29	46 (79.3)	0 (0.0)	0 (0.0)	8 (13.8)	4 (6.9)	58	
30–39	31 (75.6)	0 (0.0)	4 (9.8)	4 (9.8)	2 (4.9)	41	
40–49	44 (77.2)	0 (0.0)	4 (7.0)	4 (7.0)	5 (8.8)	57	
50–59	29 (67.4)	2 (4.7)	6 (14.0)	3 (7.0)	3 (7.0)	43	
≥60	50 (65.8)	3 (3.9)	10 (13.2)	11 (14.5)	2 (2.6)	76	
Total	220 (72.8)	5 (1.7)	26 (8.6)	35 (11.6)	16 (5.3)	302	
Sex							
Female	142 (72.1)	4 (2.0)	20 (10.2)	22 (11.2)	9 (4.6)	197	0.15
Male	78 (74.3)	1 (1.0)	6 (5.7)	13 (12.4)	7 (6.7)	105	
Total	220 (72.8)	5 (1.7)	26 (8.6)	35 (11.6)	16 (5.3)	302	

CT: Computed tomography, RCI: Rehabilitation Council of India

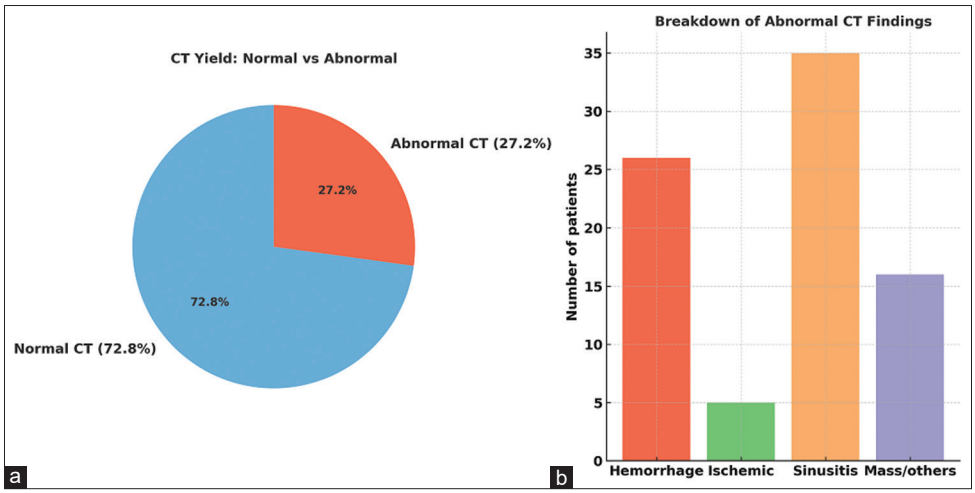

Figure 1: Summary of computed tomography (CT) findings in adult patients with non-traumatic headache ($n = 302$). (a). Overall CT yield showing normal (72.8%) versus abnormal (27.2%) scans. (b) Distribution of abnormal CT findings, including intracerebral hemorrhage (8.6%), ischemic infarct (1.7%), sinusitis (11.6%), and mass/Rehabilitation Council of India/others (5.3%) [Figue 1]

demonstrated high abnormal findings, particularly hemorrhage (14.0%). Gender-based analysis also indicated that females presented with a slightly increased percentage of intracerebral hemorrhage (10.2% vs. 5.7% in males), and males presented with slightly higher percentages of sinusitis (12.4% vs. 11.2%). The *P*-value of 0.55 for age groups and 0.15 for gender indicates no statistical significance, though clinical trends are evident.

Table 6 demonstrates the correlation of comorbidities, symptoms, and abnormal CT findings of the patient. The results demonstrate statistical significance among some of the variables and abnormal neuroimaging. Hypertension was discovered to be statistically related to abnormal CT findings ($P = 0.04$), suggesting that patients with hypertension presenting with headache have higher chances of underlying pathology. Similarly, unconsciousness as a presentation symptom also showed a statistically significant association with abnormal CT results ($P = 0.011$).

Table 6: CT findings by age group and gender

Comorbidity	Abnormal CT (Yes)	Abnormal CT (No)	*P*-value
HTN	14	68	0.04
DM	20	62	
TB	0	82	
Previous stroke	0	82	
Symptom			
Unconsciousness	1	81	0.011
Vomiting/Nausea	0	82	
Convulsion	0	82	
Slurring speech	0	82	
Blurring vision	0	82	

CT: Computed tomography, HTN: Hypertension, DM: Diabetes mellitus, TB: Tuberculosis

Discussion

This study provided valuable information regarding the epidemiological trends, clinical presentation, and radiological findings in this group. The overall proportion of abnormal CT scans (27.2%) was greater than the widely documented range of 2–15% in comparable groups.[12,13] There are several possible reasons for this variation, including the demographics of the patient population, institutional imaging criteria, and inclusion of findings such as sinusitis, which some prior studies might differently classify. This high yield highlights the significance of population-

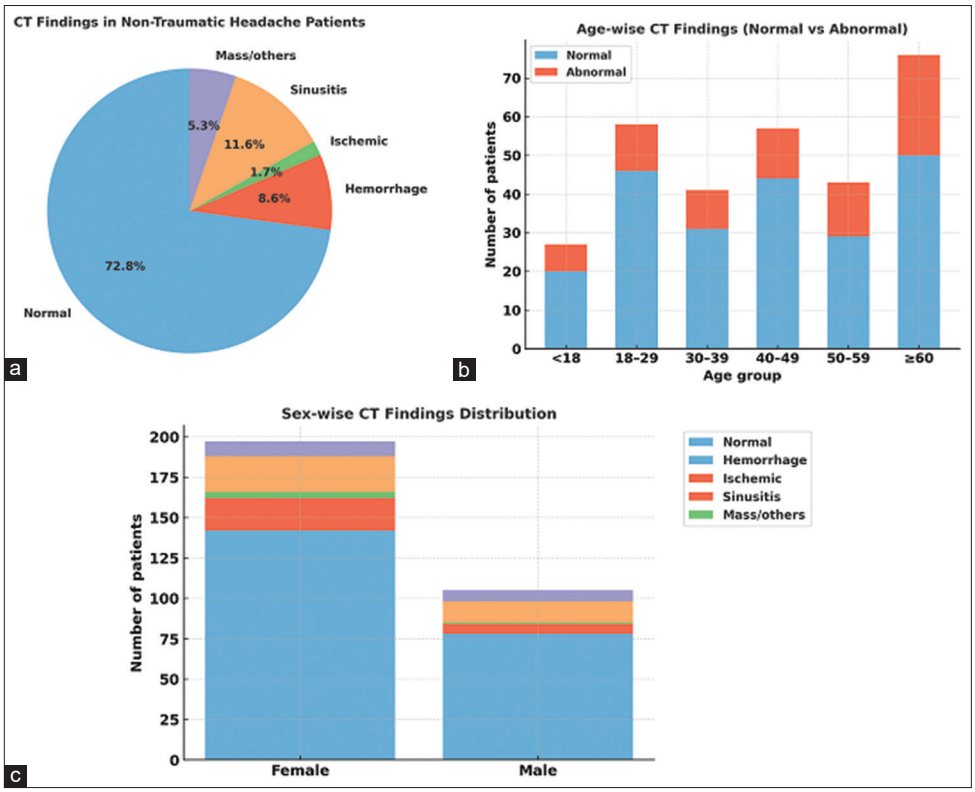

Figure 2: Burden, causes, and radiological findings among adult patients with non-traumatic headache (n = 302). (a) Distribution of computed tomography (CT) findings (pie chart) showing that the majority were normal (72.8%), followed by sinusitis (11.6%), intracerebral hemorrhage (8.6%), mass/Rehabilitation Council of India/others (5.3%), and ischemic infarct (1.7%). (b). Age-wise CT findings (bar chart), illustrating that abnormal findings were more frequent in older age groups (≥50 years). (c). Sex-wise distribution of CT findings (stacked bar chart), showing similar overall trends between males and females, with slightly higher hemorrhage among females and more sinusitis among males [Figue 2]

specific and practice-based considerations in the interpretation of neuroimaging findings. The demographic analysis of our cohort revealed a predominance of females (65.2%) and a large proportion of elderly patients (25.2% were ≥60 years old), consistent with Morgenstern *et al*., epidemiological trends in headache presentation.[14] The relatively high proportion of elderly individuals may partially explain the increased abnormal CT yield, as advanced age is an established risk factor for secondary headache etiologies.[15] Gender distribution mirrored the known predominance of headache disorders among women, and particularly migraine, but both sexes demonstrated appreciable rates of underlying pathology, underscoring the necessity for generalized vigilance irrespective of demographic subsets. Among abnormal CT diagnoses, sinusitis was most frequent (11.6%), followed by intracerebral hemorrhage (8.6%). This differs from the report of Linn *et al*., of higher subarachnoid hemorrhage or intracranial mass lesions incidence.[16] The high rate of sinusitis may possibly be accounted for by regional and seasonal variation and variation in diagnostic interpretation. Nevertheless, the high proportion of intracerebral hemorrhage helps to emphasize the valuable role of CT imaging in the detection of life-threatening processes necessitating emergent intervention. The association of comorbidities with abnormal CT findings also improves clinical

decision-making. Hypertension had a significant correlation with abnormal scans (P = 0.04), consistent with Qureshi *et al*. and Ariesen *et al*., implicating it in cerebrovascular pathology.[17,18] Since hypertension is a major risk factor for ischemic and hemorrhagic stroke, its presence in headache patients ought to arouse suspicion. Similarly, unconsciousness was also strongly associated with abnormal CT results (P = 0.011), which supports current guidelines acknowledging altered mental status as a major red flag for urgent neuroimaging.[19] Notably, certain classically quoted warning symptoms, vomiting/nausea, convulsions, and focal neurological deficits, did not demonstrate statistically significant associations with abnormal CT findings. This result contradicts classical reliance on individual red flag symptoms.[20] On the contrary, it highlights the need for a multifactorial, integrative approach when evaluating headache patients in the emergency setting. The heterogeneity of presentations highlights the challenge in striking a balance between sensitivity for critical pathology and avoiding unnecessary imaging. Age-stratified analysis also highlighted the relevance of patient characteristics, with those ≥50 years of age demonstrating increased percentages of abnormal CT results, particularly hemorrhagic events. Such a trend is in line with guideline recommendations for more liberal imaging in older patients with headache.[21] Gender analysis, while not statistically significant, indicated increased intracerebral hemorrhage rates for females, which may be due to hormonal factors, migraine-associated complications, or gender-specific risk factors that should be further investigated. These findings have important implications for emergency practice and resource planning. The relatively high diagnostic yield suggests that institutional imaging practices as they stand are possibly appropriately sensitive, although the cost-effectiveness must be carefully examined. Identification of high-risk groups, particularly hypertensive patients and those with altered consciousness, permits an evidence-based basis for imaging resource triage without loss of diagnostic sensitivity for serious pathology.

Limitations of the study

This study was conducted at a single institution, and this may limit the generalizability of findings to other clinical practice settings with different patient populations and styles of practice. The retrospective design and utilization of CT imaging alone may have underestimated the true prevalence of certain pathologic processes that are better imaged with other imaging modalities, such as magnetic resonance imaging.

Conclusion

This study demonstrates that non-traumatic headache in the ED setting has a significant rate (27.2%) of abnormal CT findings, most of which are sinusitis and intracerebral hemorrhage. Age, particularly over 50 years, and comorbidities such as hypertension significantly influence the likelihood of abnormal neuroimaging results. The close association of changed consciousness with abnormal CT scans reinforces the place of mental status assessment in clinical decision-making. These findings provide evidence for a multifactorial approach to the application of neuroimaging according to several clinical factors rather than the application of individual red flag symptoms in isolation.

Recommendation

Future studies should focus on the development and validation of clinical decision rules that synthesize multiple risk factors to optimize neuroimaging utilization without compromising diagnostic sensitivity. Prospective, multi-institutional comparisons of the diagnostic yields of the different imaging modalities would be especially useful evidence for building headache evaluation protocols.

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Conflict of Interest

None declared.

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