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Research article

# The degree and appropriateness of computed tomography utilization for diagnosis of headaches in Ghana

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ABSTRACT

*Introduction:* Headache is a common and sometimes debilitating medical condition. Patients presenting with no neurologic anomaly, nontraumatic primary headache require careful evaluation before neuroimaging. National Guidelines standardizing exploitation of Computed Tomography (CT), the most utilized imaging modality in this clinical scenario, has not been established in Ghana, a developing country with limited healthcare resources. The country has not also adopted existing guidelines such as the National Institute for Health and Care Excellence (NICE) of the United Kingdom or the Appropriateness Criteria (AC) of the American College of Radiologists (ACR). The purpose of this review was to analyze the propensity of CT utilization for diagnosing headaches against the AC of the ACR and discuss some of the socio-economic inferences thereof.

*Methods:* This study retrospectively reviewed CT imaging records and clinical data of all patients referred for head CT scans between 1st January 2016 and 31st December 2018 at five major health facilities (four tertiary government hospitals and one private hospital) across Ghana. We isolated all head CT scans performed for the diagnosis of headache for analysis. We analyzed the type of presenting headache, CT findings, gender distribution, pattern of referrals, and head CT appropriateness against the AC of the ACR.

*Results:* A total of 44,218 patients were referred to the five facilities for head CT secondary to diverse indications for the period. All non-trauma cases were 41.7%; trauma cases were 31.6%, the majority (72.3%) were from road traffic accidents. The majority (64.9%) of trauma casualties were males. A total of 11,806 (26.7%) patients were referred for a head CT scan for the diagnosis of headache. The private hospital recorded the highest referrals for head CT scan for diagnosis of headache. The gender distribution of all headache patients was 57.6% females, and 42.4% were males. The age distribution showed 19.3% were children, 71.2% were adults, and the aged constituted 9.4%. The results showed 2.8% significant cranial CT findings of all reviewed headache patients. Pathological findings among the cohort of children were 0.6%.

The sources and pattern of referrals showed 57.3% were from the Outpatient Department, 26.6% from the Emergency Department, in-patients' referrals were 9.4%, and specialist consultation was 7.1%. Analysis of CT scans performed against the AC of the ACR, showed 69.0% of headache patients were likely scanned inappropriately.

*Conclusions:* There is a need to implement international best practice guidelines or develop a national neuroimaging policy to protect patients. Unjustified CT utilization for diagnosis of headaches exposes patients to unnecessary ionizing radiation that can instigate cancer and unnecessary expenditure. Head CT scan for some headache patients with normal neurologic findings may be unnecessary in an emerging country like Ghana. Clinicians must, therefore, be discerning in CT scan requests for the diagnosis of headache.

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## 1. Introduction

Headache is the diffuse or focal pain in various parts of the head, with the pain not confined to an area of nerve distribution [1, 2].

There are over 150 types of headaches grouped into primary and secondary headaches [3, 4, 5]. Primary headaches are not well understood, any disease or underlying medical condition does not cause them, and they are classified according to their clinical pattern. The most common types being tension-type headaches, migraines, and cluster headaches. In related studies, the global 1-year prevalence rates are 46 % for all primary headache disorders, 42 % for tension-type headache, 11 % for migraines, and 3 % for chronic daily headaches [6, 7]. The global lifetime prevalence for all primary headaches was 64 % [8]. However, secondary headaches are those with an underlying disease thought to be the cause of the headache or if a close temporal relationship is present with the headache [4, 5].

In other studies, nontraumatic headaches were identified as the fifth leading reason for emergency department (ED) visits, accounting for some 3.8 million visits per year (2.8% of all ED visits) [9, 10]. The total high numbers of hospital visits of patients with headache substantially affect resource utilization and patient management in general.

Neuroimaging for primary headaches is a diagnostic option that plays an indispensable role in managing the condition [11, 12]. Studies have shown that up to 14% of all headache cases had one form of neuroimaging or another, with about 5.5% of the imaged patients having any significant pathologic finding [13]. In other recent studies, up to 31% of headache patients had neuroimaging [14]. According to the Appropriateness Criteria (AC) of the American College of Radiologists (ACR), Computed Tomography (CT) scan or Magnetic Resonance Imaging (MRI) of the head remains the best choice when imaging is indicated [15].

Ghana is a developing country challenged by the availability of neuroimaging services. It is important to note that the availability and affordability of neuroimaging, especially MRI, is a challenge for most patients in Ghana [16, 17, 18]. The most predominant neuroimaging modality is computed tomography. There are about 35 CT scanners for the whole country; mostly concentrated at the regional capitals therefore accessibility of CT neuroimaging services is a challenge [18].

National Guidelines standardizing Computed Tomography, the most utilized imaging modality in the diagnosis of headaches, have not been established in Ghana. The country has not also adopted existing guidelines such as the Appropriateness Criteria (AC) of the American College of Radiologists (ACR) or the National Institute for Health and Care Excellence (NICE) of the United Kingdom [15, 19]. There is no national data on physicians' natural tendency to request neuroimaging for patients with headache disorders. Information on health facilities utilization of CT and prevalence of positive findings will inform policymakers and guide judicious use of health care resources such as diagnostic imaging in the country. Such information is also crucial as it may provide more significant insights when the evaluated data is matched against the AC of the ACR, for instance. It will also allow us to determine the current CT imaging trends for the management of headaches in Ghana.

Headache disorders affect all ages, races, income levels, and geographical areas, causing a significant burden to sufferers (personal, quality of life, and financial). The socio-economic burden of headache is enormous as, in some cases, there is a significant loss of working or school hours and reduced productivity. It is estimated that about 1.7–4% of the world's population experience headaches on 15 or more days of the month, impacting their family, social life, and employment [20].

There has not been any review done in Ghana to ascertain the scale and frequency of CT scan applications for managing headaches and attendant appropriateness.

Therefore, we decided to conduct a sizeable cross-sectional retrospective review of patients' data referred for head CT scan to diagnose headaches across multiple health facilities in Ghana. In this paper, we report our CT scans' findings, the propensities of CT application to diagnose headache, and appropriateness of CT imaging to diagnose headaches by matching the data against the AC of the ACR.

## 2. Materials and methods

### 2.1. Study area

The review was conducted using five health facilities across Ghana (four tertiary government hospitals and one private hospital).

The Cape Coast Teaching hospital (CCTH) is one of the four teaching hospitals in Ghana. Cape Coast is a Metropolis, the administrative capital of the Central Region of Ghana. The hospital provides healthcare services to patients from the metropolis and, indeed, from the entire central region and beyond [21].

The Korle-Bu Teaching Hospital (KBTH) is the premier hospital of Ghana and is in Accra, the capital of Ghana, in the Greater Accra Region. The KBTH has a bed capacity of 2,000 with seven clinical and diagnostic Departments/Units. It has an average daily OPD attendance of 1,500 patients, and about 250 patients admitted daily. It is currently the third-largest hospital in Africa and the leading national referral center in Ghana [22].

The Komfo Anokye Teaching Hospital (KATH) is in Kumasi, the Regional Capital of Ashanti Region of Ghana, with a total projected population of 4,780,380 (2010 Ghana Population Census). The geographical location of this 1200-bed hospital, the country's road network, and the commercial nature of Kumasi make it accessible to all parts of the country. It takes direct referrals from 12 out of the 16 administrative regions in Ghana. It also receives patients from neighboring countries, such as Cote d'Ivoire and Burkina Faso [23].

The Sunyani Government Regional Hospital (SGRH) is in the Bono Region of Ghana with a population of about 74,240 (2010 Ghana Population Census). It is an ultramodern 300-bed capacity hospital. It is accessible to all the areas that share boundaries with the region and others that are farther away [24].

The Private Diagnostic Imaging Centre (PDIC) is a privately owned center located in Accra, Ghana's capital. The private hospital has an average OPD attendance of about 260 patients a day. The hospital has high coverage, and it provides an opportunity to compare imaging services at the center with the other four Government-owned health facilities listed above.

### 2.2. Study population

The study involved a data review of 44,218 head CT information of all patients who had undergone head CT scans and met our inclusion criteria between the period of January 2016 to December 2018.

### 2.3. Study design

This study retrospectively reviewed all CT imaging records and clinical data of all patients referred for head CT scans to diagnose headaches in the five health facilities where access was granted to undertake the review. Radiologists diligently reviewed all CT scan data and reports that met our study criteria. One of the authors reviewed each patient's referral chart and the CT scan report and findings.

For convenience, we classified indications for all head CT scans performed at the centres into headache, trauma, and non-trauma.

We employed three different kinds of age classifications for convenience. The categories are children ($\leq$17), adults (18–60 years), and elderly ($\geq$61 years).

The objectives for the audit were to:

1. Determine the percentage of head CT scans done for the diagnosis of headaches and evaluate CT utilization trends at the centers over the study period.
2. Evaluate the incidence of headaches and demographic characteristics.

3. Determine the most prevalent type of headaches
4. Analyze the prevalence of significant pathological lesions.
5. Analyze the patterns of referrals for head CT scan for the diagnosis of headaches.
6. Analyze the appropriateness of head CT for diagnosis of headaches by matching against the AC of the ACR.

### 2.4. Inclusion criteria

All head CT scans performed to diagnose headaches from 1st January 2016 to 31st December 2018 were retrieved for audit. Patients referred for head CT scan with a diagnosis of headache of all types with no other neurological deficits or focal findings on physical examination before referral to the CT center were included.

### 2.5. Exclusion criteria

All head CT scans that did not meet our inclusion criteria were excluded.

All head CT scans of patients with obvious neurological deficits were excluded.

All head CT scans due to other indications were excluded.

### 2.6. Data analysis

The data obtained were entered and analyzed using the Statistical Package for Social Sciences (SPSS v.23.0 software). Proportions presented for categorical variables using frequencies, percentages, and Chi-square where appropriate.

### 2.7. Ethical clearance

This study was a retrospective review of head CT scans. However, Ethical clearance and institutional review board approval obtained from the Cape Coast Teaching Hospital Ethical Review Committee (Reference number: CCTHERC/EC/2018/05). The Korle-Bu Teaching Hospital Scientific and Technical Committee/Institutional Review Board (Reference number: KBTH-STC/IRB/000119/2019) and the heads of all the health facilities involved in the study. Data security and confidentiality assured as patient personal information not included in the final report.

Informed consent was not obtained from all patients as the review was a retrospective study.

## 3. Results

This retrospective review involved an analysis of 44,218 head CT data of referred patients to the CT centres of five health facilities across Ghana for the period 1st January 2016 to 31st December 2018. A total of 11,806 (26,7%) of all head CT scans were for the diagnosis of headache for the period across all five centres.

### 3.1. Distribution of clinical indications for head CT and gender

All head CT scans analyzed for convenience, were classified into the following clinical indications: headache, trauma, and non-trauma —the total results of clinical indication and gender distribution across all the centres illustrated in Figure 1.

### 3.2. Yearly CT utilization across the centres for the period of study

The year to year head CT utilization for all clinical indications is illustrated in Figure 2. The results showed a significant increase in head CT scans for all clinical indications between 2016 and 2017. However, there was a decrease of 22% and 16.4%, respectively, for Non-Trauma and Headache clinical indications between 2017 and 2018.

### 3.3. Percentage of head CT utilization for diagnosis of headache at each facility

The percentage of head CT for diagnosis of headache compared to the total head CT scans for all clinical indications performed at the centres for the period is illustrated in Figure 3.

### 3.4. Yearly gender distribution of headache referrals to centres for head CT scan

Figure 4 illustrates the yearly CT utilization for the diagnosis of headache and the gender distribution of referred patients across all centres. The total three-year head CT utilization across all five centers was 11,806 (26.7%).

### 3.5. Age distribution of headache patients

The age distribution of headache patients reviewed for convenience was grouped into, children (0–17-year-old), adults (18–60 years old) and aged (61 years and above). The mean age of the patients was 49.25 (STD = 20.7489) years, with the youngest and oldest patient being 5 and 100

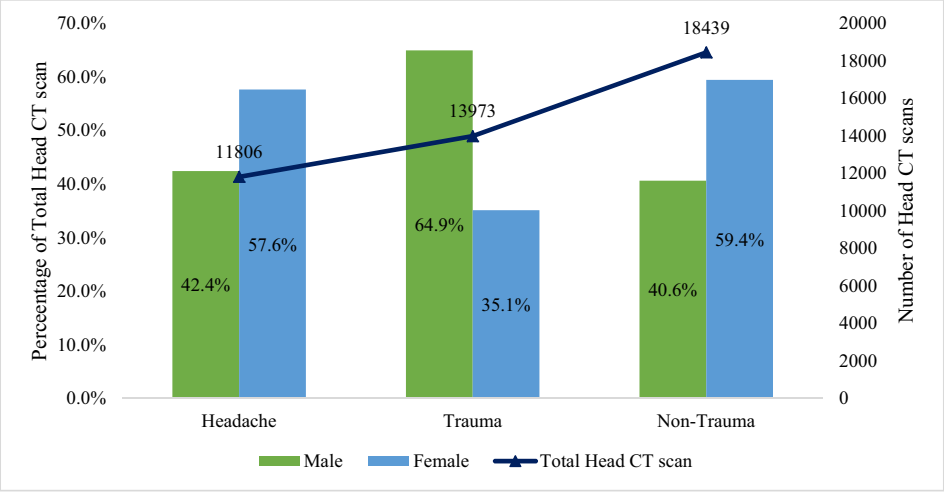


**Figure 1.** Distribution of Clinical Indications for head CT and Gender across centres.

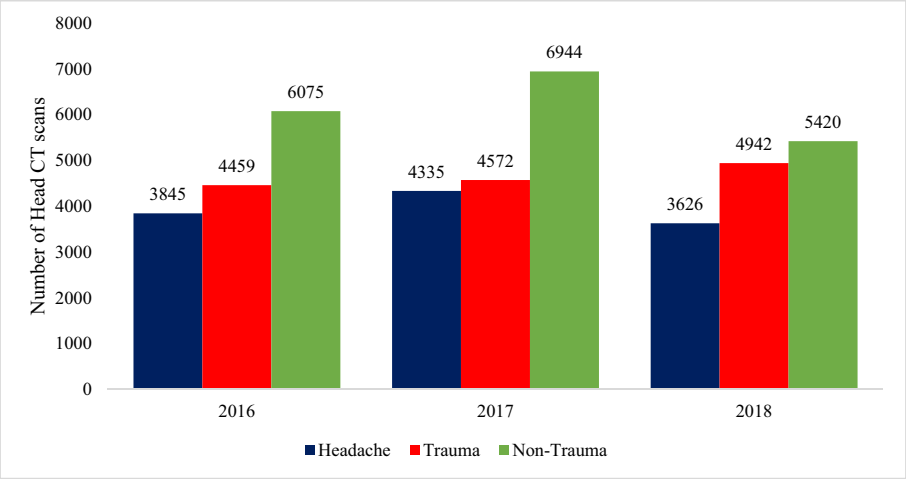


**Figure 2.** Yearly head CT utilization for all clinical indications across the centres.

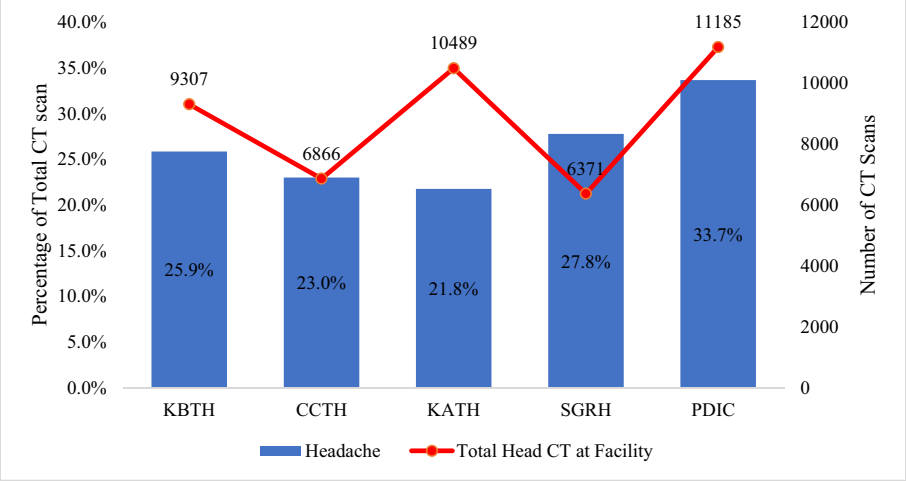


**Figure 3.** Percentage of total head CT for Diagnosis of Headache at each facility. KBTH-Korle-Bu Teaching Hospital, CCTH-Cape Coast Teaching Hospital, KATH-Komfo Anokye Teaching Hospital, SGRH-Sunyani Government Regional Hospital, PDIC-Private Diagnostic Imaging Centre.

years old, respectively. The age distribution and gender represented in Table 1.

### *3.6. Analysis of significant head CT scan findings for diagnosis of headache*

There were normal findings in 11475 (97.2%) of all head CT scans for the diagnosis of headache. Pathological findings elicited in 331 (2.8%) of cases. The pathological findings in children (1–17 years) were 71 (0.6%), adults were 206 (1.7%) and 54 (0.5%) were aged (61 yrs and above). The breakdown of the pathological findings is illustrated in Figure 5.

### *3.7. Appropriateness of head CT for diagnosis of headaches against the AC of the ACR*

The appropriateness of head CT scan performed for each type of presenting headache was matched against the AC of the ACR and the results are shown in Table 2.

**Variants for ACR criteria for headache** [15]

1. **Variant 1:** Sudden, Severe Headache or "Worst Headache of Life."
   **Initial Imaging (CT Head):** The most appropriate initial imaging test in this clinical setting is a non-contrast head CT. Failure to obtain the head CT accounts for 73% of misdiagnosis. There is no evidence to support the use of CT with intravenous (IV) contrast or CT without and with IV contrast in this setting.
2. **Variant 2:** New Headache with Optic Disc Edema.
   **Initial Imaging (CT Head):** Non contrast head CT is useful to assess for space-occupying processes, such as intracranial hemorrhage, mass effect, macroadenoma causing optic chiasm compression, and hydrocephalus. Although findings such as high attenuation within the venous sinuses may be evident, there is wide variability of venous anatomic differences, and non-contrast CT is not as accurate as dedicated venographic imaging for detection of venous sinus thrombosis. The use of contrast should be for venographic assessment, detailed in CT venogram (CTV) below. Postcontrast head CT may be considered for patients unwilling or unable to undergo MRI for comprehensive parenchymal evaluation.
3. **Variant 3:** New or Progressively Worsening Headache With One or More of the Following "Red Flags": Subacute Head Trauma, Related Activity or Event (Sexual Activity, Exertion, Position), Neurological Deficit, Known or Suspected Cancer, Immunosuppressed or Immunocompromised State, Currently Pregnant, or 50 Years of Age or Older.
   **Initial Imaging:** In all of these circumstances, non-contrast CT can be sufficient to exclude new haemorrhage, significant mass effect, or

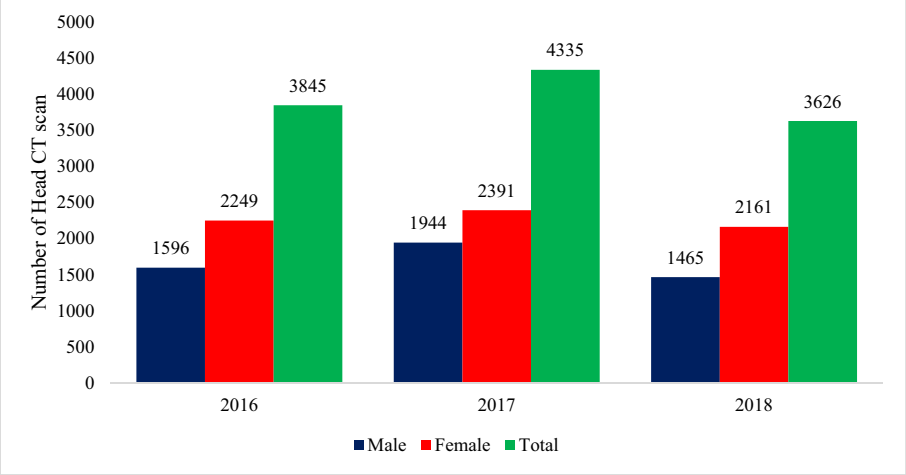


**Figure 4.** Year on year gender distribution of head CT scan for Diagnosis of headache.

**Table 1.** Demographic characteristics of headache patients.

| | Children (0–17 yrs) | Adults (18–60 yrs) | Aged (61 yrs and above) | Total |
|---|---|---|---|---|
| Male | 966 | 3564 | 475 | 5005 |
| Female | 1313 | 4842 | 646 | 6801 |
| Total | 2279 | 8406 | 1121 | 11806 |
| Percentage | 19.3 | 71.2 | 9.5 | 100.0 |

hydrocephalus. Please see the Safety Considerations in Pregnant Patients section later for details. There is no evidence to support the use of CT head with contrast as the initial imaging procedure in this clinical setting.

4. **Variant 4:** New Headache. Classic Migraine or Tension-Type Primary Headache. Normal Neurologic Examination.
**Initial Imaging:** Head CT scans have been shown to yield positive results in only 0.4% of patients that are referred with a nontraumatic headache.

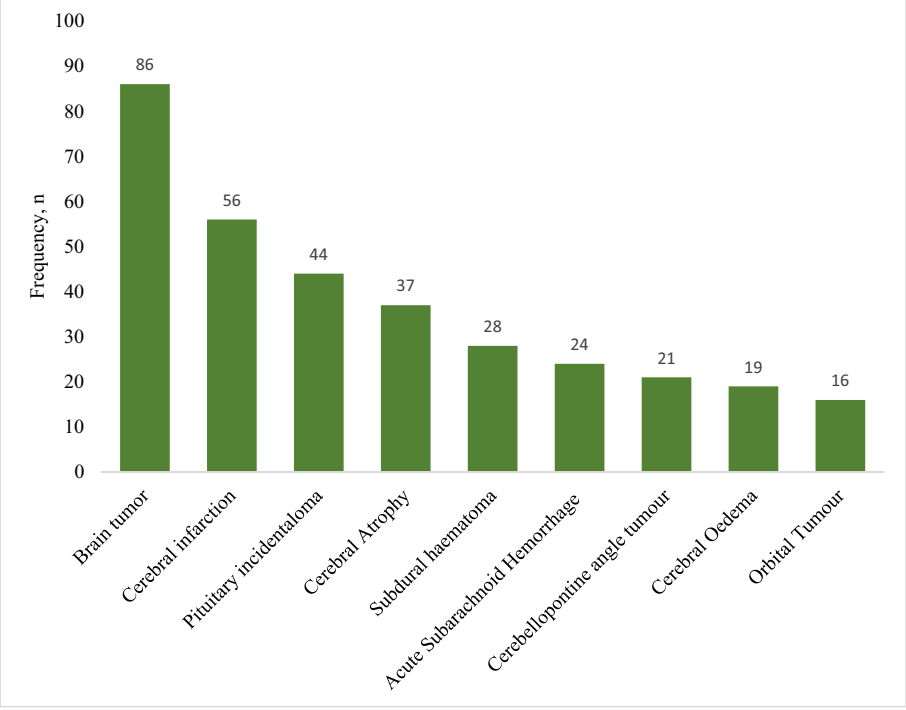


**Figure 5.** Pattern of pathological findings on head CT scan.

**Table 2.** Appropriateness of head CT examinations against the ACR headache criteria variants.

| Indication for CT | Freq. | Percent. | Appropriateness level according to ACR |
|---|---|---|---|
| Migraine | 3042 | 25.8 | Not appropriate according to variant 4 |
| Chronic headache | 1378 | 11.7 | Not appropriate according to variant 6 |
| Recurrent headache | 824 | 7.0 | Not appropriate according to variant 6 |
| Severe headache - TTH | 1389 | 11.8 | Not appropriate according to variant 4 |
| Persistent headache | 609 | 5.2 | Not appropriate according to variant 6 |
| General headache | 324 | 2.7 | Not appropriate according to variant 6 |
| Depression & headache | 307 | 2.6 | Not appropriate according to variant 6 |
| Right sided headache | 273 | 2.3 | Not appropriate according to variant 6 |
| Recurrent Severe headache | 615 | 5.2 | Usually appropriate according to variant 1 |
| Thunderclap | 1720 | 14.6 | Usually appropriate according to variant 1 |
| Severe occipital headache | 1325 | 11.2 | Usually appropriate according to variant 1 |
| Total | 11806 | 100.0 | |

5. **Variant 5:** New Primary Headache of Suspected Trigeminal Autonomic Origin.
   **Initial Imaging:** CT may reveal suprasellar extent of a pituitary mass; however, it is less sensitive than MRI for evaluation of Sella processes.
6. **Variant 6:** Chronic Headache. No New Features. No Neurologic Deficit.
   **Initial Imaging:** In the evaluation of patients with chronic headache with no new features and no concerning findings on clinical or physical examination, there is no relevant literature to support the use of CT head in the initial evaluation.

The analysis and matching of our data against the six variants of the Appropriateness Criteria (AC) of the American College of Radiologists (ACR) to ascertain the appropriateness of utilization of CT scan for the diagnosis of headache were based on the information available on the patient's referral form received at the CT centres. Therefore, most of the patients presented with a definite diagnosis of the type of headache written by the diagnosing clinician. Availability or non-availability of "red flags" can only be ascertained from the patient's complete clinical chart, which was not available to us. Our paper is a retrospective review, and so we were a bit handicapped with this information. The analysis of headache type and mapping it against the variants of AC of the ACR was based solely on the definite clinical diagnosis of the type of headache on the referral document.

As standard practice head CT scan is indicated and appropriate when any of the "red flags" is present. We acknowledge that, CT scan use for the diagnosis of headache is justified when matched appropriately with the variants.

All patients reviewed had an initial CT scan without contrast. The administration of contrast is performed only after eliciting a suspicious lesion. Inference from Table 2, the degree of appropriateness or inappropriateness of all head CT scans for the diagnosis of headache showed that 69% of the head CT scans were not appropriate versus 31% of head CT found to be appropriate according to the AC of the ACR mapping.

### *3.8. Pattern of referral for headache patients to CT scan centre*

Analysis of headache patients pattern of referral to the CT centres showed a majority (57%) were referred from the out-patient department, 26% from the accident and emergency, the in-patient referrals were 10%, and the least, 7% were from specialist consultation.

## 4. Discussion

This audit, to our knowledge, documents for the first time and evaluates the degree of CT utilization in the diagnosis of headache, demographic characteristics of headache patients, pattern of referrals, and degree of appropriateness of head CT for diagnosis of headache in Ghana. The role of neuroimaging mostly CT (in the case of Ghana because MRI services are almost non-existent) in investigating headache particularly in emergency settings is well established in clinical practice [25, 26, 27]. Ghana has 56 Radiologists for a population of 30 million whose distribution are skewed in favour of urban areas, creating a huge service gap with the few radiologists overburdened with work. The only way to bridge this service gap while increasing numbers of radiologists by training is from the application of information communication technology (ICT) [28, 29].

In this audit, we reviewed a total of 44,218 head CT scans of varied indications which were performed across all five facilities for the three years evaluated. As can be inferred from Figure 1, Non-traumatic indications were the highest of which females were 59.4% and 40.6% males. The most non-traumatic condition diagnosed by head CT was Cerebro-Vascular Accident (CVA), constituting 34.2% of cases.

Trauma cases were 31.6%, of which there was a high male preponderance for trauma 64.9%, and females constituted 35.1%. The most prevalent cause of trauma was Road Traffic Accident (RTA), which made up 72.3% of all trauma cases. The high incidence of RTA across the country is confirmed in a study that highlighted the high spate of RTA in Ghana, and this is a preventable public health situation that has to be confronted with all urgency [30].

The utilization of CT for the management of headache especially in emergency situations is very necessary and important [3, 27]. In our audit, the utilization of CT for diagnosis of headache was 26.7%, with the majority of headache patients been females (57.6%) similar to previous studies that reported an overall female preponderance for headache [31, 32]. The mean age of patients for this study was 49.25 (STD = 20.7489) years with the adult age cohort been the majority (71.2%) from Table 1. This finding is significant as it has direct implications on the productivity of the country and the socio-economic correlation cannot be over emphasized. In a study in the USA on the prevalence and burden of migraine in the United States, the majority of patients presenting with headaches were between the ages of 25 and 55 years old [33]. Headache disorders affect all ages, races, income levels, and geographical areas, causing a significant burden to sufferers (personal, quality of life, and financial). The socio-economic burden of headache is enormous as, in some cases, there is a significant loss of working or school hours and reduced productivity [20].

Our audit showed the total number of children referred for head CT scan for the diagnosis of headaches constituted 19.3% of all headache patients which had CT scan. Although unnecessary for children with headaches and good history, CT scans were still requested. Fewer than one percent of pediatric brain abnormalities present with headache as the only symptom [34]. Additionally, repeated CT scans may increase the lifetime risk of cancer [35, 36], although in our audit we could not

ascertain the records on repeated head CT scans from the patients CT records and this has been acknowledged as a limitation to our study. The prevalence and risks of headache in children according to various studies are mostly as a result of a dysfunctional family situation, caffeine ingestion, smoking, a low level of physical activity, physical or emotional abuse, bullying by peers, unfair treatment in school, and insufficient leisure time [34]. Chronic medications usually account for headache in the elderly; therefore, clinicians must be circumspect in requesting head CT for these patients [37].

Our review elicited five frequent types of headaches, as depicted in Table 2. They were consistent between the five centers, but similar to other studies [2, 6].

Figure 2 illustrates the degree of referrals to the various centres for head CT scan for the diagnosis of headaches. The utilization of CT was highest in the private diagnostic imaging center (PDIC), which could be explained by varied reasons, including but not limited to income generation activity. Over 90% of all PDIC patients were OPD referrals. The CT utilization across the four government facilities was also generally high, albeit some of the CT scanners were non-functional for a period, especially in 2018.

The pattern of referral of headache patients referred for head CT showed a majority (57%) of patients were from the outpatient department, 26% from the accident and emergency, the in-patient were 10%, and the least, 7% were from specialist consultation. Consulting clinicians must refer headache patients for specialist Neurologist evaluation. However, the availability of Specialist consultations in Ghana is a luxury as specialists are limited [38, 39]; therefore, this can affect the accessibility of headache patients for competent Specialist Neurologist evaluation.

The high utilization of CT scans for the diagnosis of headaches has been a concern despite the existence of guidelines in other countries [32]. In our audit, headache patients at all the centres were initially scanned without contrast and a repeated scan with contrast is done only when indicated. All CT scans services are paid for by the patients.

By matching our data against the AC of the ACR [15] to determine the appropriateness of the head CT scans performed for the diagnosis of headache, it can be deduced from Table 2 of the results that 69% head CT scans were not appropriate versus 31% of head CT were found to be appropriate according to the AC of the ACR. Table 2 also showed that 69% of the patients presented with diverse categories of headaches and may have been exposed to unnecessary ionizing radiation and associated financial burden to the patient. However, the results also showed that it was appropriate for patients presenting with severe headaches, thunderclaps, recurrent severe headaches, and severe occipital headaches to be referred for head CT scans without IV contrast according to the AC of the ACR.

Based on our comprehensive data analysis from the five facilities, the utilization of head CT scans for the diagnosis of headaches for the period was 26.7%. This by our estimation means the degree of head CT utilization is quite high. Therefore, Clinicians, Neurologists, Radiologists, and policymakers are to institute neuroimaging protocols for headaches. Computed Tomography services are limited, especially outside Accra, the national capital [18]; therefore, patients referred for CT must travel for several kilometers to access CT services, and the cost burden of CT imaging on the average Ghanaian is substantially overbearing [18, 38].

The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) [40] reported the contribution of CT procedures to collective dose from diagnostic radiology in all developed countries with a frequency of about 35% during the period 1991–1996 and 40% during the period 1996–2000. The highest of 62% contribution was from the period 2000–2010.

Patients' protection from unnecessary ionizing radiation and cost is paramount. Many governments, seeking to oblige healthcare costs, do not acknowledge the substantial burden of headache on society [20]. The direct costs of treating headaches are small compared to the substantial indirect-cost savings from (e.g., by reducing lost working days) if resources to treat headache disorders were appropriately made available [20]. Medication overuse in headache is usually less diagnosed, and therefore consulting physicians must take this problem into account.

Our study has several strengths. We have analyzed data from several Government referral-based facilities as well as a private health facility and there are striking similarities in the trends between the centers, which indicate that utilization of CT for the diagnosis of headache has a consistent pattern. This review is the first to comprehensively audit the propensity of CT utilization for headaches diagnosis in Ghana. However, there are limitations, as well.

## 5. Limitations of the study

- There was no direct link between the CT scan center and the outpatient department. Thus, patient's information, such as short history, occupation, and other clinical examination findings, could not be assessed.
- We were unable to ascertain if a complete neurological examination were performed for all patients as there was no indication of same on the patients' referral documentation
- Comprehensive patient CT data management and history was a challenge. Therefore, we could not isolate cases of patients who had repeated head CT examinations for the diagnosis of headache.
- There was no MRI control study of patients as availability of MRI services is almost non-existence in Ghana.

## 6. Conclusions

There is a need to implement international best practice guidelines or develop a national neuroimaging policy to protect patients. Unjustified CT utilization for diagnosis of headaches exposes patients to unnecessary ionizing radiation that can cause cancer and expenditure. Clinicians must, therefore, be discerning in head CT scan requests for the diagnosis of headache.

## Declarations

### *Author contribution statement*

Philip Narteh Gorleku, Emmanuel Kobina Mesi Edzie: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Klenam Dzefi-Tettey, Jacob Setorglo: Analyzed and interpreted the data; Wrote the paper.

Albert Dayor Piersson, Isaac Frimpong Brobbey, Emmanuel Worlali Fiagbedzi: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Ishmael Nii Ofori, Edmund Kwadwo Kwakye Brakohiapa: Analyzed and interpreted the data.

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### *Data availability statement*

Data will be made available on request.

### Declaration of interests statement

The authors declare no conflict of interest.

### Additional information

No additional information is available for this paper.

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