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Research article

Incidence rate and age of onset of first stroke from CT scan examinations in Cape Coast metropolis

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ABSTRACT

Introduction: The trends in the incidence and age of onset of first stroke is lacking in Ghana and with an increasing elderly population, such trends are projected to increase in developing countries. Through the review of Computed Tomography (CT) scan examinations and patients' records; we assessed the incidence rate and age of onset of first stroke in Cape Coast Metropolis.

Methods: This study retrospectively reviewed all imaging records and clinical data of all stroke patients referred for CT scans in the radiology department of the Cape Coast Teaching Hospital (CCTH) between January 2017 and December 2019. All CT confirmed cases of stroke were classified as either hemorrhagic stroke or ischemic stroke. Age adjusted annual incidence rate with 95% Confidence Intervals (CIs) were calculated assuming a Poisson distribution. Mean difference were tested using one way Analysis of Variance (ANOVA).

Results: 840 patients with first onset of stroke were identified, comprising 417 (49.6%) males and 423 (50.4%) females. There was a statistically significant difference in the mean age of onset of first stroke in males (61.47 ± 13.36 years) and in females (63.41 ± 15.41 years), $p = 0.049$. The incidence of first stroke for the entire age categories were higher in males compared to the same age categories in females, except for patients aged 35–44 years in 2017, 25–34 years in 2018, 15–24 years and 75 years or older age groups in 2019. Males had hemorrhagic stroke at an older age (64.41 ± 15.31 years) compared to ischemic stroke (60.40 ± 12.42 years) in this study. This difference was statistically significant ($p = 0.014$). There was no significant difference in the mean age of onset of first stroke for the respective years under study: $F(3, 836) = 0.693$, $P = 0.500$.

Conclusion: The findings of this study imply that the incidence rate of stroke is higher in males than in females and increases with age. The majority of the strokes were ischemic.

1. Introduction

Cerebrovascular accidents (CVA) have been identified as one of the leading cause of mortality and disability worldwide. According to the World Health Organization estimates in 2016, stroke has accounted for about 10.2% of deaths worldwide [1]. Broadly categorized as either ischemic or hemorrhagic, the diagnosis of stroke requires neuroimaging with computed tomography (CT) and/or Magnetic Resonance Imaging (MRI) in determining stroke types and management [2]. To differentiate ischemic from hemorrhagic stroke, a brain CT is usually the first imaging modality considered especially in our setting where CT scan has been reported as one of the most available imaging modalities [3]. Three main stages are used to describe the CT manifestations of stroke: acute (less than 24 h), subacute (24 h–5 days) and chronic (weeks) [4]. Approximately 80–87% of strokes are from infarction due to thrombotic or embolic cerebrovascular occlusion and the remaining 13–20% constitutes hemorrhagic stroke [5].

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Nearly, three-quarters of all stroke cases occur in people over the age of 65 years, and its prevalence is expected to rise in the next generation, as projections from the United Nations world population prospects indicate that, by 2050, one in six people in the world will be over the age of 65 years up from one in eleven in 2019 [6,7].

Stroke and other non-communicable diseases have become a major public health issue in Africa and other low- and middle-income nations, as current evidence suggests such settings are affected by the overall global burden of stroke. For instance, of the reported 5.9 million strokes related deaths worldwide in 2010, approximately 4.2 million were from Low Middle Income Countries (LMICs) [8]. Furthermore, the burden of stroke is predicted to increase in these regions as a result of urbanization, poor socio-economic status, and a change in population demographic structure from young to an aging population [8]. In Africa, Community-based studies revealed an age-standardized annual stroke incidence rate of up to 316 per 100 000 population, and age-standardized prevalence rates of up to 981 per 100 000. A stroke-prevalence study in rural South Africa, provided an age-standardized stroke prevalence of 290 per 100 000 people over the age of 15 years. A repeat rural Tanzanian study also showed an increase in prevalence per 100 000 population from 127 among people aged 15 years and above in 1994 to 300 in 2010. Comparatively, the incidence of stroke has significantly declined in many high-income countries contrast to trends in African countries [9].

Globally, over 70% of all strokes occur above the age of 65 years and incidence of stroke double with each decade after the age of 45 years [10]. In Ghana, stroke is one of the top five causes of death and one of the frequent cases admitted in hospitals. For instance, trends in stroke admission in Central Ghana indicated that stroke admissions has progressively increased from 5.32 per 1000 admissions in 1983 to 13.85 per 1000 admissions in 2010 [11]. Furthermore, data from admission and discharge registers of the Komfo Anokye Teaching Hospital showed that 9.1% of adult admissions were stroke related cases and accounted for 13.2% of all adult deaths [12]. With an ever increasing elderly population, stroke-related health problems and their impact on quality of life have become very relevant. Information on incidence and age of onset of first stroke is extremely important in laying out interventional packages in the management of this disorder. Such information is limited in Ghana, hence, this study in the population of the Cape Coast metropolis of Ghana with the objectives below:

- To determine the mean age of onset of first stroke and assess the trends over the study period.
- To assess the annual incidence of stroke by sex.
- To determine the commonest type of stroke in our population
- To ascertain the association between the type of stroke and the age and sex of patients.

2. Methods

2.1. Study site

The study was conducted in the Cape Coast Metropolis which is one of the seventeen districts of the Central Region of southern Ghana with a population of 169,894 which amounts to 7.7% of the region's total population. Males constitute 48.7% and females represent 51.3% [13]. The proportion of the metropolis youth (15–35 years) per the National Youth Policy is 46.8% with a relatively small number (4.5%) of the elderly population (60 years and older). The Metropolis is endowed with a Teaching Hospital, a District Hospital and various Clinics that provide health care to the populace.

2.2. Study design

This study retrospectively reviewed all imaging records and clinical data of all stroke patients referred for CT scans in the radiology department of the Cape Coast Teaching Hospital (CCTH). CCTH is the only tertiary facility located in the Cape Coast Metropolis and serves as referral center for those in the region and beyond. All CT confirmed cases of stroke were classified as either hemorrhagic stroke or ischemic stroke. Two different kinds of age classifications were used. First, the Ghana age structure standards, where patients were grouped into one of these categories: early working age (15–24 years), prime working age (25–54 years), mature working age (55–64 years) and the elderly ($\geq$65 years) described as age group A and a second age distribution with equal width intervals ($\leq$14 years, 15–24 years, 25–34 years, 35–44 years, 45–54 years, 55–64 years, 65–74 years, $\geq$ 75 years) to estimate the incidence rates for the various age categories referred to as age group B in this study.

2.3. Data collection

The numbers of stroke of first onset were assessed from all cranial CT scans done between January 2017 and December 2019. All cranial CT images were acquired with a multi-detector 16-slice Toshiba Acquilion CT scanner, model TSX-101A manufactured by Toshiba Medical Systems (Otawara, Tochigi, Japan). The images were acquired from the base of skull to the vertex. The parameters used were: tube voltage 120 kV; tube current-exposure time, 225mAs, slice thickness of 5mm, rotation time 0.75s and collimation 1 $\times$ 16. All CVA cases diagnosed over the period were consecutively retrieved and reviewed from the Lightwave Health Management Information System (LHMIS) and Picture Archiving Communication System (PACS) by two independent radiologists and a radiographer. A detailed review of the medical records (history of stroke occurrence and clinical examination) were done by the researchers from the LHMIS in order to ensure only cases of first-ever stroke experienced by a given patient during the study period were included. A total of 1374 stroke cases were diagnosed over the period comprising 840 first onset and 534, which were recurrent strokes. The age and sex of the patients and stroke types were collated and organized for analysis.

2.4. Statistical analysis

Annual specific incidence rates of first-ever stroke were calculated by dividing the number of stroke events by the total population in the region for the respective years (2017, 2018, and 2019) based on projections from the District Analytical Report for Cape Coast Municipality, provided by the Ghana Statistical Service [14]. Direct method of standardization was used to adjust for age specific rates based on the new WHO world population distribution standard in order to overcome the effects of variations in age structure [15]. The incidence rates with 95% confidence intervals (CIs) were estimated using Poisson distribution. We tested for the significant difference in the annual mean age of onset for first stroke and for both hemorrhagic and ischemic stroke using one way Analysis of Variance (ANOVA), F-test and the Robust test for equality of means. Multiple comparisons were done using the Games-Howell's test. Preliminary analyses were done to check for violation of assumptions particularly (normality, homogeneity of variance, and Poisson distribution test) for analyses where applicable. Mean values are quoted at absolute values $\pm$standard deviation. All two-sided p-values $\leq$ 0.05 were considered statistically significant and used Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) version 20.0 for the analyses.

2.5. Ethical consideration

Ethical clearance for the study was sought and approved by the Ethical Review Committee of CCTH with clearance number CCTHERC/EC/2018/35. Patient informed consent for this study could not be obtained as this was a retrospective study but anonymity and confidentiality were ensured throughout the study.

3. Results

In total, 840 patients with onset of first stroke were identified on CT scan examination, from January 2017 to December 2019 with a male-to-female ratio of 97:100 and an average age of 62.45 ± 14.45 years, with the youngest aged 15 years and the oldest 106 years. Over the whole period, 429 patients (51.0%), and 411 (48.9%) were 15–64 years and ≥65 years respectively. Overall, 227 (27.0%) and 613 (73.0%) of hemorrhagic and ischemic stroke cases were diagnosed respectively and both cases were more common in females [423 (50.4%) against 417 (49.6%) in males] although there were no significant difference in the proportion of males and females with stroke (P = 0.977). Males had hemorrhagic stroke at an older age (64.41 ± 15.31 years) compared to ischemic stroke (60.40 ± 12.42 years) in this study. This difference was statistically significant (p = 0.014). There was a statistically significant difference in the mean age of onset of first stroke in males (61.47 ± 13.36 years) and in females (63.41 ± 15.41 years), p = 0.049. There was a significantly higher proportion of patients aged 65 years and older (elderly) with stroke (P < 0.001) followed by patients who were in their prime working age (25–54 years). In 2017, 2018 and 2019 there were 216(25.7%), 371(44.2%) and 253 (30.1%) onset of first stroke cases respectively. The changes in the proportion of stroke among the age groups over the study period were not statistically significant (Tables 1 and 2).

The mean age for ischemic stroke was significantly lower in males compared to the females (p = 0.027) whereas the change of 0.62 year (p = 0.083) for hemorrhagic stroke was not significant. The mean age in males significantly increased from 60.50 years in 2017 to 63.30 years (p = 0.029) in 2018 and fell significantly to 59.43 years (p = 0.029) in 2019. However, the mean age in females decreased from 63.14 years in 2017 to 62.91 years (p = 0.703) in 2018 and increased to 64.34 years (p = 0.703) in 2019, but these changes were not statistically significant (Table 2).

For the entire period, hemorrhagic stroke was dominant in the elderly population with a fraction of 62.1%, 67.0% and 44.9% for 2017, 2018 and 2019 respectively. For 2018, no incidence of hemorrhagic stroke was recorded in the early working age (15–24 years) but contributed to 1.7% and 2.9% of the total hemorrhagic stroke for 2017 and 2019 respectively. For the mature working age group (55–64 years) the proportion of hemorrhagic stroke increased from time to time. Thus, there was an increase in proportion from 10.3% in 2017 to 15.0% in 2018, and from 15.0% to 15.9% in 2019. Like the hemorrhagic stroke, the proportion of ischemic stroke was also predominant in the elderly population for each year among all age groups; 42.4%, 45.0%, and 47.8% in 2017, 2018 and 2019 respectively. The proportion of ischemic cases decreased from time to time among the prime working age group (25–54 years) from 30.4% to 28.4% in 2018 and finally to 24.5% in 2019 (Figure 1).

The incidence rate of stroke increased as age increased for all the years of this study and the rate was higher for those aged 65–74 years. The annual incidence of stroke increased by more than double in males aged 65–74 years from [IR = 72.39 per 100,000, 95% CI = 44.76–100.01] in 2017 to [IR = 194.88 per 100,000, 95% CI = 150.10–239.67] in 2018. For both sexes, the overall annual rate of incidence was higher in 2018 [IR = 455.69 per 100,000, 95% CI = 319.95–591.43] for males and [IR = 307.68 per 100,000, 95% CI = 205.10–410.26] for females. The incidence of first stroke for the entire age categories were higher in males compared to the same age categories in females, except for patients aged 35–44 years in 2017, 25–34 years in 2018, 15–24 years and 75 years or older age groups in 2019. In 2019, the incidence of stroke increased for males aged between 15 and 44 years and fell sharply for those aged 45 years and above. In females, the incidence rate fell in 2019 for the entire age categories except those aged between 15 and 24 years (Table 3 & Figure 2).

The graph shows an increasing pattern of stroke as age increases peaking at age between 65 and 74 years. The slope was steeper for males in 2018 compared to females in the same year.

The overall mean age of patients was 62.45 ± 14.454 years; 64.72 ± 16.044 years for hemorrhagic stroke and 61.61 ± 13.738 years for ischemic stroke. The annual mean age of onset of first stroke slightly

Table 1. Socio-demographic characteristics of onset of first stroke by type of stroke and year of first onset.

Stroke Type				
	Hemorrhagic	Ischemic	Overall	P-value
Number of Cases	227 (27.0%)	613 (73.0%)	840 (100%)	-
Age Group A				
15–24 years	3 (30.0%)	7 (70.0%)	10 (1.2%)	<0.001*
25–54 years	58 (25.4%)	170 (74.6%)	228 (27.1%)	
55–64 years	32 (16.8%)	159 (83.2%)	191 (22.7%)	
≥65 years	134 (32.6%)	277 (67.4%)	411 (48.9%)	
Gender				
Male	112 (26.9%)	305 (73.1%)	417 (49.6%)	0.977
Female	115 (27.2%)	308 (72.8%)	423 (50.4%)	
Year of First onset				
	2017	**2018**	**2019**	**P-value**
Number of stroke cases	216 (25.7%)	371 (44.2%)	253 (30.1%)	-
Age Group A				
15–24 years	3 (30.0%)	2 (20.0%)	5 (50.0%)	0.651
25–54 years	63 (27.6%)	95 (41.7%)	70 (30.7%)	
55–64 years	47 (24.6%)	85 (44.5%)	59 (30.9%)	
≥65 years	103 (25.1%)	189 (46.0%)	119 (29.0%)	
Gender				
Male	103 (24.7%)	192 (46.0%)	112 (29.3%)	0.550
Female	113 (26.7%)	179 (42.3%)	131 (31.0%)	
Stroke Type				
Hemorrhagic	58 (25.6%)	100 (44.1%)	69 (30.4%)	0.994
Ischemic	158 (25.8%)	271 (44.2%)	184 (30.0%)	

$\chi 2$ test for the other variables.
* Statistically significant.

Table 2. Mean distribution of patients with onset of first stroke.

Item	Mean ± Standard Deviation	P-value
Mean Age of patients	62.45 ± 14.45	-
Mean Age of Males	61.47 ± 13.36	0.049*
Mean Age of Females	63.41 ± 15.41	
Mean Age of hemorrhagic patients	64.72 ± 16.04	0.001*
Mean Age of ischemic patients	61.61 ± 13.74	
Mean Age of Males with hemorrhagic Stroke	64.41 ± 15.31	0.014*
Mean Age of Males with ischemic Stroke	60.40 ± 12.42	
Mean Age of Females with hemorrhagic Stroke	65.03 ± 16.79	0.189
Mean Age of Females with ischemic Stroke	62.81 ± 14.85	
Mean Age of Males with hemorrhagic Stroke	64.41 ± 15.31	0.083
Mean Age of Females with hemorrhagic Stroke	65.03 ± 16.79	
Mean Age of Males with ischemic Stroke	60.40 ± 12.42	0.027*
Mean Age of Females with ischemic Stroke	62.81 ± 14.85	
Mean Age of Males in 2017	60.50 ± 14.24	0.029*
Mean Age of Males in 2018	63.30 ± 11.53	
Mean Age of Males in 2019	59.43 ± 14.91	
Mean Age of Females in 2017	63.14 ± 15.32	0.703
Mean Age of Females in 2018	62.91 ± 15.45	
Mean Age of Females in 2019	64.34 ± 15.52	

P-values obtained from one way ANOVA.
* Statistically significant.

increased in 2017 from 61.88 ± 14.841 to 63.11 ± 13.546 years in 2018 and slightly reduced to 61.97 ± 15.397 in 2019. There was no significant difference in the mean age of onset of first stroke for the respective years under study: F (3, 836) = 0.693, P = 0.500 (Table 4). However, there was a significant difference in the annual mean age of onset of hemorrhagic stroke for the three years under review: F (3, 227) = 4.023, P = 0.019. The mean age for hemorrhagic stroke was 65.88 ± 17.711 for 2017, 67.12 ± 13.478 for 2018 and 62.28 ± 17.275 for 2019. Post-hoc comparisons revealed that the mean age of first onset of stroke for 2018 was significantly different from the mean age of first onset for 2019 [6.845, 95%CI = -0.96–12.72, P = 0.018]. The mean age of ischemic stroke was 60.41 ± 13.404, 61.63 ± 13.292 and 62.61 ± 14.632 for 2017, 2018 and 2019 respectively. There was no significant difference in the mean age of first onset for ischemic stroke: F (3, 613) = 1.008, P = 0.337 (Tables 4 and 5).

4. Discussion

Previous studies in Ghana have examined the incidence of stroke from clinical examinations [11, 12]. This study however is arguably the first to report on incidence and age of onset of first stroke determined from neuroimaging (CT scan) examination in Ghana. This is even more relevant given CT scan being the gold standard for diagnosis of stroke and proper management of acute stroke syndrome [16].

In this study, the proportion of males and females were 49.6% and 50.4% respectively. The slightly higher proportion of females (1.01) is contrary to other studies in sub-Saharan Africa and developing countries

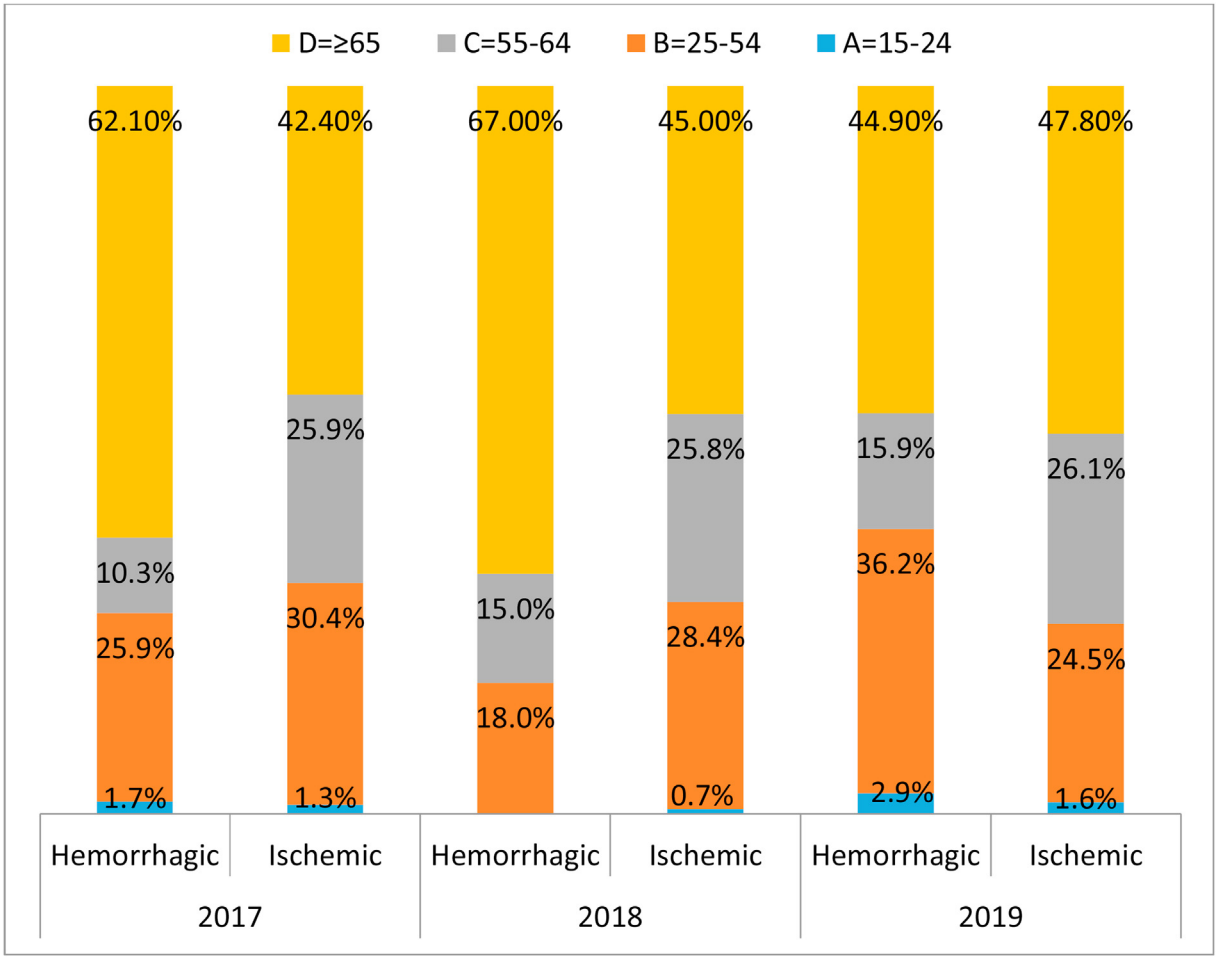

Figure 1. Proportion of stroke type for the respective years stratified by age group.

Table 3. Annual age-adjusted incidence per 100,000 population for 2017–2019.

Variable	Male			Female		
Age Group B	Pop.	Count (N)	IR per 100000 (95%CI)	Pop.	Count (N)	IR per 100000 (95%CI)
2017						
≤14	32905	0	0	33584	0	0
15–24	28812	2	1.16 (-0.45–2.76)	29143	1	0.57 (-055–1.70)
25–34	15806	7	3.93 (0.08–7.79)	15118	3	3.08 (-0.41–6.57)
35–44	8526	12	9.67 (1.93–17.40)	9531	9	12.97 (4.50–21.45)
45–54	5651	21	42.40 (24.30–60.50)	6989	21	34.28 (19.64–48.93)
55–64	3654	30	58.85 (36.31–81.38	4195	19	37.46 (20.65–54.26)
65–74	1857	30	72.39 (44.76–100.01)	2472	32	66.93 (43.89–89.96)
≥75	1302	20	42.37 (22.93–61.81)	2303	28	37.26 (23.55–50.98)
Total	98513	122	230.77 (129.86–331.67)	103335	113	192.56 (111.27–277.84)
2018						
≤14	32852	0	0	33530	0	0
15–24	28812	1	0.58 (-0.56–1.71)	29143	1	0.57 (-0.55–1.70)
25–34	15806	1	0.98 (-0.94–2.91)	15118	6	6.17 (1.23–11.10)
35–44	8526	11	17.73 (7.26–28.20)	9531	12	17.30 (7.52–27.08)
45–54	5651	32	64.61 (42.29–86.93)	6989	35	57.14 (38.23–76.02)
55–64	3654	48	108.64 (78.11–139.17)	4195	37	72.94 (49.54–96.34)
65–74	1857	70	194.88 (150.10–239.67)	2473	48	100.35 (72.24–128.50)
≥75	1302	29	68.27 (43.70–92.84)	2304	40	53.21 (36.87–69.56)
Total	97158	192	455.69 (319.95–591.43)	100979	179	307.68 (205.10–410.26)
2019						
≤14	32721	0	0	33396	0	0
15–24	28828	2	1.16 (-0.45–2.76)	29159	3	1.71 (-0.23–3.66)
25–34	15815	7	6.88 (1.78–11.97)	15126	3	3.08 (-0.41–6.57)
35–44	8530	12	19.33 (8.40–30.26)	9536	8	11.53 (3.54–19.52)
45–54	5654	21	42.38 (24.29–60.47)	6992	20	32.65 (18.36–46.94)
55–64	3656	30	67.86 (43.68–92.05)	4197	29	57.17 (36.43–77.91)
65–74	1861	30	83.38 (53.76–112.93)	2478	29	60.63 (38.69–82.56)
≥75	1304	20	47.01 (26.57–67.45)	2308	39	51.88 (35.74–68.03)
Total	98513	122	267.96 (158.03–377.89)	103335	131	218.66 (132.14–305.19)

Pop. Population; **IR** = Incidence rate, **CI** = Confidence.

[17, 18]. Stroke tends to be more common among males than in females. However, due to the high life expectancy of the latter group and high incidence of stroke at older ages, the number of cases of stroke is higher among women rather than men as found in our study. In Ghana, the life expectancy for females is 64.4 years which is higher than 62.5 years life expectancy for males [19]. For all the age groups, the males outnumbered the females except for patients aged 35–44 years in 2017, 25–34 years in 2018, 15–24 years and 75 years or older age groups in 2019 (Table 3). In Africa, the mean age of onset of first stroke was reported as 57.0 years in 2009 [20]. In other studies, the mean age of stroke patients in sub-Saharan Africa was 58.0 years, which was about 10–15 years younger than patients in developed countries [21]. An INTERSTROKE study in 2010 showed a mean age of onset of first stroke of 66.0 years in high income countries and reports from the Global Burden of Disease (GBD) in 2014 indicated that the mean age of people with stroke has significantly increased in high income countries from 73.9 to 74.5 years [22, 23]. The mean age of onset of first stroke was 62.45 years from our study (Table 2). Other studies conducted in the southern part of Ghana in 2012 and 2014 also showed a mean age of 63.7 and 64.6 years respectively and a mean age of 62.0 years among older adults have also been reported [11, 12, 24]. In Ghana, the population of older adults has increased more than seven-fold from 213,477 in the 1960 census to 1, 643,381 in the 2010 census with 6.7% aged 60 or over [25]. Due to the age structure including the high prevalence of the older adults with stroke and the limited life expectancy caused by higher rates of non-communicable diseases such as stroke [7, 26], the mean age of stroke victims will be lower compared to high income countries which is demonstrated in our study and other Ghanaian studies.

In our study, 613 (73.0%) had ischemic stroke while 227 (27.0%) suffered hemorrhagic stroke (Table 1). According to studies, the disproportionate distribution of the two types of stroke has hampered the prognostic determinants of the two stroke types. In the western countries, ischemic stroke cases are ten times more frequent than hemorrhagic stroke rendering statistical validation of the two types of stroke difficult [27, 28, 29]. While hemorrhagic stroke appears to be more associated with hypertension, ischemic stroke is more related to factors such as smoking, dyslipidemia, cardiac disease and atherosclerosis [30] accounting for the predominance of ischemic stroke in the developed world since these risk factors are commonly seen in those settings [31]. Western lifestyle is now commonly adopted in many African countries [32], and thus it is expected that the distribution of stroke risk factors and type of stroke in Africa would become similar to what is observed in the western world. In Ghana, though smoking prevalence is below 10%, there is high prevalence of dyslipidemia in the Cape Coast Metropolis and cardiac disease has also increased progressively over the past decade [33, 34, 35]. Ischemic stroke is emerging as a significant contributor to stroke burden in Ghana and other sub-Saharan African countries. From 1954 to 1981, hemorrhagic stroke was the predominant stroke type accounting for 80–90% of all stroke mortality in Ghana [36, 37]. After a decline in hemorrhagic stroke to 60% in 1994 and 1998, ischemic stroke was becoming more common in the country [38]. In a recent study in 2014, ischemic stroke accounted for about 78% of all strokes which agrees with

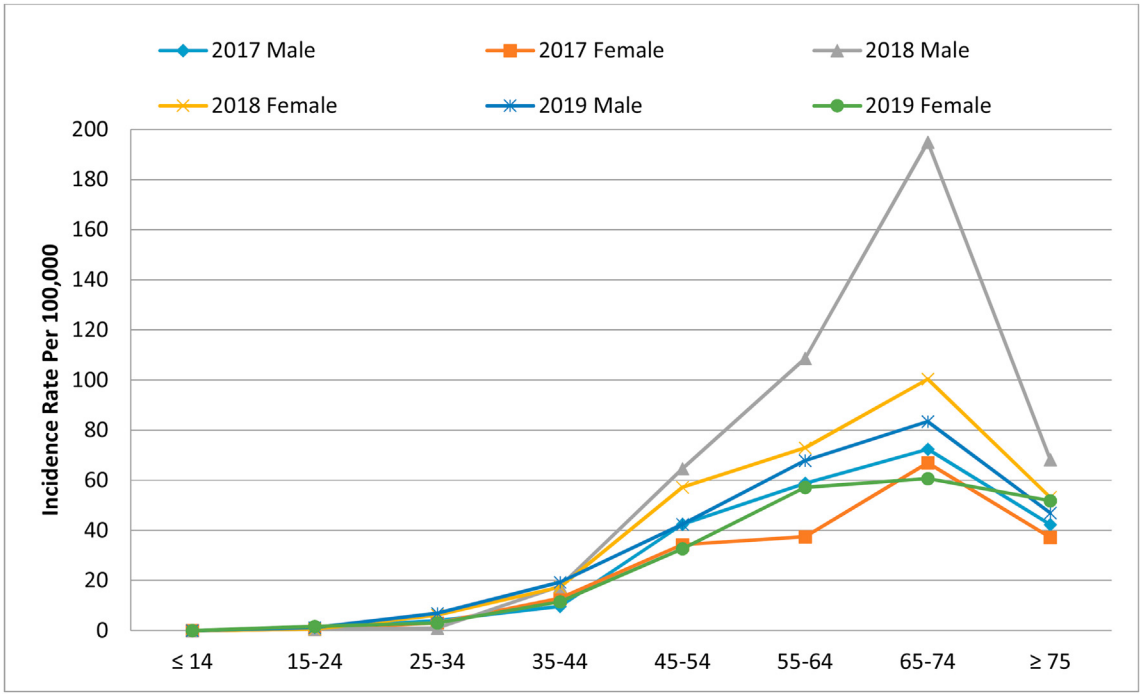

Figure 2. Pattern of stroke incidence according to age and sex.

Table 4. Analysis of variance of the age of onset of first stroke and stroke types for 2017–2019.

		Hemorrhagic				Ischemic Stroke			
Dependent Variable	Year	Count(N)	Mean (SD)	F-value	p-value	Count(N)	Mean (SD)	F-value	p-value
Age of first onset	2017	58	65.88 (17.711)	4.023	0.019*	158	60.41 (13.404)	1.088	0.337
	2018	100	67.12 (13.478)			271	61.63 (13.293)		
	2019	69	62.28 (17.275)			184	62.61 (14.632)		
	Total	227	64.72 (16.044)			613	61.61 (13.738)		

Overall			
Year	Count(N)	Mean (SD)	F-value	p-value
2017	216	61.88 (14.841)	0.693	0.500
2018	371	63.11 (13.546)		
2019	253	61.97 (15.397)		
Total	840	62.45 (14.454)		

* Statistically significant.

Table 5. Post hoc test of the age of first onset for hemorrhagic stroke for 2017–2019.

Dependent variable	Year (I)	Year(J)	Mean Difference (95%CI)	p-value
Age of first onset	2017	2018	-1.241 (-7.64–5.16)	0.889
		2019	5.604 (-1.80–13.01)	0.175
	2018	2017	1.241 (-5.16–7.64)	0.889
		2019	6.845 (-0.96–12.72)	0.018*
	2019	2017	-5.604 (-13.01–1.80)	0.175
	2018		-6.845 (-12.72–-0.96)	0.018*

* Statistically significant.

the 73.0% of ischemic stroke found in this study [39]. Although ischemic stroke was still more common than hemorrhagic stroke the proportion 73.0% found in this study was much less than the 87.0% reported by the American Heart Association in 2016 [40].

The mean age of onset of first stroke increased by 1.23 years in 2018 and decreased by 1.14 years in 2019 (Table 4). The overall mean age of stroke onset was significantly lower by 1.94 years ($p = 0.049$) in men compared to women. Over the study period, the mean age of onset in males increased in the first period and fell in the last period with the reverse of this trend seen in the female population (Table 2). Some studies have also found that mean age at first stroke increased among females, but unchanged among males. Other studies have shown a trend towards higher ages in both sexes with time while others have shown a declining age at onset of first stroke [41, 42, 43].

The incidence of stroke has substantially reduced in developed countries but increasing in the developing countries. In high income settings, the absolute number of strokes occurring is not falling but declining with a steady rate of incidence. For instance, in the United Kingdom, it is projected that if age-specific stroke incidence continues to decrease at its current rate, there would still be a 13% increase in the number of first-ever strokes given a projected aging population and a 22% decrease in the age-standardized incidence rates of stroke, have also been reported on a four year population based study in Korea [44, 45]. Similar projections have also been reported for other European countries [46, 47]. In developing countries, the burden of stroke has risen sharply. Recent trends suggest that sub-Saharan Africa now bears the highest burden of stroke worldwide with age-standardized stroke incidence rates of up to 316 per 100 000 population [9]. Epidemiologic studies have shown differences in stroke incidence and prevalence rate in males and females and differences by age and age group [48]. In our study, we saw a rising incidence rate of stroke with age. This finding is similar to results obtained in Harare, Zimbabwe. These two studies however differ in respect to the male to female incidence rates. In Zimbabwe, except for age group 45–54 years, the age specific rates for both sexes rose with age but higher in females at all age strata [49]. In the early stage of our study (2017–2018), we saw a similar trend in the rising of incidence rate with age except for $\geq$75 years but were higher in males. The stroke incidence rates by sex seem to differ from place to place. In the WHO stroke incidence study, the rates were higher for women in the participating Scandinavian centers, whereas the incidence rates were higher for men in most of the Japanese centers [50]. This observed variation in male/female ratio of incidence rates cannot be readily explained. In a systematic review article on sex differences in stroke epidemiology, the authors suggested that a possible reason accounting for this variation could be genetic factors but they could not find support for this assumption in literature [48]. Nonetheless, there was a dramatic fall in the incidence of stroke at the end of the study period (2019) especially in the males (Figure 2).

Finally, the proportion of stroke in the working age (25–64) constituted almost half (49.8%) of the total stroke cases recorded for the entire period with a declining rate of incidence in 2019 (Table 3). While we were unable to assess the risk factors associated with stroke, evidence suggests that nearly 70% of all stroke cases results from high blood pressure and the working age class are less likely to receive information about lifestyle changes to address hypertension [51, 52]. In Ghana, blood pressure control is poor and increases the risk of stroke in the working age class given the low awareness rate of high blood pressure [53]. A slowdown in the working age population as a result of stroke could inhibit the growth of an economy given their significant strides in all aspects of the economy.

4.1. Limitations of the study

A major limitation for this study was that we could not explain the reasons accounting for both the high and low incidence rates mainly because we did not assess the risk factors associated with stroke. Our study was a retrospective study and some data retrieved from the LHMIS lacked vital information needed to assess the risk factors and hence its neglect. Secondly, the number of stroke cases may have been underestimated due to the possibility of missing very early/minor strokes since CT perfusion and angiography are currently not available in CCTH, also, stroke cases resulting from the outright death of patients thereby not presenting for CT scan examination. Another limitation to this study is the relatively low number of the studied population and hence the results and conclusions may be limited.

5. Conclusion

The incidence rate of first stroke for the entire age categories were higher in males compared to the same age categories in females, with only a few exceptions. A decline in stroke incidence rate in the working age during the last period of the study is positive from an economic and public health perspective given their substantial productive life. Majority of stroke cases were ischemic and reducing the numbers in ischemic stroke by simple lifestyle changes can significantly reduce the burden of stroke overall. Since the average age of onset of first stroke is low from our study compared to the high-income countries, efforts to increase the average age of onset of first stroke must be directed towards increasing the awareness of the causes and prevention of strokes.

Implication for practice

The low average age of onset of first stroke in our study compared to the high-income countries implies that practitioners must put in more effort to raise the awareness of the causes and prevention of stroke.

Declarations

Author contribution statement

Emmanuel K.M. Edzie, Philip N. Gorleku and Klenam Dzefi-Tettey: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Ewurama Andam Idun, Adu Tutu Amankwa and Eric Aidoo: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Abdul Raman Asemah and Henry Kusodzi: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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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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