



Prevalence and Risk Factors of Young Adult Stroke: A Five-Year Retrospective Study in Physiotherapy Clinics in Kano, North Western, Nigeria

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Abstract

Stroke is an important cause of morbidity and mortality in young adults especially in developing countries. The aim of this study was to determine the prevalence and risk factors of stroke among young adults who received post-stroke rehabilitation in physiotherapy clinics in Kano, North-western, Nigeria. The retrospective descriptive study was carried out in Murtala Muhammad Specialist Hospital, Muhammad Abdullahi Wase Teaching Hospital, and Aminu Kano Teaching Hospital. Relevant socio-demographic and clinical information were collected from the patients' case files. The data obtained were analysed with descriptive statistics of frequencies and percentages. Four hundred and seven (407) out of 1,792 stroke cases were aged ≤ 45 years, giving a proportion of 22.7%; slight majority of those affected were females (53.32%). The prevalence of young adult stroke in Kano Metropolis was 7.7 per 100,000. Most of the young adult stroke cases occurred among house wives (34.89%). The main risk factor of stroke among young adults in this study was hypertension (75.92%), followed by head injury (10.07%) and sickle cell disease (8.85%). It was concluded that the prevalence and proportion of young adult stroke were not high in Kano Metropolis when compared with what obtains in other parts of the West African sub-region and Europe. The main risk factor for stroke among young adults was hypertension. Physiotherapists and other health professionals should embark on community awareness campaign on the need for young adults to have their blood pressures measured regularly and to be enlightened about the menace of undiagnosed hypertension to their health and wellbeing.

Keywords: Young-Adult-Stroke; Prevalence; Risk Factors; Proportion

Introduction

Young adults are an active age group that contributes to the socioeconomic development of every society (Ghandehari & Izadi-Mood, 2006; Balci, Utku, Asil & Celik, 2011). Although stroke is more common among the elderly, it is surprisingly not uncommon in young adults (Naess *et al.*, 2002; Marini *et al.*, 2011; Owolabi & Ibrahim, 2012) and is particularly tragic when it occurs in this age group (Ghandehari & Izadi-

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Mood, 2006; Eze *et al.*, 2019). The devastating impact of stroke is usually felt by the affected individuals, their families and the society at large (Nedeltchev *et al.*, 2005). Stroke in young adults is a major cause of morbidity and loss of years of productive life (Bhatt *et al.*, 2018) including loss of jobs and marital problems (Leys *et al.*, 2002). Compared with stroke in the elderly, stroke in the socio-economically active age group (young adults) has a disproportionately larger economic impact by rendering such survivors disabled during or even before their most productive years (Jacobs *et al.*, 2002; Ghandehari & Izadi-Mood 2006; Onwuchekwa *et al.*, 2009; Kumar *et al.*, 2011). Disability from young adult stroke ranges from 6% to 29% (Leys *et al.*, 2002; Nedeltchev *et al.*, 2005; Naess *et al.*, 2002) and the outcome of the condition in this age group can be affected negatively by factors such as anterior circulation stroke, diabetes mellitus and the severity of the initial stroke (Nedeltchev *et al.*, 2005; Naess *et al.*, 2002).

To date, the global incidence of young adult stroke remains a gap in the literature (Boot *et al.*, 2020). However, the incidence in Europe is between 8.6 to 19.1/100,000, for crude rates, and 8.7 to 21.0/100,000 for standardised rates (Marini *et al.*, 2011) and up to 20.0/100,000 in most Northern American and Asian countries (Boot *et al.*, 2020). A study revealed that young adult stroke constitutes 24.3% of stroke cases in the West African sub-region (Sarfo *et al.*, 2018). The outcomes of hospital based studies in Nigeria showed that young adult stroke constitutes 8.8% of stroke cases in Port Harcourt (Onwuchekwa *et al.*, 2009), 29.3% in Kano (Owolabi & Ibrahim, 2012) and 20.04% in Abakaliki (Eze *et al.*, 2019).

Stroke in young adults can be linked to large vessel atherosclerosis, cardio-embolism, small vessel disease (Renna *et al.*, 2014; Li *et al.*, 2017; van Alebeek *et al.*, 2017), patent foramen ovale (Mackey 2014; Renna *et al.*, 2014; Bhatt *et al.*, 2018) and cervical artery dissection (Mackey 2014; Bhatt *et al.*, 2018). The risk factors of young adult stroke ranges from hypertension (35% to 88.7%), smoking (11.1% to 50.7%), hyperlipidemia (9.9% to 53%), and diabetes mellitus (11.1% to 22.6%) (Lee *et al.*, 2002; Lipska *et al.*, 2007; Onwuchekwa *et al.*, 2009; Dharmasaroja *et al.*, 2010; Balci *et al.*, 2011; Kumar *et al.*, 2011; Owolabi & Ibrahim, 2012; Mackey, 2014; Renna *et al.*, 2014; Sarfo *et al.*, 2018). Others risk factors include human immunodeficiency virus infection (7.4% to 8.5%) (Onwuchekwa *et al.*, 2009; Owolabi & Ibrahim, 2012; Eze *et al.*, 2019), family history of stroke (18% to 29.3%) (Lee *et al.*, 2002; Balci *et al.*, 2011; Bhatt *et al.*, 2018), oral contraceptive use (7% to 25%) (Carolei *et al.*, 1993; Kristensen *et al.*, 1997; Balci *et al.*, 2011; van Alebeek *et al.*, 2017), sickle cell disease (2.8%) (Owolabi & Ibrahim, 2012), excessive stress (14.5%) (Sarfo *et al.*, 2018) and substance abuse (Owolabi & Ibrahim, 2012; Bhatt *et al.*, 2018).

In spite of the huge socio-economic impact of stroke in this age group, there is, however, a scarcity of published data on the prevalence (per 100,000 of the population) of stroke among young adults in Nigeria. Furthermore, the proportion of young adult stroke was 29.3% in Kano (Owolabi & Ibrahim, 2012), 8.8% in Port Harcourt (Onwuchekwa *et al.*, 2009) and 20.04% in Abakaliki (Eze *et al.*, 2019). A recent multi-site study by Sarfo *et al.* (2018) revealed a high and rising burden of stroke among young Africans in the proportion of 24.3%. This outcome is still less than the

proportion of young adult stroke that was reported earlier in Kano by Owolabi and Ibrahim (2012). To the best of our knowledge, published research in Kano to highlight the possible change that might have occurred in the prevalence of stroke among young adults in over the last five years is not available. This dearth of published data on the prevalence of stroke in young adults in Kano prompted this study. The aim of this study was, therefore, to determine the prevalence and risk factors of stroke among young adults who were treated, within the defined period, at the physiotherapy clinics of the selected hospitals in Kano.

Methods

The study was a retrospective review of cases of young adult stroke aged 18 to 45 years managed in outpatient physiotherapy departments of Aminu Kano Teaching Hospital, Murtala Muhammad Specialist Hospital, and Muhammad Abdullahi Wase Teaching Hospital in Kano Metropolis between 1st January 2007 and 31st December, 2011. Considerable variations exists in defining the appropriate age range for young adult in the literature, but most studies used 18-45 years (Leys *et al.*, 2002; Onwuchekwa *et al.*, 2009; Kumar *et al.*, 2011; Marini *et al.*, 2011). Ethical approval was sought and obtained from the ethics committee of Aminu Kano Teaching Hospital and that of Kano State Ministry of Health. Following approval, the case files of all stroke patients managed at the out-patient units of the selected physiotherapy departments were retrieved and the study population was obtained. A proforma was used to record the data obtained from the patients' case notes that included name of hospital, date of onset of stroke, aetiology, type of stroke, associated risk factors, side affected, age, sex, occupation, height, weight and functional status.

Only stroke cases in which the dates of onset of the stroke fell within the period selected for this study were selected. In addition, cases without a detailed description of the patients' socio-demographic characteristics such as age, sex, marital status, occupation and clinical characteristics that include etiology, risk factors and side affected were not included.

Determination of proportion and prevalence

The proportion of young adult stroke was calculated as the number of young adult stroke cases divided by the total number of stroke cases multiplied by one hundred. Prevalence was calculated as the number of young adult stroke cases divided by the population of young adults in Kano State (5,295,420) based on the 2006 census data (<https://www.citypopulation.de/php/nigeria-admin.php?admlid=NGA020>).

Using the frequentist approach, prevalence per 1,000 of the population is given by

$$\frac{\text{Total number of cases}}{\text{Total population of cases}} \times 1,000 \text{ (Oskoui } et al., 2013)$$

By extension, the prevalence of young adult stroke per 100,000 of the population =

$$\frac{\text{Total number of young adult stroke cases}}{\text{Total population of young adult stroke cases in Kano State}} \times 100,000$$

Data analysis

The data obtained were analysed using descriptive statistics of frequency and percentages and illustrated using tables. All analysis was performed using SPSS version 16.0 software.

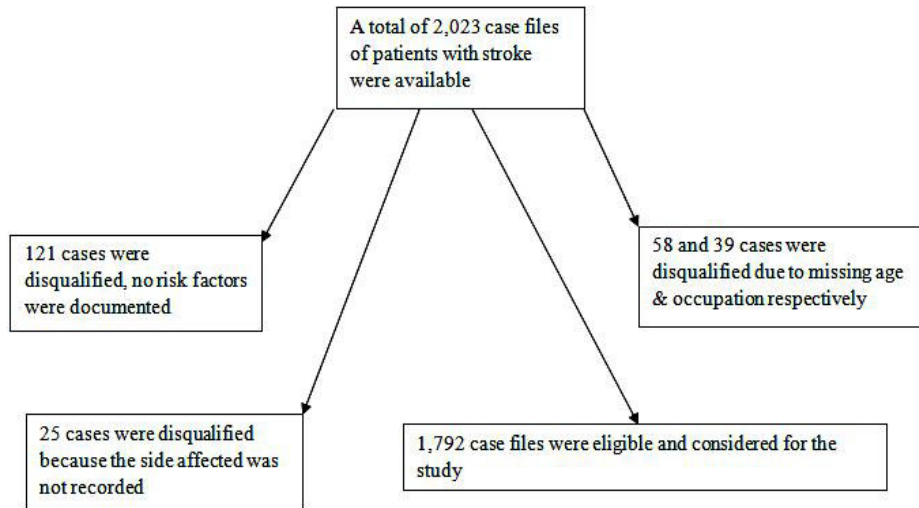


Figure 1: Flowchart illustrating case ascertainment process

Results

It is important to note that in almost all the case files reviewed, the aetiology, type of stroke (ischaemic or haemorrhagic), and anthropometrics were not captured by the attending physiotherapists. Therefore, these were excluded from the criteria, but their exclusion in this report has been highlighted as a serious limitation.

Overall, 1,792 case files of patients with stroke were retrieved and this comprised 805 (44.9%) males and 987 (55.1%) females. There were 1,385 (77.29%) cases of adult stroke out of which 615 (44.40%) were males and 770 (55.60%) were females. Young adult stroke cases were 407 (22.71%) of which 190 (46.68%) were males and 217 (53.32%) were females.

We found 407/5,295,420 (7.7 per 100,000) to be the prevalence of young adult stroke in Kano Metropolis. The proportion of the condition was 407/1,792 (22.71%). Most of the young adult stroke cases occurred among house wives (34.89%, n = 142) followed by civil servants (24.08% n = 98) and traders (21.62%, n = 88) (Table 1). The main risk factor of stroke among young adults in this study was hypertension, 309 (75.92%) followed by head injury, 41 (10.07%) and sickle cell disease, 36 (8.85%). High blood pressure was also observed to be the main cause of stroke in those aged >45 years (1,317 [95.09%]). This was followed by diabetes, 29 (2.09%) and head injury, 21(1.52%) (Table 1). Furthermore, the results showed that young adult stroke had the highest proportion in 2010 (25.62%) and the least proportion occurred in 2008 (17.22%). The results are presented in Table 2.

Table 1: *Socio-demographic and clinical characteristics of patients whose cases were reviewed*

Variables	Young adult cases ≤45 years, n (%)	Adults cases >45 years, n (%)
Occupation		
Civil Servants	98 (24.08)	177 (12.78)
Traders	88 (21.62)	414 (29.89)
House Wives	142 (34.89)	599 (43.25)
Students	66 (16.22)	0 (0)
Farmers	9 (2.21)	117 (8.45)
Total	407 (100)	1,385 (100)
Risk factors		
Hypertension	309 (75.92)	1,317 (95.09)
Sickle Cell Disease	36 (8.85)	9 (0.65)
Head Injury	41 (10.07)	21 (1.52)
Diabetes	8 (1.97)	29 (2.09)
HIV	0 (0)	2 (0.14)
High Fever	2 (0.49)	0 (0)
Meningitis	2 (0.49)	0 (0)
Cerebral Embolism	9 (2.21)	7 (0.51)
Total	407 (100)	1,385 (100)
Side affected		
Left	260 (63.88)	744 (53.71)
Right	147 (36.12)	641 (46.28)
Total	407 (100)	1,385 (100)

Note. Total number of young adult cases = 407, total number of adult cases = 1,385, HIV = Human Immunodeficiency Virus

Table 2: *Proportion of young adult stroke cases across the years under review*

Year	Young adult cases ≤45 years, n (%)	Adult cases >45 years, n (%)	Total
2007	83 (23.92)	264 (76.08)	347
2008	68 (17.22)	327 (82.78)	395
2009	88 (24.51)	271 (75.49)	359
2010	83 (25.62)	241 (74.38)	324
2011	85 (23.16)	282 (76.84)	367
Total	407 (22.71)	1,385 (77.29)	1,792

Discussion

The study described the prevalence and risk factors of young adult stroke in Kano over a 5-year period. The proportion of young adult stroke was 22.7%. This means that young adult stroke cases accounted for about 23% of the total stroke cases in Kano in the 5 years under review. By extension, it means that one out of every 5 persons with stroke in Kano was a young person under the age of 45 years. A previous prospective study in Kano has reported a higher proportion of 29.3% (Owolabi & Ibrahim, 2012). The high proportion of one young adult stroke case out of every three stroke cases reported by Owolabi and Ibrahim (2012) could be due to the fact that the prospective study covered two of the major hospitals in Kano and, probably, the cases of young

adult stroke were higher in those health centers at the time of the study. On the other hand, the proportions were lower in other parts of the country. For example, it was 8.8% (one young adult case out of every eleven stroke cases) in Port Harcourt (Onwuchekwa *et al.*, 2009) and 20.04% (one young adult case out of every five stroke cases) in Abakaliki (Eze *et al.*, 2019). Furthermore a multi-site study that covered the West African sub-region revealed that the burden of stroke among young Africans is in the proportion of 24.3% (one young adult case out of every 4 stroke cases).

The present study observed that female young adults were slightly more affected by stroke than their male counterparts. A previous study by Onwuchekwa *et al.* (2009) also reported that there were more young females with stroke than males. Several explanations for the increased risk of stroke among young adult females when compared with their male counterpart have been provided. Women are exposed to the use of oral contraceptives which is a risk factor for stroke. They are also predisposed to preeclampsia, gestational hypertension and diabetes and complications during partus such as traumatic arterial dissection and amniotic fluid emboli (van Alebeek *et al.*, 2017).

The observation in this study was that the prevalence of young adult stroke in Kano Metropolis was 7.7/100,000. Though there was no empirical figure for the global incidence of young adult stroke (Boot *et al.*, 2020), the prevalence obtained in this study was not on the high side when compared with what obtained in Europe, 8.63 to 19.12/100,000 for crude rates, and 8.70 to 21.02/100,000 for standardised rates (Marini *et al.*, 2011) and up to 20/100,000 in most North American, and Asian countries including Australian (Boot *et al.*, 2020). Our result was also lower than those obtained in previous studies where 23/100,000 (Jacobs *et al.*, 2002), 11.4/100,000 (Naess *et al.*, 2002) and 8/100,000 (Ghandehari & Izadi-Mood, 2006) were reported. The outcome above implies that cases of young adult stroke were less prevalent in Kano when compared with the West world. This outcome is also very possible due to under reporting of stroke cases in our clime attributable to cultural issues as some of the patients with stroke might be taken to herbalists for traditional remedies or to places of worship for special prayers. In addition, many others may not attend hospital because they cannot afford to settle hospital bills. With such cases in mind, one may not be very emphatic to say that the prevalence of young adult stroke in Kano is lower than that of Western countries.

Furthermore, when the proportion of young adult stroke was analysed across the five years of this review, the highest proportion of cases was observed in 2010 (25.62%) and the least proportion occurred in 2008 (17.22%). This outcome is not unlikely owing to the fact that a prospective study that was conducted in the same environment has reported the highest proportion of young adult stroke in Nigeria of 29.3% (Owolabi & Ibrahim, 2012).

Finally in the current study, the main risk factor of stroke among young adults was hypertension. This was followed by head injury, sickle cell disease and cerebral embolism. Many studies around the world have reported hypertension as being the major risk factor for young stroke (Kumar *et al.*, 2011; Dharmasaroja *et al.*, 2010; Balci

et al., 2011; Lipska *et al.*, 2007; Owolabi & Ibrahim 2012; Onwuchekwa *et al.*, 2009; Lee *et al.*, 2002; Sarfo *et al.*, 2018). Hypertension has been recognized as the greatest risk factor for young adult stroke worldwide. Undiagnosed and untreated hypertension, pregnancy-induced hypertension and hypertensive heart disease are the major culprits. In the case of traumatic brain injury, studies have found that head injury is an independent and significant risk factor for ischaemic stroke (Burke *et al.*, 2013; Lee *et al.*, 2014). Also, a recent study has reported that half of the individuals with head injury aged ≤ 40 years had arterial ischaemic stroke (Kowalski *et al.*, 2017). Others studies have reported diabetes mellitus (Balci *et al.*, 2011; Lipska *et al.*, 2007; Owolabi & Ibrahim, 2012; Onwuchekwa *et al.*, 2009; Sarfo *et al.*, 2018) and sickle cell disease (Owolabi & Ibrahim, 2012) as risk factors for young adult stroke.

Our study has some major limitations, due the poor clerking pattern by some physiotherapists. For example, almost all the case files did not specify the exact aetiology and the type of stroke (ischaemic or haemorrhagic) and anthropometrics such as height, weight and BMI were not documented. The limitations above have prevented the presentation of results on type of stroke and BMI of the patients. It is important to note that the 2006 census data (see Appendix) did not give the exact population figures for individuals within the age ranges of 18-45 years. Therefore, the population figures for the age range of 10-49 years were used instead.

Conclusion

The prevalence and proportion of young adult stroke were not high in Kano Metropolis when compared with figures from the West African sub-region and Europe. The main risk factor for young adult stroke is hypertension. Physiotherapist and other health professionals should embark on community awareness campaign on the need for young adults to have their blood pressures measured regularly and to be enlightened about the menace of undiagnosed hypertension on their health and wellbeing.

References

- Balci, K., Utku, U., Asil, T., & Celik, Y. (2011). Ischemic stroke in young adults: risk factors, subtypes, and prognosis. *The Neurologist*, 17(1), 16-20.
- Bhatt, N. Malik, A.M., & Chaturvedi, S. (2018). Stroke in young adults: 5 NEW THINGS. *Neurology, Clinical Practice*, 8(6), 1-6.
- Boot, E., Ekker, M.S., Putaala, J., Kittner, S., De Leeuw, F-E., & Tuladhar, A.M. (2020). Ischaemic stroke in young adults: a global perspective. *Journal of Neurology Neurosurgery Psychiatry*, 91, 411-417.
- Burke, J.F., Stulc, J.L., Skolarus, L.E., Sear, E.D., Zahuranec, D.B., & Morgenstern, L.B. (2013). Traumatic brain injury may be an independent risk factor for stroke. *Neurology*, 81(1), 33-39.
- Carolei, A., Marini, C., Ferranti, E., Frontoni, M., Prencipe, M., Fieschi, C., & the National Research Council Study Group Stroke. (1993). A Prospective Study of Cerebral Ischemia in the Young Analysis of Pathogenic Determinants. *Stroke*, 24, 362-367.
- Dharmasaroja, P.A., Muengtawepongsa, S., Lechawanich, C., & Pattaraarchachai, J. (2011). Causes of ischemic stroke in young adults in Thailand: a pilot study. *Journal of Stroke and Cerebrovascular Diseases*, 20(3), 247-50.

- Eze, C., Kalu, U., & Isiguzo, G. (2019). Stroke in Young Adults: Experience at Abakaliki South East Nigeria. *World Journal of Neuroscience*, 9, 217-223.
- Ghandehari, K., & Izadi-Mood, Z. (2006). Etiology of young adult onset brain infarction in Iran. *Archives of Iranian Medicine*, 9(3), 240-3.
- Jacobs, B.S., Boden-Albala, B., Lin, I., & Sacco, R.L. (2002). Stroke in the Young in the Northern Manhattan Stroke Study. *Stroke*, 33, 2789-2793.
- Kowalski, R.G., Haarbauer-Krupa, J.K., Bell, J.M., Corrigan, J.D., Hammond, F.M., Torbey, M.T., Hofmann, M.C., Dams-O'Connor, K., Miller, A.C., & Whiteneck, G.G. (2017). Acute Ischemic Stroke After Moderate to Severe Traumatic Brain Injury Incidence and Impact on Outcome. *Stroke*, 48, 1802-1809.
- Kristensen, B., Malm, J., Carlberg, B., Stegmayr, B., Backman, C., Fagerlund, M., & Olsson, T. (1997). Epidemiology and etiology of ischemic stroke in young adults aged 18 to 44 years in northern Sweden. *Stroke*, 28(9), 1702-9.
- Kumar, H.N.H., Kalra, B., Goyal, N., Jayaram, S., & Kumar, S. G. (2011). A study on profile and risk factors of stroke in young adults (15-45 years) from coastal South India. *Annals of Tropical Medicine Public Health*, 4, 25-28.
- Lee, T-H., Hsu, W-C., Chen, C-J., & Chen, S-T. (2002). Etiologic Study of Young Ischemic Stroke in Taiwan. *Stroke*, 33(8), 1950-1955.
- Lee, Y., Lee, C., Huang, M., Hsu, C., & Su, Y. (2014). Increased risk of ischemic stroke in patients with mild traumatic brain injury: a nationwide cohort study. *Scandinavian Journal of Trauma Resuscitation Emergency Medicine*, 22, 66.
- Leys, D., Bandu, L., Hénon, H., Lucas, C., Mounier-Vehier, F., Rondepierre, P., & Godefroy, O. (2002). Clinical outcome in 287 consecutive young adults (15 to 45 years) with ischemic stroke. *Neurology*, 59, 26–33.
- Li, F., Yang, L., Yang, R., Xu, W., Chen, F., Li, N., & Zhang, J. (2017). Ischemic Stroke in Young Adults of Northern China: Characteristics and Risk Factors for Recurrence. *European Journal of Neurology*, 77, 115–122.
- Li, Z., Wang, J., Luo, S., Wei, J., & Hu, X. (2013). Classification analysis of young stroke in Zhuhai city, China. *Neuroscience Discovery*, 1(1), 2.
- Lipska, K., Sylaja, P.N., Sarma, P.S., Thankappan, K.R., Kutty, V.R., Vasana, R.S., & Radhakrishnan, K. (2007). Risk factors for acute ischaemic stroke in young adults in South India. *Journal of Neurology Neurosurgery and Psychiatry*, 78(9), 959-963.
- Mackey, J. (2014). Evaluation and Management of Stroke in Young Adults. *Continuum (Minneapolis)*, 20(2), 352-369.
- Marini, C., Russo, T., & Felzani, G. (2011). Incidence of Stroke in Young Adults: A Review. *Stroke Research and Treatment*. 2011, 535672.
- Naess, H., Nyland, H.I., Thomassen, L., Aarseth, J., Nyland, G., & Myhr, K-M. (2002). Incidence and Short-Term Outcome of Cerebral Infarction in Young Adults in Western Norway. *Stroke*, 33, 2105-2108.
- Nedeltchev, K., der Maur, T.A., Georgiadis, D., Arnold, M., Caso, V., Mattle, H., Schroth, P.G., Remonda, L., Sturzenegger, M., Fischer, U., & Baumgartner, R.W. (2005). Ischaemic stroke in young adults: predictors of outcome and recurrence. *Journal of Neurology Neurosurgery and Psychiatry*, 76, 191-195.
- Onwuchekwa, A.C., Onwuchekwa, R.C., & Asekomeh, E.G. (2009). Stroke in young Nigerian adults. *Journal of Vascular Nursing*, 27(4), 98-102.

- Oskoui, M., Joseph, L., Dagenais, L., & Shevell, M. (2013). Prevalence of Cerebral Palsy in Quebec: Alternative Approaches. *Neuroepidemiology*, *40*, 264–268
- Owolabi, L.F., & Ibrahim, A. (2012). Stroke in Young Adults: A Prospective Study from Northwestern Nigeria. *ISRN Neurology*. *2012*, 468706.
- Renna, R., Pilato, F., Profice, P., Rossi, E., De Stefano, V., & Di Lazzaro, V. (2014). Risk Factor and Etiology Analysis of Ischemic Stroke in Young Adult Patients. *Journal of stroke and cerebrovascular disease*, *23*(3), E221-E227.
- Sarfo, F.S., Ovbiagele, B., Gebregziabher, M., Wahab, K., Akinyemi, R., Akpalu, A., Akpa, O., Obiako, R., Owolabi, L., Jenkins, C., & Owolabi, M. (2018). Stroke Among Young West Africans Evidence From the SIREN (Stroke Investigative Research and Educational Network) Large Multisite Case-Control Study. *Stroke*, *49*, 1116-1122.
- van Alebeek, M.E., Arntz, R.M., Ekker, M.S., Synhaeve, N.E., Maaijwee, N.A., Schoonderwaldt, H., van der Vlugt, M.J., van Dijk, E.J., Rutten-Jacobs, L.C.A., & de Leeuw, F. (2017). Risk factors and mechanisms of stroke in young adults: The FUTURE study. *Journal of Cerebral Blood Flow & Metabolism*, *38*(9), 1631-1641.

Appendix

Population of Kano State Based on 2006 Census Data

Age Range	Population
0-9 years	3,322,489
10-19 years	2,079,592
20-29 years	1,570,195
30-39 years	1,015,902
40-49 years	629,731
50-59 years	356,584
60-69 years	194,580
70-79 years	120,312
80+ years	111,903
Total	9,401,288

Available at <https://www.citypopulation.de/php/nigeria-admin.php?adm1id=NGA020>