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Research article

Stroke signs knowledge and factors associated with a delayed hospital arrival of patients with acute stroke in Kinshasa

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ABSTRACT

Background: Rapid recognition and early medical intervention are essential to reduce stroke-related mortality and long-term disability. This study aimed to evaluate awareness of stroke symptoms/signs and determine factors delaying the hospital arrival of patients with acute stroke in Kinshasa.

Methods: Patients with stroke and/or accompanying family members were interviewed using a standard questionnaire, and their medical records were reviewed. Factors independently associated with a late arrival (≥4.5 h) to the hospital were identified using the logistic regression test in forward multivariate analysis.

Results: Overall, 202 patients with an average age of 57.9 ± 13.1 years were included. Only 27 (13.4%) patients immediately associated the initial symptoms with a stroke episode. Delayed hospital arrival was observed in 180 (89.1%) patients. Unmarried status (adjusted odds ratio [aOR], 2.29; 95% confidence interval [CI], 1.17–4.88; p = 0.007), low education level (aOR, 2.29; 95% CI, (1.12–5.10; p = 0,014), absence of impaired consciousness (aOR, 3.12; 95% CI, 1.52–4.43; p = 0.005), absence of a history of hypertention (aOR, 1.85; 95% CI, 1.18–3.78; p = 0.041), absence of a history of diabetes (aOR, 1.93; 95% CI, 1.15–4.58; p = 0.013), heavy alcohol consumption (aOR, 1.83; 95% CI, 1.12–2.83; p = 0.045), absence of a severe to very severe stroke (aOR, 4.93; 95% CI, 0.82–1.01; p = 0.002), and presence of ischemic stroke (aOR, 2.93; 95% CI, 1.54–4.59; p = 0.001) were identified as independent determinants of delayed hospital arrival.

Conclusions: This study depicted a low stroke awareness rate and a much longer prehospital delay than evidence-based guidelines recommend and identified eight factors that public health actions could target to promote the earliest management of stroke.

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1. Background

Stroke is a leading cause of death, disability, and dementia worldwide [1]. According to the Global Burden of Disease Study 2019 [2], the incidence and prevalence of stroke were 12.2 million and 101 million, respectively. The study also reported that stroke caused 143 million disability-adjusted life-years (DALYs) and 6.55 million deaths. Globally, stroke was also the third-leading level 3 cause of death and disability combined in 2019, after neonatal disorders and ischemic heart disease. Low-income countries pay the highest cost of stroke, with an age-standardized stroke rate 3.7 times higher and a stroke mortality rate 3.6 times higher than those in high-income countries. That year, 89.0% of stroke-related DALYs and 86.0% of all stroke-related deaths were recorded in lower-income, lower–middle-income, and upper–middle-income countries. Sub-Saharan Africa is currently experiencing an unprecedentedly increased stroke burden, with the highest age-standardized incidence, prevalence, and mortality rates for stroke [3]. This region lacks a structured organization of stroke management.

Early recognition, early transportation by emergency medical services to dedicated stroke units, early brain imaging, and early medical intervention [4–7] are the basis of stroke management. All guidelines for stroke management published in Africa [8], Europe [9], and the USA [5] reiterate that an improvement in the prognosis of stroke is possible, not only in terms of reducing mortality but also in reducing disability and the risk of institutionalization, provided that care is organized in a specialized and structured chain from the place of stroke occurrence to home return.

Implementing these recommendations and educating the general public and healthcare personnel has proven effective [10,11]. The Democratic Republic of Congo (DRC) is among the many poor developing countries in Africa where all the above is almost non-existent. Previous studies on stroke awareness and factors affecting delayed hospital arrival of patients with stroke have been carried out mainly in Western countries, in an organized socioeconomic, cultural, and health system background that differs fundamentally from that of the DRC.

In Europe and USA, only one-third of patients with acute stroke arrive at the hospital in adequate time to receive thrombolytic treatment [12].

In Africa, data on this theme are rather rare. A systematic review of the literature representing 14/54 African countries reported that the proportion of stroke patients arriving in hospital within the recommended time range ranged from 10% in sub-Saharan Africa, specifically in Nigeria, to 43% in North Africa, specifically in Tunisia, and the median interval between the onset of stroke and hospitalization was 31 h [13]. Bachadi et al. reported poor identification of stroke symptoms in developing countries [14]. This ignorance is among the major reason for patients' delayed hospital arrival.

Thus, this study aimed to establish patients' knowledge of stroke signs and determine factors delaying the hospital arrival of patients with acute stroke in Kinshasa, the capital of the DRC, as these data are still lacking. Results from this study can inform public health strategies for increasing the public's recognition and response to stroke symptoms/signs and thus reduce stroke-related mortality and disability.

2. Methods

2.1. Study design and setting

This prospective multicenter cohort study included 202 patients with confirmed stroke diagnosis between May and October 2022 in 12 hospitals in the city of Kinshasa, the only one where brain imaging (computed tomography [CT] and/or magnetic resonance

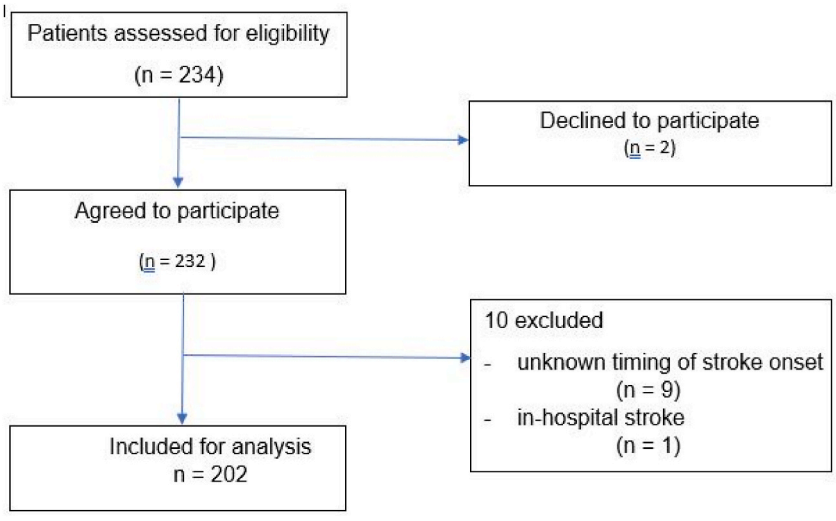

Fig. 1. Study flowchart.

imaging [MRI]) was operational and available 24 h a day during the study period.

2.2. Patient selection

Patients of any sex and age admitted to one of the recruiting hospitals, with a neuroradiologically confirmed stroke, were considered eligible for this study. A total of 234 participants initially fulfilled these inclusion criteria. Of these, 2 have declined to participate and 10 were excluded because of unknown timing of stroke onset in 9 patients and in-hospital stroke in 1 patient. Fig. 1 summarizes the patient selection procedure.

2.3. Study procedures

Two trained finalist medical students, supervised by a cardiologist and a neurologist, both of the University of Kinshasa, interviewed in person all patients and/or their accompanying family members using a standardized questionnaire at the prehospital phase, defined as the time between stroke onset and admission to the recruitment hospital. The interviews were conducted at the bedside on the workday following admission. The questionnaire included sociodemographic questions (i.e., age, sex, marital status, level of education, religion, and occupation), known cardiovascular and neurological history (i.e., ischemic heart disease, obliterating arterial disease of the lower limbs, carotid angioplasty or coronary artery bypass surgery, heart rhythm disorder, heart failure, chronic renal failure, neoplasia, pulmonary embolism, and previous stroke), risk factors (i.e., hypertension, sudden death, dyslipidemia, hyperuricemia, tobacco, and heavy alcohol intake), time at which the first stroke signs/symptoms were noted, nature of the first signs/symptoms, first person who noticed these signs/symptoms, recognition of these signs/symptoms as suggesting a stroke, decision to consult when the first signs/symptoms are recognized, mode of transport used to get to the recruiting hospital, and time between the onset of the first signs/symptoms and the arrival at the recruiting hospital. Each patient's medical record was reviewed for vital signs, stroke severity, and brain imaging results. These data were recorded on an ad hoc data collection sheet.

2.4. Operational definitions

Knowledge of stroke signs was defined as the patient's awareness that the presenting signs/symptoms could be due to a stroke. Educational level was dichotomized into high (academic) or low (below academic level). The first time the patient or a witness noted clear neurological signs was defined as the stroke onset time. Two stroke categories were categorized: day-onset stroke, when first stroke signs occurred between 6:00 and 18:00, and night-onset stroke when first signs of stroke occurred between 18:00 and 6:00. Prehospital delay was calculated based on the stroke onset time and time of arrival at the recruitment hospital.

Patients who arrived at the recruitment hospital before 4.5 h of stroke onset were classified as "early arrivals"; all other patients were classified as "late arrivals." Drinking more than two glasses of beer or its equivalent every day for at least a year was considered excessive alcohol consumption [15]. Stroke severity was categorized according to the National Institutes of Health Stroke Scale (NIHSS) score and classified into five levels: NIHSS $\leq$5 (minor), NIHSS 6–10 (mild), NIHSS 11–15 (moderate), NIHSS 16–20 (severe), and NIHSS >20 (very severe) [16]. A high NIHSS score was defined as NIHSS $\geq$16. The stroke subtype (ischemic or hemorrhagic) was determined by brain imaging (CT or MRI).

2.5. Statistical analyses

Qualitative data were represented in absolute and relative frequency (%), and quantitative data in the form of the standard deviation of the mean (if normal distribution). Pearson's Chi-square or Fischer's exact test was used to compare proportions. Student's t-test was used to compare the means of two groups with normal distributions. The normal distribution of each variable was assessed by the Kolmogorov–Smirnov test. Simple logistic regression was used to determine which factors were predictive of late hospital arrival. The following variables were entered into the univariate analysis: sociodemographic [age group, Sex, civil status, Education level, Occupation, First sign/symptom noted by the patient or the witness, the one who first noticed these signs/symptoms, stroke awareness, decision to immediately contact the EMS, Reasons for the delayed decision to contact EMS, cerebrovascular risk factors, Stroke episode recurrence, existence of sequelae from previous episodes, type of the last stroke, Stroke onset time, first hospital contact, conveyance, stroke severity, and stroke type. The odds ratios (ORs) and their 95% confidence intervals (95% CIs) were finally calculated to assess the degree of association between the variables and delayed hospital arrival. When the associations were observed between delayed hospital arrival and these independent variables, the effects of potential confounders were examined by adjustment in a conditional logistic regression (multivariate analysis). The calculated adjusted odds ratio estimated the degree of association between the delayed hospital arrival and independent variables.

A value of $p < 0.05$ was considered the threshold of statistical significance. IBM SPSS Statistics for Windows version 24 (IBM Corp., Armonk, NY) was used to analyze all data.

3. Results

3.1. General characteristics of the study population

The study population consisted of 202 patients, of whom 106 (52.5%) were men and 96 (47.5%) were women, with a sex ratio of 1.1.

3.2. Prevalence of delayed hospital arrival

As illustrated in Fig. 2, the delayed hospital arrival was observed in 180 out of 202 patients, accounting for 89.1%.

3.3. Sociodemographic characteristics of the study population

Table 1 shows the sociodemographic characteristics of the study population as a whole and by arrival time. The mean age of the patients was 57.9 ± 13.1 years (range, 21–96 years). Sixty-five (32.2%) patients were between 51 and 60 years old. One hundred and eighteen (58.4%) and one hundred twenty-eight (63.4%) participants were married and had a low academic level respectively. Catholic religion and revival churches were the most popular religious denominations with 74 (36.6%) and 73 (36.1%) participants, respectively. Unemployed people and public servants were the most represented occupational groups, comprising 60 (29.7%) and 57 (28.2%) participants, respectively. The same table shows that there were significantly more married and fewer widowers (p value = 0.015) in the group of late arrivals, compared to that of early arrivals. However, no statistically significant difference was found between the two groups with respect to age groups (p value = 0.591), gender (p value = 0.084), educational level (p value = 0.556), religion (p value = 0.411), and occupation (p value = 0.554).

Symptomatologic characteristics and alertness of the study population as a whole and by arrival time.

Table 2 illustrates the symptomatology of the study population as a whole and by arrival time. Motor deficits (hemiparesis and hemiplegia) and impaired consciousness were reported by 95 (47.0%) and 60 (29.7%) participants, respectively. 115 (56.9%) patients have noticed the first symptoms by themselves. Moreover, only 27 (13.4%) of the patients immediately associated the first symptoms with a stroke episode, and only 59 (29.2%) had the initiative to consult a hospital immediately. Ignorance of the state of emergency and the hope of spontaneous remission have been put forward as the reason for the delay in taking the initiative to consult by 91 (45%) and 38 (18.8%) patients, respectively. The same table shows that there were significantly more patients who decided to consult EMS immediately in the group of patients arriving at the hospital before 4.5 h than in the group of patients arriving late at the hospital (p value = <0.001). All other features of symptomatology and patient alertness were cited in similar proportions by early and late arrivals.

3.4. Cardiovascular risk factors and history of stroke in the study population

As illustrated in Table 3, hypertension, heavy alcohol consumption, and cigarette smoking were the most common cardiovascular risk factors found in 124 (61.4%), 70 (34.7%), and 34 (16.8%) participants. About 166 (82%) of the patients were in their first episode of stroke, whereas 32 (15.8%) were in their second episode, and only 4 (2%) were in their third or more episodes. In the late arrivals group, there was significantly more patients aged over 55 years (p = 0.028) compared to the early arrivals group, while the distribution of the other cerebrovascular risk factors was similar in both groups.

4. Timestamps and patient trajectories

Table 4 describes the time frame, timing of key events, and patient trajectory from the stroke site to the recruiting hospital. Day-onset stroke occurred in 131 (64.9%) participants. Moreover, 149 (73.8%) participants had gone through other medical centers before arriving at the recruitment center.The most common means of transport used to reach the hospital were public transport, a neighbor's car, and a personal car at 134 (66%), 32 (15.8%), and 23 (11.4%), respectively. Only 8 (4%) patients have utilized medical transport (ambulance).

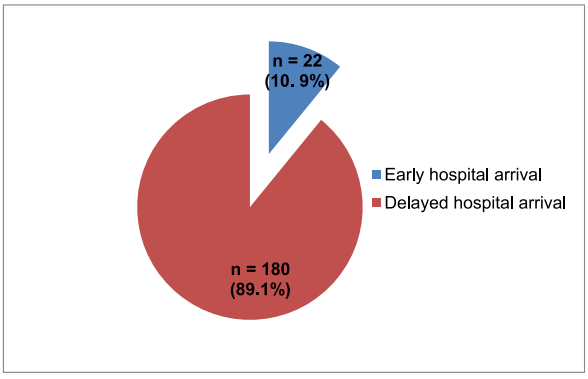

Fig. 2. Prevalence of delayed hospital arrival.

Table 1
Sociodemographic characteristics of the study population as a whole and by arrival time.

Variables	Overall n = 202	Early arrivals (n = 22)	Late arrivals (n = 180)	p
Age (years)	57.9 ± 13.1			0.591
<40	15 (7.4)	1(4.5)	14(7.8)	
40–50	43 (21.3)	6(27.3)	37(20.6)	
51–60	65 (32.2)	4(18.2)	61(33.9)	
61–70	36 (17.8)	5(22.7)	31(17.2)	
>70	43 (21.3)	6(27.3)	3(20.6)	
Male	106 (52.5)	8(36.4)	98(54.4)	0.084
Civil status				0.015
Married	118 (58.4)	8(36.4)	110(61.1)	
Unmarried	26 (12.9)	6(27.3)	20(11.1)	
Divorced	15 (7.4)	0(0.0)	15(8.3)	
Widower	43 (21.3)	8(36.4)	35(19.4)	
Education level				0.556
Low	128 (63.4)	15 (68.2)	113 (62.8)	
Academic	74 (36.6)	7(31.8)	67(37.2)	
Religion				0.411
Catholic	74 (36.6)	10(45.5)	64(35.6)	
Protestant	26 (12.9)	1(4.5)	25(13.9)	
Kimbanguist	13 (6.4)	1(4.5)	12(6.7)	
Revival church	73 (36.1)	10(45.5)	63(35.0)	
Others	16 (7.9)	0(0.0)	16(8.9)	
Occupation				0.554
Unemployed	60 (29.7)	6(27.3)	54(30.0)	
State official	57 (28.2)	4(18.2)	53(29.4)	
Artisan/merchant	45 (22.3)	7(31.8)	38(21.1)	
Corporate agent	40 (19.8)	5(22.7)	35(19.4)	

Table 2
Symptomatologic characteristics and alertness of the study population as a whole and by arrival time.

Variables	Overall (n = 202)	Early arrivals (n = 22)	Late arrivals (n = 180)	P
First sign/symptom noted by the patient or the witness				
Facial paralysis	35 (17.3%)	2(9.1)	33(18.3)	0.224
Impaired consciousness	60 (29.7%)	13(59.1)	82(45.6)	0.165
Impaired sensitivity	19 (9.4%)	3(13.6)	16(8.9)	0.342
Slurred speech	36 (17.8%)	2(9.1)	34(18.9)	0.206
Blurred vision	6 (3.0%)	0(0.0)	6(3.3)	0.496
Balance disorder	8 (4.0%)	1(4.5)	7(3.9)	0.609
Hemiparesis or hemiplegia	95 (47.0%)	13(59.1)	82(45.6)	0.165
Headache	43 (21.3%)	4(18.2)	39(21.7)	0.477
Dizziness	29 (14.4%)	3(13.6)	26(14.4)	0.609
Others	63 (29.2%)	9 (40.9)	54 (30.0)	0.331
Who first noticed these signs/symptoms				0.237
Patient himself	115 (56.9%)	10(45.5)	105(58.3)	
Spouse/family member	76 (37.6%)	10(45.5)	66(36.7)	
Colleague	7 (3.5%)	2(9.1)	5(2.8)	
A stranger	4 (2.0%)	0(0.0)	4(2.2)	
Stroke signs awareness	27 (13.4%)	5(22.7)	22(12.2)	0.150

EMS, emergency medical services.

4.1. Stroke severity and brain imaging

As shown in Table 5, about 111 (54.9%) patients had a moderate stroke; 19 (9.4%), had minor; 40 (19.8%), had mild; 21 (10.4%), had severe stroke; and 11 (5.4%), had very severe stroke. In 201 (99.5%) patients, the stroke diagnosis was obtained with a brain scanner, and MRI was used for only 1 (0.5%) patient. Ischemic stroke was found in 142 (70.3%) participants, whereas hemorrhagic stroke was found in 60 (29.7%) participants. The same table shows that there were significantly more severe stroke (p value = 0.001) and very severe stroke (p value = 0.012) in the early arrival group than in the late arrival group. There was also significantly more hemorrhagic stroke in the early arrival group than in the late arrival group (p value = 0.044).

4.2. Determinants of late arrival in the recruiting hospital

Following univariate analysis (Table 6), twelve factors were significantly associated with late arrival: Age <55 years, being unmarried, low education level, being a member of a revival church, hemiparesis or hemiplegia, do not having impaired consciousness,

Table 3
Medical history and stroke type of the study population as a whole and by arrival time.

Variables	Overall (n = 202)	Early arrivals (n = 22)	Late arrivals (n = 180)	p
Age >55 years	85 (42.1)	11(50.0)	74(58.0)	0.028
Hypertension	124 (61.4%)	14(63.6)	110(61.1)	0.507
Diabetes	35 (17.3%)	6(27.3)	29(16.1)	0.156
Cigarette smoking	34 (16.8%)	2(9.1)	32(17.8)	0.243
Heavy alcohol consumption	70 (34.7%)	8(36.4)	62(34.4)	0.516
Stroke episode recurrence				0.506
First episode	166 (82.2%)	18(81.8)	148(82.2)	
Second episode	32 (15.8%)	3(13.6)	29(16.1)	
Third episode or more	4 (2.0%)	1(4.5)	3(1.7)	
Existence of sequelae from previous episodes?	24 (11.8%)	3 (13.6)	21 (11.6)	0.593
Type of last stroke episode				0.806
Ischemic	12 (33.3%)	2(50.0	10(31.3	
Hemorrhagic	7 (19.4%)	1(25.0	6(18.8	
Undetermined	17 (47.2%)	1(25.0	16(50.0	

Table 4
Timestamps and *trajectories of the study population as a whole and by arrival time.

Variables	Overall (n = 202)	Early arrivals (n = 22)	Late arrivals (n = 180)	p
Stroke onset time				0.508
Day-onset	131 (64.9%)	14 (63.6)	117(65.0)	
Night-onset	71 (35.1%)	8 (36.4)	63 (35.0)	
First hospital contact				**0.032**
Peripheral center/hospital	149 (73.8%)	12(54.5)	137(76.1)	
Recruitment hospital emergencies	53 (26.2%)	10(45.5)	43(23.9)	
Decision to immediately contact the EMS	59 (29.2%)	17(77.3)	42(23.3)	<0.001
Reasons for the delayed decision to contact EMS				
Ignorance of the state of emergency	91 (45.0%)	2(40.0)	89(64.5)	0.254
Hope for spontaneous remission	38 (18.8%)	2(40.0)	36(26.1)	0.401
Financial problem	17 (8.4%)	0(0.0)	17(12.3)	0.526
Security issue	11 (5.4%)	2(4.4)	9(9.2)	0.266
Transport problem	11 (5.4%)	0(0.0)	11(8.0)	0.666
Other reason	12 (5.9%)	1 (4.5)	11 (6.1)	0.134
Conveyance				**0.001**
Personal car	23 (11.4%)	6 (27.3)	17(9.4)	
Neighbor/brother's car	32 (15.8%)	5(22.7)	27(15.0)	
Transit car/bus	134 (66.3%)	8(36.4)	126(70.0)	
Other	13 (6.4%)	3 (13.6)	10 (5.5)	

Table 5
Stroke severity and brain imaging of the study population as a whole and by arrival time.

Variable	Overall (n = 202)	Early arrivals (n = 22)	Late arrivals (n = 180)	p
NIHSS score				
≤5 (minor)	19 (9.4)	6 (27.3)	13 (7.2)	0.060
6–10 (mild)	40 (19.8)	11 (50)	29 (16.1)	0.064
11–15 (moderate)	111 (54.9)	14 (60.6)	97 (53.8)	0.920
16–20 (severe)	21 (10.4)	18 (81.8)	3 (1.6)	0.001
>20 (very severe)	11 (5.4)	9 (40.9)	2 (1.1)	0.012
Brain imaging for diagnosis				0.619
MRI	1 (0.5)	0(0.0)	1(0.8)	
CT	201 (99.5)	22(100.0)	179(99.2)	
Stroke type				0.044
Ischemic	142 (70.3)	12(54.5)	130(72.2)	
Hemorrhagic	60 (29.7)	10(45.5)	50(27.8)	

CT, computed tomography; MRI, magnetic resonance imaging; NIHSS, National Institutes of Health Stroke Scale.

having impaired sensitivity, do not having history of hypertension, do not having history of diabetes, having a heavy alcohol intake, do not having a severe to very severe stroke, and having ischemic stroke type. After adjustment in the multivariate analysis, unmarried status, low education level, absence of impaired consciousness, absence of a history of hypertension, absence of a history of diabetes, heavy alcohol consumption, absence of a severe to very severe stroke, and presence of ischemic stroke type persisted as the independent factors for late hospital arrival. Being unmarried multiplied this risk by threefold (aOR, 2.29; 95% CI, 1.17–4.88; p = 0.007), low education level multiplied this risk by threefold (aOR, 2.29; 95% CI, (1.12–5.10; p = 0,014), absence of impaired consciousness

Table 6
Bivariate and multivariate analyses of the factors associated with late hospital arrival.

Variables	Univariate analysis		Multivariate analysis	
	p	OR (95%CI)	p	aOR (95%CI)
Age <55 years				
No				1
Yes	**0.045**	1.92 (1.1–4.2)	0.469	1.43 (0.71–2.88)
Civil status				
Married		1		1
Unmarried	**0.001**	3.37 (1.33–4.25)	**0.007**	2.29 (1.17–4.88)
Education level				
Academic		1		1
Low	0.002	2.84 (1.02–3.31)	0.014	2.29 (1.12–5.10)
Revival church				
No		1		1
Yes	**0.017**	2.32 (1.40–4.00)	0.409	1.32 (0.96–1.54)
Hemiparesis or hemiplegia				
No		1		1
Yes	**0.041**	1.85 (1.35–3.56)	0.146	1.86 (0.81–4.28)
Impaired consciousness				
Yes		1		1
No	0.014	6.5 (3.5–8.0)	0.005	3.12 (1.52–4.43)
Impaired sensitivity				
No		1		1
Yes	**0.017**	2.11 (1.21–2.96)	1.42	1.08 (0.15–7.79)
Hypertension				
Yes		1		1
No	**0.036**	2.83 (1.44–9.33)	**0.041**	1.85 (1.18–3.78)
Diabetes mellitus				
Yes		1		1
No	0.027	2.31 (1.11–3.43)	0.013	1.93 (1.15–4.58)
Heavy alcohol intake				
No		1		1
Yes	0.038	1.97 (1.22–4.46)	0.045	1.83 (1.12–2.83)
Severe to very severe stroke				
Yes		1		1
No	**0.017**	0.32 (0.21–0.92)	0.002	4.93 (0.82–1.01)
Stroke type				
Hemorragic		1		1
Ischemic	**0.005**	3.04 (2.61–8.94)	**0.001**	2.93 (1.54–4.59)

multiplied this risk by threefold (aOR, 3.12; 95% CI, 1.52–4.43; p = 0.005), absence of a history of hypertension multiplied this risk by twofold (aOR, 1.85; 95% CI, 1.18–3.78; p = 0.041), absence of a history of diabetes multiplied this risk by twofold (aOR, 1.93; 95% CI, 1.15–4.58; p = 0.013), heavy alcohol consumption multiplied this risk by twofold (aOR, 1.83; 95% CI, 1.12–2.83; p = 0.045), absence of a severe to very severe stroke multiplied this risk by twofold fivefold (aOR, 4.93; 95% CI, 0.82–1.01; p = 0.002), and presence of ischemic stroke multiplied this risk by threefold (aOR, 2.93; 95% CI, 1.54–4.59; p = 0.001).

5. Discussion

This study aimed to evaluate awareness of stroke symptoms/signs and identify factors associated with a delayed hospital arrival of patients with acute stroke.

This study showed a low rate (13.4%) of stroke awareness and identified eight factors independently associated with delayed prehospital arrival.

This study found no sex preponderance in stroke presentation, in contrast with other African in-hospital-based studies [17–23] who found a male predominance. Other studies, in Kenya [24] and in South Africa, found a female predominance [25–27]. These differences may reflect the combined effect of sex (i.e., biological characteristics, including their genetic, biological, and physiological expression), gender (in the sense of a social concept that includes gender identification, expression, roles, and stereotypes for women, men, and sex-diverse people) [28], and gendered exposures [29] in different regions.

The age of the patients was 57.9 ± 13.1 years, similar to those in most previous local studies [18,19,30,31] and studies in the Middle East and North Africa [32], but higher than that in a recent Senegalese study [23], with most of the participants in their 40s. It was lower than that in Kenyan studies where the stroke occurred, on average, in the 70s [24]. Globally, although all age groups can be affected from birth, with an ascent that becomes exponential after the age of 65, evidence suggests that indigenous African populations experience stroke at a younger age [33,34]. An earlier age of onset is also evidenced in low–middle-income countries compared with high-income countries, regardless of sex, stroke subtype, and whether data were collected at the population or hospital level [35–37]. This age variability of stroke occurrence could be explained by healthcare access and quality [38] and could be attributed to the early onset of stroke risk factors such as hypertension in the DRC and elsewhere in Africa [39].

Prehospital delay was noted in 180 (89.1%) patients. Similarly, high prevalence of prehospital delay was found in other low- and middle-income countries. Ogbole found a prevalence of 89.2%) in Nigeria([40], Kakame found 90.9% in Ouganda [41], and Gaurav found a prevalence of 79.8% % in Napal [42]. Research from a few high-income countries in Asia and Europe revealed a prevalence of less than 50% of prehospital delay [43–45]. Thus, individuals with acute stroke in low- and middle-income countries typically present significantly later than those in high-income nations. This could be explained by inadequately developed stroke pre-hospital referral systems and limited community knowledge of the importance of arriving early to an institution that can provide vital stroke services. It should be noted that different thresholds were used to define late hospital arrival: 3 h [23,46], 4 h [47], and 4.5 h for most studies [48–50], and even 6 h [51] for others. The 4.5-h threshold used in this study is the standard time for administering intravenous thrombolysis.

Hypertension was the participants' primary modifiable cardiovascular risk factor in the current study. The same has been found in the INTERSTROKE study for African countries included in the study [52] and in other studies in DRC [18,19,53] and elsewhere [23,24]. As the incidence of stroke increases in proportion to blood pressure [54] and the decrease in stroke mortality over the past decade is attributed, at least in part, to aggressive treatment of hypertension [55], hypertension is the leading modifiable contributor to stroke, with approximately 52% of all strokes attributable to hypertension [56].

In this study, ischemic stroke was predominant (70%). This finding is consistent with the results of other studies [18,24,33,34] that revealed ischemic stroke as the predominant stroke phenotype. Genetic factors and geographical location potentially influence the occurrence of stroke type [33].

In this study, 16% of the patients were in their second episode, whereas 2% were in their third or more episodes. This stroke recurrence rate is close to that reported in other African studies [57–59] and eight countries from South, East, and Southeast Asia [60], suggesting a need for strategies to improve secondary prevention.

Motor deficit and impaired consciousness were the most common symptoms reported by 47% and 29.7% of the patients, respectively. This finding of a motor deficit is the most frequently reported stroke warning sign, which is consistent with nearly all previous studies [49,61–65].

Patients with day-onset stroke were predominant (64.9%), similar to most previously available studies on circadian stroke onset [66–70]. This rhythmicity of stroke onset through the nychthemeron, with a clearly diurnal predominance, has been observed for both hemorrhagic and ischemic strokes when taken broadly and by subtypes [68].

Only 13% of patients immediately recognized their stroke warning signs. This is probably the lowest ever-reported rates of the awareness of stroke symptoms, as a recent systematic review of published articles from 2010 to 2020 revealed a knowledge rate of the signs/symptoms of stroke ranging from 23.6% to 87% [71]. This great disparity in stroke awareness rates across studies probably reflects inequalities in access to stroke information, according to the general culture of the populations and the strategic approach of the health authorities in the fight against stroke.

Only 29% immediately searched for medical care, whereas international guidelines recommend requesting emergency services promptly at the first sign of stroke [5,72]. The saying "Time is brain! " should be taught during mass awareness campaigns. This short, easy-to-remember message is a direct way to convey the message that stroke is a medical emergency.

Only 10.9% of patients consulted the recruiting hospital within 4.5 h; in most patients, the time from stroke onset to presentation was $\geq$24 h. To promote the earliest possible access to treatment, the evaluation of intervals between stroke onset and hospital arrival has been the subject of numerous studies [25,49,58,73–75] to determine the most appropriate interventions. They have produced divergent results, reflecting the methodological differences, cultural and educational differences of the populations studied, and differences in the health service organization in general and the stroke chain in particular.

This study identified 12 factors that were associated with late arrival to the hospital.

In bivariate analysis, age under 55 was associated with pre-hospital delay, but this association was not significant in multivariate analysis.This finding is consistent with the study results of Masumoto et al. [76], which showed that older participants appeared more interested in their health than younger participants.

In this study, being unmarried appeared to double the likelihood of late hospital arrival. This finding recalls the study of Braydon Dymm et al. [46] which showed married status was associated with higher odds of early arrival. This can be attributed to the fact that a married person can rely on their partner not only to spot early warning signs of stroke when the victim is unable to do so, but also to assist in arranging the transfer to the emergency room.

In this study, low education level doubled the risk of prehospital delay. This finding is in line with previous studies who depicted an association of high education level with a low probability of prehospital delay [47,77,78]. A low level of education can result in not having the basic information to identify the symptoms of a stroke, understand its potential seriousness, and grasp the importance of promptly seeking help from emergency services if a stroke occurs.

According to the present study, in bivariate analysis, attending revival churches was associated with prehospital delay, but this association was not significant in multivariate analysis. These patients may rely first on prayer or subjective interventions by their pastor or providence, thus explaining their delayed hospital arrival [79].

According to the present study, in bivariate analysis, motor deficit (Hemiparesis or hemiplegia) was associated with pre-hospital delay, but this association was not significant in multivariate analysis.

In this study, the absence of impaired consciousness tripled the likelywood of prehospital delay. This would be explained by the fact that an impaired consiousness would be seen by the entourage as a sign of great gravity, and would motivate it to consult medical services promptly, while when the patient remains lucid, it would reassure the entourage.

In this study, being non-diabetic and being non-hypertensive increased the risk of prehospital delay by twofold. This is in accordance with the finding by Kakame who found that prehospital delays were less common in patients with diabetes, hypertension, and

chronic care clinic attendance [41]. This would be explained by the fact that individuals with diabetes and hypertension, in contrast to those without, would obtain health education that can enhance their capacity to identify stroke symptoms and comprehend the necessity of seeking immediate medical care. It is noteworthy that other studies found no discernible difference in prehospital delay in patients with concomitant conditions including diabetes and hypertension [43,80].

Heavy alcohol consumption doubled the likelihood of delayed hospital arrival. The analysis of the Emerging Risk Factors Collaboration and UK Biobank cohorts [81] found that average alcohol use is correlated with an increased risk of fatal and non-fatal total stroke. If a drunken patient experiences a stroke, prompt use of emergency services is unlikely, depending on the assistance of the witnesses, if any.

The current study found that there was a five-fold increase in the likelihood of delayed hospital arrival when the stroke is not severe. In addiction, ischemic stroke type tripled the risk of delayed hospital arrival. This aligns with the results of Ashraf et al., who reported that hemorrhagic strokes are more associated with reduced delays than ischemic strokes [47]. Thus, the severity of the signs is an important stimulus to seek medical services urgently. This explanation would also justify the finding of previous studies that depicted significantly higher NIHSS in patients arriving early [47]. It is crucial for the general population to understand that while a severe neurological deficit can improve with early reperfusion, as a minor deficit can worsen in the absence of early and adequate management. Indeed, in case of cerebral arterial occlusion, there is an irreversible ischemic necrosis centre in which the blood flow is less than 10 mL/min/100 g, and around it, an area of tissue with an intermediate flow between 10 and 25 mL/min/100 g: this area is referred to as ischemic penumbra corresponds to the part of the brain tissue ischemia where blood flow is insufficient to maintain normal cell function, but cell survival remains assured initially. However, if the arterial occlusion persists, penumbra is at risk of evolution towards cell death, while reperfusion will conversely restore normal cell function.

5.1. Study strengths and limitations

This study is the first to provide background information on stroke awareness and factors delaying the hospital arrival of patients with acute stroke in Kinshasa. The multicentric nature of the study suggests excellent external validity; in other words, a good degree of applicability of the results. However, our study must be interpreted in the context of its potential limitations, including the limitations inherent in the cross-sectional design, precludeding the assessment of cause-and-effect relationships. Furthermore, this study is limited by its analysis of a relatively small sample. This can be explained by the five-month study period. Thus, the patients studied do not necessarily constitute a representative group of the populations supposed to be studied, which constitutes a potential selection bias.In addition, some relevant factors, such as not having any telephone contact, distance hospital or posterior circulation stroke, whose association with delay hospital has been demonstrated through studies conducted elsewhere [82], were not addressed in this study. Further studies over a longer period are needed to ensure the inclusion of a larger sample size and provide additional information on other sociodemographic, economic, cultural and environmental variables, the association of which with delayed hospiotal arrival would be considered plausible. It is also important to recognize that interview data may be of questionable accuracy due to cognitive and/or emotional bias.

6. Conclusions and recommendations

This study depicted a low rate of stroke awareness and a high prevalence of delayed hospital arrival in patients with stroke, along with various determinants of this late arrival, highlighting the need of media information campaigns for the general public and health professionals. Efforts should be made to enable prompt recognition of stroke symptoms and to understand the critical importance of seeking emergency medical assistance without hesitation. The Ministry of Health ought to implement a coordinated stroke care pathway and provide a toll-free hotline for patients and their families to seek assistance. This stroke care pathway would be accountable for expeditiously coordinating the transportation (by medical vehicle or other means) and the admission to a hospital where diagnostic resources and expert personnel for stroke management are available.

Ethics approval and consent to participate

The Congolese National Health Ethics Committee (reference number: 450/CNES/BN/PMMF/2022) reviewed and approved this study, and all the included patients provided written informed consent. The rules of confidentiality and ethics have been respected according to the 1964 Declaration of Helsinki.

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Data availability statement

Because the consent given by study participants did not include data sharing with third parties, anonymized data can be made available to investigators for analysis on reasonable request to the corresponding author.

CRediT authorship contribution statement

Igor KAZADI KABANDA: Writing – review & editing, Writing – original draft, Data curation, Conceptualization. **Credo KIANGEBENI NGONZO:** Writing – review & editing, Writing – original draft, Data curation, Conceptualization. **Christian-Khalifa EMEKA BOWAMOU:** Writing – review & editing, Writing – original draft, Data curation, Conceptualization. **Jean-Paul DIVENGI NZAMBI:** Supervision, Data curation. **Nono KIATOKO PONTE:** Supervision, Data curation. **Olivier TUYINAMA MADODA:** Supervision, Data curation, Conceptualization. **Aliocha NKODILA NATUHOYILA:** Validation, Formal analysis, Data curation. **Jean-Paul DIVENGI NZAMBI:** Validation, Supervision, Conceptualization. **Benjamin LONGO-MBENZA:** Validation, Supervision, Conceptualization. **Degani BANZULU BOMBA:** Validation, Supervision, Conceptualization. **Bernard KIANU PHANZU:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Conceptualization.

Declaration of generative AI and AI-assisted technologies in the writing process

We certify that no artificial intelligence/large language model were used at any stage of this research manuscript writing.

Declaration of competing interest

All authors do not have competing interest.

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