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## Consequences of Stroke on the Walking Parameters of Hemiparetic Patients in Borgou (Benin)

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### Abstract

**Background:** After a stroke, the accomplishment of daily life activities depends on the recovery of the motor function. Few data are available on post stroke walk recovery in the African context. This study aimed to determine the relationship between the age of stroke occurrence in Benin and its consequences on the walking speed and endurance of hemiplegic patients.

**Methods and findings:** This was a cross-sectional pilot study and carried out at the University hospital of Borgou and included 22 hemiplegic people (63.8% men). The Measurement of Functional Ambulation Classification, Barthel Index and Modified Rankins Scale to evaluate the functional ability; and walking speed over 10 m and 6 minutes walking test (endurance), for the motor performance. The subjects (54.9 ± 5.5 years old) have an average speed of 0.82 ± 0.2 m.s<sup>-1</sup> (16.7 ± 2.6 steps) and an average endurance of 329.3 ± 67.1 m. The comparison of the 2 sub-groups statistically different in age (p<0.05): G1: <55 years old (51 ± 3.2 years) and G2 ≥ 55 years old (58.8 ± 4.4 years) but no significant difference has seen in the walking speed, the number of steps and endurance (p>0.05).

**Conclusion:** The young age of the participants did not allow making a remarkable difference between the walking performance, the number of steps and the endurance of the two subgroups of patients aged 43 to 68 years. Therefore we need the multicenter studies in order to study the real impact of age and other factors to the walking speed, endurance and performance.

**Keywords:** Stroke; Age; Walking; Performance; Benin

### Introduction

The cerebrovascular accidents (CVA) are among the most frequent neurologic disorders, where the vital prognosis is very often higher [1]. Stroke is defined as being a fast development of localized or total signs of cerebral dysfunction with symptoms lasting more than 24 h, being able to lead to death, without other apparent cause than a vascular one [1]. According to the World health Organization (WHO), one person in the world is affected by a stroke every 5 s. It is a pandemic whose world incidence projection is nearly 23 million cases in 2030 against 16 million in 2005 [2]. Strokes are, in the industrialized countries, the third cause of mortality after cancers and cardiovascular affections [3]. In Africa, they cause death in more than 4% cases in Nigeria [4], 9.3% in Ivory Coast [3]. Stroke constitutes one of the first causes of disability [5] and lasting handicap for the third of survivors [6]. Then they have an extremely heavy social contribution. In fact, the occurrence of cerebrovascular accidents is at the origin of motor and cognitive after-effects, but also of a decrease in the capacity to make effort, because of the motor deficit whose main causes are confinement, immobility and the breakdown of functional capacities [7].

The capacity of a person to assume daily life activities after a stroke depends on the recovery of motor function [8]. It is characterized by the capacity of the individual to achieve in a similar way the movements necessitating the same effectors and muscular activation process as before stroke [9]. The multidisciplinary care, leading to this motor recovery makes it possible to improve functional autonomy, to reduce the duration of hospitalization and to increase the prevalence of home returning [10]. Post stroke recovery depends on many factors [11]. It is thus important to evaluate this recovery. The various evaluations are made with functional tests and scales. The tests used include that allowing quantifying the level of functional recovery of walking [12]. In fact, a good functional walking recovery is associated with a good motor recovery [4].

Concerning the post stroke walking capacity in Africa, the few studies that exist focus briefly on the subject. Several reasons explain this [12,13]. As mentioned in the literature, if CVA in developed countries is the prerogative of the people of average age higher than 65, in Africa, its victims are relatively younger [2]. However it was proven that the walking parameters change under the combined effect of physiological and pathological ageing [14,15]. As a matter of fact, in the process of normal aging, the walking speed drops continuously; after 60 years old, it reduces by 1% each year [16]. This research aims to determine the relationship between the average age of stroke occurrence in Benin and its functional consequences on the walking parameters (speed and endurance) of hemiplegic patients.

## Material and Methods

### Study and setting

It was a pilot and cross-sectional study, with a prospective collection of data. It had as framework the University hospital of Borgou (CHUD-B) located in the North-West of Benin. This choice was operated because of the favorable conditions to the achievement of the study. In this hospital we have two neurologists with competence in stroke, two neurosurgeons, three intensive care specialists, one cardiologist and one rehabilitation unit with five physiotherapists.

### Participants

We had included in this study all stroke hemiplegic patients admitted during 1<sup>st</sup> January to 31<sup>st</sup> December 2016 with the given consent.

### Study sample

The study sample was made up thanks to an exhaustive census of all the medical files of hemiplegic patients. These files were obtained from the health centers and from the structure specialized in taking care of stroke survivors and physiotherapy in the department of Borgou. To participate in the investigation, patients should comply with the following criteria

**Inclusion criteria:** All medical files of hemiplegic patients available between 1<sup>st</sup> January and 31<sup>st</sup> December 2016. Patients available and have given their clearly written consents to take part in all the phases of the study. Patients have carried out all the tests of evaluation of motricity (performance of walk and functional scales).

**Exclusion criteria:** Every hemiplegic patient's medical files without general information (age, sex, place, year of consultation). Every participant who could not carry out all the tests envisaged within the framework of the study.

### Procedures

A screening of the patients' files made it possible to retain those who could be taken into account in the study. Inclusions were made, as the patients filled the criteria. For each patient, it was organized:

**Pre-inclusion medical examination:** During this visit, the doctor examined the aptitude of the patient to carry out the tests of walking required in the study. The patient was then informed of the protocol. Finally, the information note and the letter of consent were left to him for reading and signature.

**Inclusive medical visit:** It took place 72 h after the visit of pre-inclusion. During this visit, the patient had given his agreement or not to take part in the investigation. In the case of an approval, information related to the characteristics of the patient, to the conditions of occurrence of the stroke, to the connected motor disorders was extracted from the patient file and were transcribed on the data collection sheet. A measurement of the functional scales was carried out. This collection of information was made by the doctor. Finally, the subject took note of the walking tests to be carried out (pre-test).

**Walking assessment visit:** The walking speed tests and walking endurance were carried out on 2 various occasions with 72 h interval between the two (2 visits). Each visit was organized as follows: 2 speed tests of walking on 10 m (separated by a pause of 5 min), a sited rest (of 15 min) and 1 walking endurance test of 6 min. The average of the values obtained for the 2 visits were taken into account.

### Materials and techniques

**The walking test on 10 meters (test of Wade):** The 10 meters walking test (10 MT) is the most used measurement to evaluate the walking speed [17,18]. The distance on the tiled floor is marked. The instructions were to carry out in one direction, the distance as fast as possible. The use of technical assistance is accepted. A stop watch is used to measure time. It is started at the beginning of the patient and is stopped as soon as he/she crosses the line at the finish. Two passages were carried out and average time recorded each time. Speed is appreciated through the formula:  $V (m.s^{-1})=d/t$  (where d=distance in meter; t=time in seconds). The number of steps is also counted during the test.

**6 minutes walking test:** The 6 minutes walking test (6 MWT) is a field test [19]. It was carried out on a preset distance long of 30 m with reversal and marked out every 3 m. The instruction is to cover the longest possible distance in 6 min. The evaluator is behind the patient in order not to influence his pace and its motivation but to point out each past minute to him.

### Variables

Patients biometric data: Age, body-mass (kg), height (cm), Body Mass Index, Gender

Stroke data: Type, the onset date, localization, side of the hemiparesis

Functional scales characterizing the patient's motricity: Barthel Index, Functional Ambulation Classification, of Rankins Modified Scale.

Walking performance: Walking Speed (10 MT), number of steps at the speed, distance covered at the walking endurance (6 MWT).

## Statistical analysis

The statistical analysis was made with SPSS. Descriptive statistics were generated for the variables under investigation. The quantitative descriptive variables were expressed on average  $\pm$  standard deviation when the distribution is normal and those qualitative, in size and percentage. Student's statistical test *t* allowed, to compare the average. The value of *p* lower than 0.05 was retained as level of significance of the statistic tests.

## Ethical Consideration

This study obtained the permission of local Ethical Committee of University of Parakou the permission of the heads of the Rehabilitation unit and physiotherapy services of the University hospital were also obtained.

The data collected were confidentially processed, because of the anonymity of the data collection files. A strict medical monitoring of the patients was carried out during the protocol and steps were taken to care of them in case any event occurred in connection with the walking performance tests.

## Results

### Distribution of the population

On the 48 received and studied files, only 22 patients fulfilled the inclusion criteria and took part in the investigation (Figure 1).

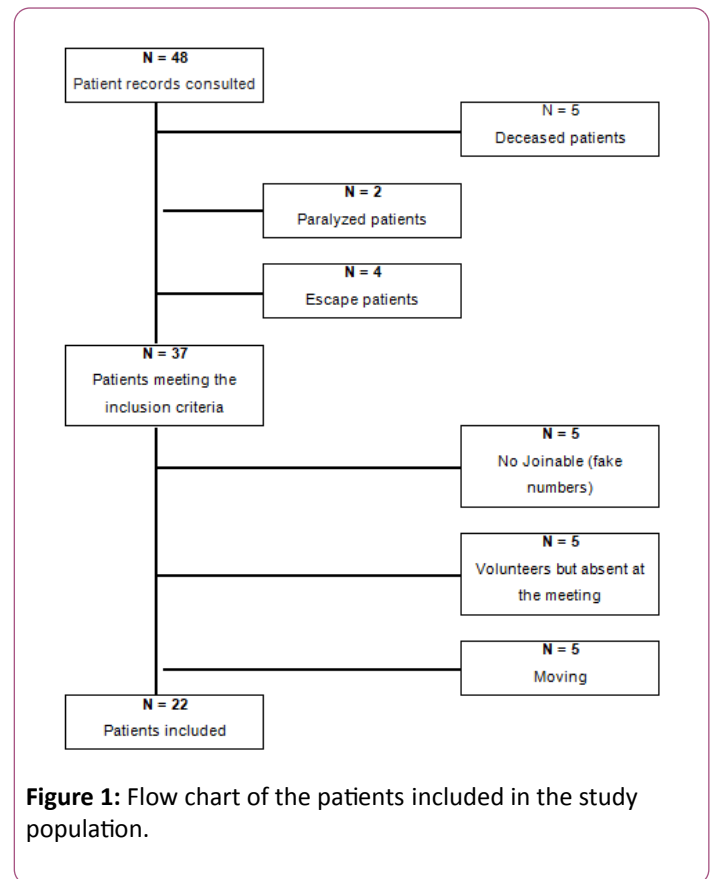
### Biometric and clinical characteristics of the population

The average age of the patients was of  $54.9 \pm 5.5$  years. Patients of less than 55 years old are 11 out of 22 (i.e. 50%). 14 patients (63.6%) were male, with a sex-ratio of 1.75 in favor of men. The mean BMI of the patients was of  $27.2 \pm 2.3$  kg.m<sup>-2</sup> (Table 1).

The stroke length (duration since the onset of the disease) of the participants in the study was  $11 \pm 4.2$  months. The type of CVA reveals an ischemic prevalence (13.6%) and was identified for 4 cases (18.2%). The patients having a left side hemiplegia accounted for 77.3% of the sample. The mean of heart rate and respiratory frequency are respectively  $66.6 \pm 14.2$  bpm and  $20.5 \pm 1.8$  pulsations per min.

### Functional scales characterizing the patient's motricity

Among the participants, 21 (95.5%) have a complete autonomy for the Barthel Index, 16 (72.7%) for the FAC and 15 (68.2%) did not present any symptom for the Modified Rankins Scale of (Table 2).



**Figure 1:** Flow chart of the patients included in the study population.

### Walking performances and connected factors

For the 10 meters walking test (10 MT), the mean walking speed was  $0.82 \pm 0.21$  m.s<sup>-1</sup> (total average of  $16.7 \pm 2.6$  steps). All the participants walked for 6 minutes during the endurance test, covering an average distance of  $329.3 \pm 67.1$  m (Table 3).

This same table indicates statistical difference between the two sub-groups: <55 years old and >55 years old (*p*=0.000). Any significant difference was seen between these subgroups for: the walking speed ( $0.85 \pm 0.2$  versus  $0.80 \pm 0.2$  m.s<sup>-1</sup>), the number of steps ( $16 \pm 1.8$  versus  $17.4 \pm 3.1$  steps) and the endurance ( $237.3 \pm 67.1$  versus  $17.4 \pm 3.1$  m), *p*<0.05.

**Table 1:** Biometric and clinical characteristics of the sample, Parakou 2016.

	Frequency (%)	Min-Max	Mean $\pm$ SD
Age (years)	22	43.0-68.0	$54.9 \pm 5.5$
<55	11 (50)	43-54	$51 \pm 3.2$
$\geq 55$	11 (50)	55-68	$58.8 \pm 4.4$
Gender			
Male	14 (63.8)		
Female	8 (36.4)		
BMI (kg.m <sup>-2</sup> )	22	20.8-30.9	$27.2 \pm 5.5$
Stroke			

Ischemic	3 (13.6)		
Hemorrhagic	1 (4.5)		
Not determined	18 (81.8)		
Side of Hemiparesis			
Left	17 (77.3)		
Right	5 (22.7)		
Seniority of stroke at time of testing (months)	22	1.6-18.4	11.6 ± 3.6
Systolic Blood Pressure (mmHg)	22	100.0-140.0	119.1 ± 11.1
Diastolic Blood Pressure (mmHg)	22	80.0-120.0	94.3-10.5
Cardiac frequency (pulsation/Min)	22	53.0-96.0	66.6 ± 14.2
Respiratory rate (Pul/Min)	22	18.0-25.0	20.5 ± 1.8
BMI: Body Mass Index; SD: Standard deviation; pul/min: pulsation per minute, Pul/min : pulsation per minute, Min: Minimum; Max: Maximum			

**Table 2:** Functional scales characterizing patient motor skills.

	Frequency (%)	Min-Max	Mean ± SD
Barthel Index	22	50 – 100	90.9 ± 9.9
Dependence (<65)	1 (4.5)		
Complete Autonomy (90-100)	21 (95.5)		
FAC	22	5.0-7.0	6.2 ± 0.5
Surveillance (5)	1 (4.5)		
Modified Independence	16 (72.7)		
Complete Independence (7)	5 (22.7)		
RMs	22	0-3	0.6 ± 1
No Symptoms (0)	15 (68.2)		
No	4 (18.2)		
Light disability	1 (4.5)		
Handicap Moderate (3)	2 (2)		
RMs: Rankins Modified Scale, FAC: Functional Classification Ambulation, Min: Minimum, Max: Maximum SD: Standard Deviation			

**Table 3:** Performance in walking and comparison by age.

	Frequency (%)	Min-Max	Mean±SD	p Value
Comparison of the average age according to the subclasses				
Age (years)	22	43.0–68.0	54.9 ± 5.5	
<55	11 (50)	43-54	51 ± 3.2	0
≥ 55	11 (50)	55-68	58.8 ± 4.4	
10 MWT				

Speed (m.s <sup>-1</sup> )	22	0.50 -1.4	0.82 ± 0.21	
<55 ans	11 (50)	0.6-1.3	0.85 ± 0.2	0.797
≥ 55 ans	11 (50)	0.5-1.4	0.80 ± 0.2	
Number of steps	22	44896	16.7 ± 2.6	
<55 ans	11 (50)	13-18	16 ± 1.8	0.562
≥ 55 ans	11 (50)	44896	17.4 ± 3.1	
6MWT				
Distance (m)	22	220-450	329 ± 67.1	
<55 years	11 (50)	240-450	327.3 ± 67.8	0.217
≥ 55 years	11 (50)	220-430	331.4 ± 21.0	
Min: Minimum; Max: Maximum; SD: Standard Deviation				

## Discussion

This study aimed to determine the relationship between the average age of stroke occurrence in Benin and its motor consequences on the walking parameters (speed and endurance) of hemiplegic patients.

### Epidemiologic characteristics of the population

Twenty-two [15] stroke survivors took part in the investigation, with a sex-ratio of 1.75 in favor of men. There is a variability of the prevalence of sexes when stroke occur. Some studies undertaken on the African continent, revealed a male preponderance with a ratio ranging between 1.3 and 1.5 [1,2,20]. A study raised a ratio with (2). However it was found through other studies, ratio-sexes in favor of women, varying between 0.82 and 0.97 [8,9].

The average age of the participants was of 54.9 ± 5.5 years. It is included in the interval from 44.5 to 61 years old as evoked by other studies undertaken on some African populations [2]. However, it is lower when it is compared with the mean values of 62 years old, resulting from studies carried out on American population with Black prevalence [2]. The values obtained in our study corroborate research works that had connection between races and age of stroke occurrence [2]. They estimated, after having compared the average age of stroke between the subjects of different race, that stroke occurs on average at 77.5 years old for white people, 65.4 years old for Latin-American and finally, 69.5 years old for Black subjects. Black subjects thus have earlier stroke than other races. It would be interesting to undertake studies in order to determine the etiology of this fact.

The majority of the patient's files (72.7%) did not inform about the type of their stroke. The reasons for that include: the high cost of the cerebral scanner, its absence in certain health centers and also the fact that the majority of the patients arrived at the hospital within a time higher than 24 hours. Former studies recorded various percentages for the cerebral scanner not carried out with stroke survivors. Thus in Nigeria, only 9% of the hospitalized patients for a stroke had benefited from a cerebral scanner [21], in Ethiopia and in Mauritania the studies gave 38.3% and 35.1% respectively [4,20]. Scanner and

MRI SCAN are practically non-existent in some African countries [4,22,23]. Our percentage is higher than the values in the studies mentioned above. However, it is explainable mainly by the non-availability of the equipment for functional exploration of the brain when a stroke occurs. In actual fact, a study confirms that in Benin there is no MRI SCAN appliance and that in the whole country, there were only three scanners [24]. At the time of this study, one of the two scanners available in the departmental of Borgou was broken down. All the patients having gone through an MRI SCAN or a cerebral scanner said they have done it in Cotonou. To that reason should be added the late arrival of patients in health center (beyond the first 6 hours after stroke). This delay would be related to cultural and economic reasons, what entails difficulties in the diagnosis of the type of CVA [4].

This study appreciated the functional status of the patients by making use amongst other things of the Barthel Index [25]. It is a reference assessment tool for vascular hemiplegia [26]. Thus in 11 month's post-stroke, the patients got scores corresponding to a complete autonomy (95.5%) and to dependence (4.5%) for the Barthel Index. They are patients presenting a very good functional state in general. They are autonomous in their daily life activities. This can be explained by: the initial status of their It is a reference assessment tool for vascular hemiplegia, the types of treatment, the socio-demographic conditions, and the quality of their health care. To these explanatory factors of the quality of this functional status, it is important to add the young age of the sample ( $54.9 \pm 5.5$  years). In fact, younger patients recover functionally more quickly of stroke [27]. It was the same in a study carried out in Senegal, where an age lower than 55, was significantly associated with motor recovery [28]. That is confirmed through the scores obtained at the level of the MIF and the modified Rankins scale.

### Walking performances and age

The evaluation of the walking speed on 10 meters gave  $0.82 \pm 0.2 \text{ m}\cdot\text{s}^{-1}$ . For healthy subjects, certain authors [28,29] have evaluated the variation of this speed between 0.9 and  $2.5 \text{ m}\cdot\text{s}^{-1}$ . The participants in this study had an average speed lower than the normal threshold for healthy subjects, approximately 12 months after the stroke. It is concerned with one of the stroke frequent consequences, resulting in muscle weakness of which one of the consequences is the reduction of walking speed [30]. However the average obtained for our sample is higher than that obtained by authors having worked on the same targets. Thus, it was found by Olney et al. [31], among 30 hemiplegic patients, slow, average and fast walking speeds, lasting respectively  $0.3 \text{ m}\cdot\text{s}^{-1}$ ,  $0.4 \text{ m}\cdot\text{s}^{-1}$  and  $0.6 \text{ m}\cdot\text{s}^{-1}$ . In addition, D'Agneli-Chevassut et al. [32] and Mizrahi et al. [33] found average speeds varying between  $0.2$  and  $0.5 \text{ m}\cdot\text{s}^{-1}$  for hemiplegic aged between 23 and 74 years of which the post stroke duration was lower than 2 years. In sub-Saharan Africa, Obembe et al. [34] had observed among 70 stroke survivors in Nigerian ( $53.5 \pm 10.4$  years; of anteriority  $18.3 \pm 8.8$  months), a mean of walking speed of  $0.6 \pm 0.3 \text{ m}\cdot\text{s}^{-1}$ . The same study presented a variation Min-max of  $0.11$ - $1.12 \text{ m}\cdot\text{s}^{-1}$  against  $0.5$ - $1.37$  for our sample.

The average distance covered by our patients at the 6 min walking Test (endurance) was of  $329.3 \pm 67.1$  meters. Studies on

walking performance on black hemiplegic subjects are rather rare. Courbon et al. [7] observe that walking is overdrawn at the hemiplegic because of neurological attack, motor deficit and coordination disorders.

In a healthy population (men: 59.5 years; women: 62 years), respective mean values of 576 m and 494 m were noted by Enright et Sherill [35] for the same test. The average obtained in the current study, is lower than that mentioned above [35]. Stroke survivors present a limitation of their capacity of endurance and effort [8,36]. This difference is related amongst other things, to the reduction of the capacity to make effort, caused by confinement and immobilization and the loss of functional capacities related to the motor deficit [8]. Our results corroborate former studies. In fact, with regard to the endurance performances of hemiplegics, it is documented in the literature median values that are lower than the performance of healthy subjects. In a study related to 24 hemiplegic people (sex-ratio 0.5; 53.3 years), Pradon et al. [37] measured, after a 16 month deadline between the occurrence of stroke and 6 minutes walking test, a performance of  $273.8 \pm 173.4$  m [37]. It is a study presenting some characteristics rather close to those of our sample. In the same vein, other authors [7,12] gave a mean value of  $267.8 \pm 154.9$  m, for a population of 21 hemiparetic ( $53.48 \pm 7.6$  years), with  $24.5 \pm 28$  months post-stroke. Eng et al. [11] measured  $267.7 \pm 93.2$  m during 6 minutes walking test for 25 subjects ( $62.6 \pm 8.5$  years) evaluated with  $4.4 \pm 3$  years on average after the stroke; whereas for older subjects ( $72.1 \pm 10.2$  years) an average value ( $215 \pm 91.6$  m) lower than ours was obtained [38]. Finally, Kelly et al. [39] measured a value close to ours ( $294.1 \pm 120.2$  m) with the 6 min test, on a group of 17 hemiplegic of 24 and 84 years old and having a post stroke duration ranging between 4 and 6 weeks.

The difference in performance can depend on the young age of our patients or several other factors. By comparing the groups of the old subjects of less than 55 with those aged of more than 55, it comes a statistically significant difference for the average age ( $p < 0.05$ ). By comparing the average performances of walking speed, pace and endurance obtained during this study, there is no significant difference between the sub-group of subjects of 55 years old or less, and those of more than 55 ( $p > 0.05$ ). This result seems to indicate that the age does not influence the motor performance and in particular the walking speed and the endurance at walking. For this purpose, it should be noticed that the influence of age on motor recovery does not meet the agreement of all, and age does not constitute, in itself, a poor prognostic factor [40,41]. Thus, other authors observe that the high age does not influence functional recovery. According to these authors, functional future remains influenced by the possible existence of intellectual deterioration, as well as the initial clinical and functional conditions [41]. Age influences the aspects relating to daily life activities, but not neurological recovery [41]. However, the comparison of the average performances of our subjects to those in the literature suggests that for subjects of 70 years old or more, the walking performances in terms of speed and endurance are less good. The oldest patient in the study being 68 years old, it is possible the idea according to which the young patients rehabilitation is easier [26,36]. A study of stronger power with a longitudinal

follow-up will make it possible to answer this assumption correctly.

## Conclusion

This study shows that the Beninese hemiplegic patients are younger than the hemiplegic patients in Western countries. Moreover, they present performances that testify a good functional state by comparing their average performances (speed and endurances) with those of older patients. It would be interesting to continue the investigations in order to better determine the role the age and functional characteristics in the recovery process.

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