

Available online at [www.sciencedirect.com](http://www.sciencedirect.com)**ScienceDirect**journal homepage: <http://www.elsevier.com/locate/poamed>**Original research article****Depression and dynamic balance recovery among stroke survivors: A preliminary investigation****Ukachukwu Okoroafor Abaraogu<sup>\*</sup>, Michael Chibuike Opara**Department of Medical Rehabilitation, Faculty of Health Science and Technology College of Medicine,  
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**ABSTRACT**

**Introduction:** Studies have suggested that there could be a link between balance problems and anxiety and depression conditions, and that rehabilitation of the balance system could help. However, a direct link has not been established between post-stroke depression and functional recovery and balance.

**Aim:** The aim of this preliminary investigation was to investigate the occurrences of depression and to assess dynamic balance recovery status of stroke survivors as a foundational study for a future large investigation to establish the relationship between depression and dynamic balance recovery.

**Material and methods:** A convenient sample of 18 stroke survivors was recruited from stroke patients attending the outpatient adult neurology unit of the Physiotherapy Department, University of Nigeria Teaching Hospital in a cross-sectional design. The Patient Health Questionnaire-9 and the Dynamic Gait Index / Functional Gait Assessment score were used to collect data for depression and dynamic balance recovery respectively. Associations between depression and dynamic balance recovery were determined using Chi-Square analysis at a confidence level of 95%. Analysis was done using SPSS v. 20.

**Results and discussion:** Result showed a high prevalence (55.60%) of post-stroke depression among stroke survivors. Majority of the survivors (88.90% of patients) had poor dynamic balance recovery.

**Conclusions:** There is a high prevalence of post-stroke depression among stroke survivors and they have poor dynamic balance. However, owing to small sample of participants in the present study, its premature to draw conclusion on the relationship between depression and dynamic balance recovery among stroke survivors from the result of this study.

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## 1. Introduction

Severe disability and significant limitation to activities of daily living are frequent sequelae of stroke, and these greatly impact postural stability,<sup>1–6</sup> further exacerbating risk of fall among stroke survivors.<sup>7</sup> Similarly, post-stroke depression (PSD) is considered the most frequent and important neuropsychiatric consequence of stroke.<sup>8,9</sup> Approximately one-third of stroke survivors experience major depression.<sup>8</sup> Moreover this condition can have an adverse effect on cognitive function, functional recovery and survival.<sup>9</sup> Although depression is important sequel of stroke, there is yet some uncertainty regarding its relationship with functional ability and balance. There is a growing interest into research on how best to restore dynamic balance mechanism in stroke survivors. Although the importance of manipulating afferent integration has been suggested,<sup>6,10</sup> however, it remains unclear how this could be effectively implemented to gain dynamic balance.

For a full functional recovery to be achieved in a stroke patient, a holistic rehabilitative intervention putting into consideration the patient's psychological and emotional state, in addition to other necessary domains, is imperative. Research into the relationship between depression, a major psychological and emotional disorder in post-stroke patients, and dynamic balance recovery in these patients is warranted.

From the foregoing, although researchers suggested that there could be a link between balance problems and anxiety and depression conditions, and that rehabilitation of the balance system could help,<sup>1–6,9,11</sup> a direct link could not be established between depression and functional recovery and balance following stroke.

## 2. Aim

The aim of this preliminary investigation was to investigate the occurrences of depression and to assess dynamic balance recovery status of stroke survivors as a foundational study for a future large investigation to establish the relationship between depression and dynamic balance recovery.

## 3. Material and methods

### 3.1. Research design

This is a cross-sectional research among stroke survivors attending the outpatient Adult Neurology Unit of Physiotherapy Department of University of Nigeria Teaching Hospital. A convenient sample of stroke survivors who met a prior selection criteria were the sample frame. To be included a stroke survivor must be ambulant, must not have any cognitive impairment, and consents to a voluntary participation in the research.

The University of Nigeria Teaching Hospital Health Research Ethics Committee approved the research protocol. Participants' informed consents were obtained prior to the

study. Participants' privacy and confidentiality were maintained by secluding the assessment areas, using code numbers instead of names in data presentation, keeping the records confidential.

### 3.2. Data analysis

Data were analyzed with the Statistical Package for Social Sciences (SPSS 20). Demographics and anthropometric as well as the depression and dynamic balance profiles were presented in tables of frequencies and percentage. Also, was presented in a table of frequency and percentage. Chi-square analysis was used to seek association between depression and balance recovery and between demographics, stroke characteristics on one hand and depression and balance recovery on the other hand.

### 3.3. Subjects description

A total of 18 stroke survivors comprising 13 males and 5 females participated in the study. At the end of the data collection process, they were categorized into the following groups: mildly depressed, moderately depressed and severely depressed. They were also categorized into those with good balance and those with poor balance.

### 3.4. Measurements

Portable weight scale and height meter were used to measure the weight and height of the participants to the nearest 0.1 kg and 0.1 cm, respectively. Mercury type sphygmomanometer as well as Littmann Classic Stethoscope was used to measure the diastolic and systolic blood pressures of the participants to the nearest 1 mmHg.

The Patient Health Questionnaire (PHQ-9) was used to measure the level of depression of the subjects. The PHQ-9 is a multipurpose instrument for screening, diagnosing, monitoring and measuring the severity of depression. It consists of nine questions designed to correspond to the nine diagnostic criteria for major depressive disorder. Items were rated from 0 (not at all) to 3 (nearly every day) according to increased frequency of experiencing difficulties in each area covered. Scores were summed and can range from 0 to 27. In line with a previous documentation,<sup>12</sup> PHQ-9 scores of 5, 10, 15, and 20 were respectively interpretive of mild, moderate, moderately severe and severe depression respectively.

Dynamic Gait Index/Functional Gait Assessment Scoring Form was used to measure the subjects' dynamic balance recovery. This test consists of 10 different tasks that the patients are rated on using an ordinal scale of 0–3 (0 – severe impairment, 1 – moderate, 2 – mild, 3 – normal) with the best possible total equal to 30 and the worst score equal to 0. A score of 19 or less is indicative of increased fall risk.<sup>12</sup> The tasks include the following: ambulating on a level surface, ambulating while changing speeds, ambulating with horizontal head turns, ambulating with vertical head turns, ambulating with pivot turns, stepping over obstacles, ambulating with a narrow base of support, ambulating with eyes closed, ambulating backwards and ascending/descending stairs.<sup>12</sup>

### 3.5. Procedure for data collection

#### 3.5.1. First step

Following ethical approval and permission from the relevant committee and department, the purpose and procedures of the study were explained to the participants on which basis their informed consents were requested and obtained. Then there was collection and documentation of demographic and other background data of the participants. These included their age, sex, duration of stroke, lesion site, marital status, occupation, level of education, religion and tribe.

#### 3.5.2. Second step

The height and weight of each participant was measured. Values obtained from these were used to calculate and record the BMI of the participants. Then the participants' blood pressure readings were measured.

#### 3.5.3. Third step

The PHQ-9 was administered on the participants. Scores for each participant were summed and interpreted as indicating either no depression, minimal, mild, moderate, moderately severe, or severe depression.

The Dynamic Gait Index/Functional Gait Assessment was administered on the participants with the tasks included as described earlier, after which total scores for each participant were summed up and categorized.

## 4. Results

### 4.1. Demographics profile of stroke survivors

A total number of 18 stroke survivors participated in the study. Majority (72.2%) were male and were 46 years or above. Most had ischemic stroke and largely (55.60%) suffered right hemispheric stroke. Secondary education was most prevalent highest formal education attained by the participants, majority of whom had had stroke for more than a year. Also, most of the participants (16; 88.90%) were either overweight or obese (see **Table 1** for details).

Depression and dynamic balance recovery profiles of stroke survivors are shown in **Table 2**. Majority of the patients (10; 55.60%) had moderate forms of depression and showed poor balance recovery (16; 88.90%). Association between demographics, stroke characteristics, and depression among stroke survivors are represented in **Table 3**.

Although majority (7; 39.00%) of patients who showed moderate and severe depression were below 65 years, the association between age and depression however was not significant. Males (6; 33.33%) were depressed more as well as those who suffered ischemic stroke (9; 50.00%) or were overweight and obese (8; 44.44%). Generally, there was no significant association between gender, weight status, stroke characteristics, and depression among stroke survivors.

### 4.2. Association between demographics, stroke characteristics, and balance recovery among stroke survivors

Majority (10; 55.60%) of patients who showed poor balance recovery were below 65 years, were males (11; 61.11%), suffered

**Table 1 – Demographics profile of stroke survivors (n = 18).**

	Frequency (n)	Percent (%)
Age		
36–45 years	1	5.60
46–55 years	4	22.20
56–65 years	6	33.30
66 years and above	7	38.90
Gender		
Male	13	72.20
Female	5	27.80
Type of stroke		
Ischemic	14	77.80
Hemorrhagic	3	16.70
TIA	1	5.60
Lesion site		
Right hemisphere	10	55.60
Left hemisphere	8	44.40
Level of education		
Nil formal	3	16.70
Primary	4	22.20
Secondary	4	22.20
Tertiary	6	33.33
Post graduate	1	5.60
Duration of stroke		
0–6 months	2	11.10
7–12 months	2	11.10
Over 1 year	14	77.80
BMI		
Underweight ( $\leq 18.4$ )	0	0.00
Normal (18.5–24.9)	2	11.10
Overweight (25.0–29.9)	13	72.20
Obese ( $\geq 30.0$ )	3	16.70

**Table 2 – Depression and dynamic balance recovery profiles of stroke survivors (n = 18).**

	Frequency (n)	Percent (%)
Depression status		
Mild	8	44.40
Moderate	9	50.00
Severe	1	5.60
Depression status		
Non-depressed	8	44.40
Depressed	10	55.60
Dynamic balance recovery		
Good balance	2	11.10
Poor balance	16	88.90

ischemic stroke (12; 66.67%) and were overweight or obese (14; 77.80%). The association between these demographics, stroke characteristics, and balance recovery are as seen in **Table 4**.

### 4.3. Association between depression and dynamic balance recovery among stroke survivors

Results are shown in **Table 5**. Two (25.00%) of the eight patients who had mild depression showed good dynamic balance recovery and the remaining 6 (75.00%) showed poor dynamic

**Table 3 – Association between demographics, stroke characteristics, and depression among stroke survivors (*n* = 18).**

	Depressed	Non-depressed	$\chi^2$	P value
	n (%)	n (%)		
<b>Age</b>				
64 years and below	7 (63.64)	4 (36.36)	0.748	0.387
65 years and above	3 (42.86)	4 (57.14)		
<b>Gender</b>				
Male	6 (46.15)	7 (53.85)	1.675	0.196
Female	4 (80.00)	1 (20.00)		
<b>Type of stroke</b>				
Ischemic	9 (64.29)	5 (35.71)		
Hemorrhagic	1 (33.33)	2 (66.67)	2.282	0.319
TIA	0 (0.00)	1 (100.00)		
<b>Lesion site</b>				
Right hemisphere	5 (50.00)	5 (50.00)	0.281	0.596
Left hemisphere	5 (62.50)	3 (37.50)		
<b>Level of education</b>				
Nil formal	3 (100.00)	0 (0.00)		
Primary	2 (50.00)	2 (50.00)		
Secondary	1 (25.00)	3 (75.00)	5.513	0.239
Tertiary	4 (66.67)	2 (33.33)		
Post graduate	0 (0.00)	1 (100.00)		
<b>Duration of stroke</b>				
0–6 months	1 (50.00)	1 (50.00)		
7–12 months	1 (50.00)	1 (50.00)	0.064	0.968
Over 1 year	8 (57.14)	6 (42.86)		
<b>BMI</b>				
Underweight ( $\leq 18.4$ )	0 (0.00)	0 (0.00)		
Normal (18.5–24.9)	2 (100.00)	0 (0.00)	2.215	0.330
Overweight (25.0–29.9)	6 (46.15)	7 (53.85)		
Obese ( $\geq 30.0$ )	2 (66.67)	1 (33.33)		

balance recovery. All patients who were moderately severely depressed showed poor dynamic balance recovery. When the classification of depression status was dichotomized – i.e. absence or presence of depression, 25.00% of patients with mild depression showed good dynamic balance, whereas all patients who were depressed showed poor dynamic balance recovery. However, there was no significant association between depression and dynamic balance recovery in stroke survivors.

## 5. Discussion

### 5.1. Prevalence of depression among stroke survivors

It was found that a greater percentage of the patients (55.60%) had depression. This is higher compared to several studies elsewhere reported.<sup>13–16</sup> Whereas previous reports have acknowledged wide variation in the frequency of depression after stroke across studies largely because of differences in patient characteristics and study designs, they have also suggested that the lowest and highest frequency of depression is found among patients in population- and rehabilitation-based studies, respectively, potentially reflecting selection bias toward the inclusion of more disabled stroke survivors in

**Table 4 – Association between demographics, stroke characteristics, and balance recovery among stroke survivors (*n* = 18).**

	Good balance	Poor balance	$\chi^2$	P value
	n (%)	n (%)		
<b>Age</b>				
64 years and below	1 (9.09)	10 (90.91)	0.117	0.732
65 years and above	1 (14.29)	6 (85.71)		
<b>Gender</b>				
Male	2 (13.38)	11 (84.62)	0.865	0.352
Female	0 (0.00)	5 (100.00)		
<b>Type of stroke</b>				
Ischemic	2 (14.29)	12 (85.71)		
Hemorrhagic	0 (0.00)	3 (100.00)	0.643	0.725
TIA	0 (0.00)	1 (100.00)		
<b>Lesion site</b>				
Right hemisphere	2 (20.00)	8 (80.00)	1.800	0.180
Left hemisphere	0 (0.00)	8 (100.00)		
<b>Level of education</b>				
Nil formal	0 (0.00)	3 (100.00)		
Primary	0 (0.00)	4 (100.00)		
Secondary	1 (25.00)	3 (75.00)	1.969	0.742
Tertiary	1 (16.67)	5 (83.33)		
Post graduate	0 (0.00)	1 (100.00)		
<b>Duration of stroke</b>				
0–6 Months	0 (0.00)	2 (100.00)		
7–12 Months	0 (0.00)	2 (100.00)	0.643	0.725
Over 1 year	2 (14.29)	12 (85.71)		
<b>BMI</b>				
Underweight ( $\leq 18.4$ )	0 (0.00)	0 (0.00)		
Normal (18.5–24.9)	0 (0.00)	2 (100.00)	0.865	0.649
Overweight (25.0–29.9)	2 (15.38)	11 (84.62)		
Obese ( $\geq 30.0$ )	0 (0.00)	3 (100.00)		

the latter studies.<sup>17–19</sup> Moreover, the time period of greatest risk of depression has traditionally been considered to be the first few months of stroke onset. This work, conversely, showed consistency in the overall frequency of depression across patients and in relation to the time periods from stroke onset. Thus raises doubts about specific biological theories related to an acute stroke lesion as the major cause of depression in this condition.

Variability between studies arises not only from the methodological problems of the investigations but also from

**Table 5 – Association between depression and dynamic balance recovery among stroke survivors (*n* = 18).**

	Good balance	Poor balance	$\chi^2$	P value
	n (%)	n (%)		
<b>Depression status</b>				
Mild	2 (25.00)	6 (75.00)		
Moderate	0 (0.00)	9 (100.00)	2.813	0.245
Severe	0 (0.00)	1 (100.00)		
<b>Depression status</b>				
Non-depressed	2 (25.00)	6 (75.00)	2.813	0.094
Depressed	0 (0.00)	10 (100.00)		

the complexity in recognizing, assessing, and diagnosing depression.<sup>20</sup> While most of the studies have based their diagnosis on different rating scales, others have used a structured interview format and the diagnostic standards defined by International Classification of Diseases or the Diagnostic and Statistical Manual of Mental Disorders.<sup>20</sup> It is important to recognize that rating scales were designed to measure depression severity in primary depressive illness rather than to diagnose depression itself, especially depression occurring as comorbidity. The correct attribution of somatic symptoms to either PSD or stroke is a very relevant issue, because such symptoms may affect rating scales. The PHQ-9 was utilized to measure depression severity and found a 55.60% prevalence of depression in the stroke survivors.

Demographic variables are important determinants of PSD.<sup>13–29</sup> Similarly, in this study, the most important determinants of depression were demographic variables like male gender and age, though with no significant association. The majority of the earlier studies<sup>13,14,16</sup> had reported female gender as being an important risk factor for PSD. However, in contrast, male gender was an important determinant in this study. This might be due to the low proportion of females in the study population.

PSD in this study was not related to stroke lesion-related parameters like age, type and side of lesion, and post-stroke duration. This is in concordance with the majority of earlier studies.<sup>13,14,28</sup> However, one study each had reported site of the lesion,<sup>21</sup> younger age,<sup>13</sup> and older age<sup>22</sup> as being among the important risk factors for PSD.

## 5.2. Dynamic balance recovery among stroke survivors

Majority of the patients showed poor dynamic balance recovery implying that there is poor dynamic balance recovery among the study population. At present, despite the abundant available literature on functional recovery and balance post-stroke, little about dynamic balance recovery in stroke survivors. Particularly, the exact pattern, rate and extent of recovery of dynamic balance in patients who have suffered an episode of stroke, acute or chronic is yet to be determined. If dynamic balance is to be taken as a component of balance, it then follows that the results of previous works on functional recovery and balance in stroke survivors<sup>23–34</sup> can be extrapolated to this present study.

Demographic variables like age and gender and stroke lesion-related parameters like type of lesion, side of lesion and post-stroke duration were not significantly associated with dynamic balance recovery in this study.

Balance recovery in post-acute stroke in-patients is characterized by a reduction in postural sway and instability<sup>35</sup> as well as by a reduction in visual dependency, particularly with regard to frontal plane balance.<sup>36,37</sup> These restoration characteristics may be important factors underlying the relearning of independent standing and walking abilities. The clear lack of normalization for measures reflecting static and dynamic aspects of postural asymmetry suggests that the functional improvements in balance and gait must be more related to other mechanisms than to the restoration of support functions and equilibrium reactions of the paretic leg.<sup>35</sup>

## 5.3. Relationship between depression and dynamic balance recovery in stroke survivors

Although association between depression and dynamic balance recovery in stroke survivors was not established, interpretation of this finding is limited by the small sample of a preliminary investigation instead of a well powered experiment. There remain paucity of literature on the relationship between depression and functional ability/disability. Several investigations have been conducted, but findings remain largely contradictory. Although relationship between PSD and functional disability have been severally suggested,<sup>17,37</sup> Kong et al. concluded that PSD has no relationship to functional disability.<sup>15</sup> The contradictions among difference researches could in part be explained by differences in participants' characteristics. Future research direction on relationships between PSD and dynamic balance recovery need incorporate all the relevant patients' variations that could intervene in the final outcome of balance so that the final relationship with PSD is clearly interpreted.

## 5.4. Limitations

This study been a pilot has some limitations. The major limitation is small sample size, unequal gender distribution and exclusion of patients with cognitive impairment. The study population is therefore not representative of the general stroke population. Another limitation to this study was the study design. This study utilized a cross-sectional survey research design, and as is typical of all cross-sectional surveys, results got could not be used to infer cause–effect relationships between the dependent and independent variables. Also, since humans are susceptible to altering or modifying their responses to life situations, consciously or unconsciously, once they are aware they are being observed or examined, the possibility that participants introduced some bias in the provision of correct information required of them could not be ruled out completely. The main study is underway to further draw a generalizable regarding stroke depression and dynamic balance recovery.

## 6. Conclusions

From the results and discussion presented in this study, the following conclusions were made:

- (1) There is a high prevalence of depression among stroke survivors.
- (2) There is poor dynamic balance recovery among stroke survivors.
- (3) Grossly limited sample size of the preliminary study preclude power of the result, and makes it premature to conclude on the relationship between depression and dynamic balance recovery in stroke survivors from the evidence of the present study. Adequately powered study is needed to synthesize robust evidence regarding depression and dynamic balance recovery in stroke survivors.

## Conflict of interest

Authors have no conflict of interest to declare.

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