International Journal of Basic, Applied and Innovative Research
ISSN: 2315 - 5388
IJBAIR, 2018, 7(2): 47 - 54
www.arpjournals.com; www.antrescentpub.com
E-ISSN: 2384 - 681X

RESEARCH PAPER

EFFECTS OF CORE STRENGTHENING EXERCISES ON DYNAMIC BALANCE AND GAIT SPEED IN STROKE SURVIVORS

Onwudiwe, C.O[1], Ezema, C.I[2], *Nweke, M.C[3], Anukam, G.O[4], Okoye,G.C[5]
[1,4]Federal Teaching Hospital Abakaliki, Ebonyi State; [2,3,5] Department of Medical Rehabilitation, Faculty of Health Sciences and Technology University of Nigeria Nsukka, Enugu Campus, Enugu Nigeria
*Corresponding author: martins.nweke@gmail.com

Published: 30th June, 2018

***Endorsed By**: Innovative Science Research Foundation (**ISREF**) and International Society of Science Researchers (**ISSCIR**).*
***Indexed By**: African Journal Online (AJOL); Texila American University; Genamics; Scholarsteer; EIJASR; CAS-American ChemicalSociety; and IRMS Informatics India (J-Gate)*

ABSTRACT

Independent ambulation is the ultimate goal of post-stroke rehabilitation, of which dynamic balance is a primary requirement. Core stability is said to be essential to balance and independent ambulation, however, core strengthening exercises have often been omitted in stroke rehabilitation. The study sought to determine the effects of core strengthening exercises on dynamic balance and gait speed in stroke survivors. A total of 48 stroke survivors participated in this study. A simple random sampling in which participants were consecutively allocated into experimental and control groups was employed. The experimental group received core strengthening exercise in addition to conventional exercise while the control group had conventional exercise only. Dynamic balance was measured by maximum reach distances and gait speed was evaluated using 10-mteres walk test. Assessment of dynamic balance and gait speed was performed before treatment and six weeks after. There was no significant difference in dynamic balance and gait speed between both groups ($P>0.05$ in each).Significant differences in dynamic balance measures and gait speed were found between pre-test and post-test values of each of experimental and control groups ($p<0.05$). A holistic approach targeting all the core muscle groups and their corresponding motions should be adopted when executing core strengthening exercise.

Keywords: Stroke, Core strengthening, Exercise, Dynamic balance, Gait,

INTRODUCTION

Stroke is an epidemic which causes enormous economic burden in many countries (Birabi *et al*., 2012). Community-based African studies reveals an age-standardized annual stroke incidence rate of up to 316 per 100 000 population, and age-standardized prevalence rates of up to 981 per 100 000 (Owolabi *et al*., 2015). In Nigeria, its prevalence is 15.6 in a hospital based study, while the overall crude prevalence rate rose from 1.14 per 1000 (male: 1.51, female: 0.69) in 2007 to 1.31 per 1000 (male: 1.54, female: 1.08) in 2014 (Sanya *et al*., 2015). Its economic burden in the country is tremendous, amounting to average of N95, 100:00 ($600) and N767, 900:00 ($4860) in government and private hospitals respectively (Owolabi *et al.*, 2015). As a non-communicable disease of public health importance, it is one of most common causes of death and neurological disability (Centre for Disease Control and Prevention of Stroke in the United States, 2015). About two-thirds of stroke survivors have residual neurological deficits that impair functional abilities, with approximately half are left with a number of physical limitations, thus making them dependent on others for most activities of daily living (Rosamond et al. 2015).Physical limitation in walking and other uses of the limbs is essential determinant of overall quality of life after stroke. As low as 75% of survivors of stroke have been reported to have ability to climb staircase, walk distances at speed needful to independent community life (Balasubramanian *et al*., 2014).

Commonest causes of physical limitations after stroke include impairments include physical impairments such as hemiparesis, spasticity, dystonia, and sensory loss, and cognitive dysfunction (Billinger, 2014).They result to inability to walk independently and increased risk of falls. Of these impairments, paresis of the upper and lower extremity musculatures has received enormous attention, while rehabilitation of postural muscles of the back has received little concern. Inhibition of abnormal tone and facilitation of normal movement of the upper and lower extremities dominate practice of stroke rehabilitation (Park, 2001; Batra *et al.,* 2001). However, recent advances in the field of neuro-rehabilitation advocate re-education of movement control through participation, and this involves strengthening all weak musculature (Morgan *et al.,* 2015), whether they are muscles of the core or at the extremity. The motor areas of both cerebral hemispheres supply nerves to the trunk as well as the extremity: as a result, upper motor lesion as in stroke could cause bilateral trunk weakness and imbalance consequently (Ko *et al.* 2014). Balance problem has been implicated in either weakness of postural muscles of the back or muscles of the lower extremity (Obembe *et al.,* 2014). While consensus evidence exists in respect of the role of conventional (lower extremity muscle strengthening) exercise in balance and gait retraining, core stability exercises have been shown to improve dynamic standing balance, functional autonomy, static balance, flexibility, and stability (Miyake *et al.*, 2013).

Core strengthening has come to connect lumbar stabilization and other therapeutic exercise regimens focusing on extremity rehabilitation. The “core” has been described as a box, with the abdominals in the front, para-spinal and gluteal muscles in the back, the diaphragm as the roof, and the pelvic floor and hip girdle musculature as the bottom (Kumaresan *et al.*, 2016). The core musculature is believed to serve as muscular corset that works to stabilize the body and spine with limb movements (Anong *et al.*, 2014). Although weakness of the trunk has been associated with spinal instability, it is not well known whether core strengthening exercises is effective in balance and gait retraining. The study therefore sought to determine the effects of core strengthening exercises on dynamic balance and gait speed in stroke survivors.

MATERIALS AND METHOD

Study Area: The study location was physiotherapy department of Federal Teaching Hospital Abakaliki, Ebonyi State. The hospital is a 438 bed space tertiary health facility in the state. Abakaliki is the capital city of the state which is located 64 kilometre southeast of Enugu. It shares boarder with Enugu in the west, Benue in the north, Cross river in the east and Abia in the south.

Subject Description: Patients with first stroke, who reported to the outpatient unit of physiotherapy department after a 6-month period of onset, but not more than 2 years, were allocated to the control group (conventional exercise) or the experimental group (core strengthening exercise).

Research Design: An experimental (pre-post-test) design. There was a controlled group made up of stroke patients, matched in age and sex to the study participants that did not receive intervention.

Sample Procedure: Simple random technique was used in which patients consecutively allocated into the study.

Sample Size: Since the prevalence rate of stroke in Nigeria is 1.31% (Sanya *et al*., 2015), using the infinite population according to Cohen (1988), which is given by relation, $n=Z^2\ p\ (1-p)/d^2$. Where n= sample size; z= 1.96 at 95% confidence interval and p= estimated population based on prevalence (1.31%). d= precision allow 5% = 0.05. Therefore $n= [1.96^2 \times 0.0114\ (1-0.0131)]/0.05^2 = 19.8$. Adding 10% attrition, sample size equals 42 (21 subjects per group). However, 48 subjects completed the study.

Subjects of the study: Patients with first stroke, who reported to the outpatient unit of physiotherapy department after a 6-month period of onset, but not more than 2 years, were allocated to the control group (conventional exercise) or the experimental group (core strengthening exercise). Subjects’ socio-demographic characteristics such as age, sex and duration of stroke were assessed and obtained. Assessment of dynamic balance and gait speed was performed before treatment and six weeks after the end of treatment.

Inclusion criteria: Adults survivors of stroke. First onset of unilateral stroke resulting in hemiplegic as diagnosed by a medical physician. Mini-mental state examination score greater than 24/30. Patients who were able to walk 10metre distance independently. Post stroke duration of at least 6 months, but not more than 2 years. Trunk impairment scale score of less than 21 out of 23.

Exclusion criteria: Patients who have had more than 1 episode of stroke. Those who have had previous lower limb fracture. Subjects who were unable to participate in low intensity exercise programmes due to severe complications from co-morbidities or were positive for human immune-deficiency virus, due to its neurologic squeal. Those diagnosed with stroke along with any other neurological disease affecting balance (Parkinson, vestibular lesion and multiple sclerosis).Subjects with impaired vision. Musculoskeletal disorders such as low backache, arthritis or degenerative diseases of lower limbs affecting motor performance.

Ethical Consideration: Signed Informed consent was obtained from the patients after they had been fully informed about the experimental procedure, risks and protocol. This was in accordance with the American College of Sports Medicine guidelines (American College of Sports Medicine, (ACSM), 2000), regarding the involvement of human subjects in research as recommended by the human subject protocol. Ethical approval was obtained from the Research and Ethics committee of FETH, Abakaliki.

Cognitive Screening: Mini-Mental State Examination (MMSE) scale was used to screen for cognitive impairment. It is a 30-point scale used in clinical and research settings for measuring cognitive impairment. It is not suitable for making diagnosis but useful in indicating presence of cognitive impairment. The MMSE is far more sensitive in detecting cognitive impairment than use of informal questioning or overall impression of a patient's orientation. Scores of 25-30 of 30 are considered normal, 21-24 as mild, 10 -20 as moderate and <10 as severe impairment. The sensitivity and specificity of MMSE are sufficient in discriminating participants with normal cognitive functioning from those with MCI and dementia (Baek *et al*., 2016). Since participants with aphasia, visual and auditory impairments were excluded from the study, MMSE was an appropriate tool for screening cognitive impairment.

The 10-Metres Walk Test: This was used to assess gait speed and limb length. It is a performance measure used to assess walking speed in metres per second over a short distance. It can be employed to determine functional mobility, gait, and vestibular function. Among stoke survivors, it has demonstrated excellent test-retest reliability (ICC = 0.95 to 0.99), with reliability for comfortable (ICC = 0.94) and fast (ICC = 0.97) gait speeds (Tyson and Connell, 2009). Small meaningful change of 0.05 m/s and substantial meaningful change of 0.10 m/s has been reported (Perera *et al*., 2006). Participants were instructed to walk a set distance of 10 meters as fast as they could and an average of 3 trials was taken as the gait speed (Dobkin *et al*., 2006). Participants were given space to accelerate to their preferred walking speeds and this initial distance was not included in determining walking speed. Walking speed was computed as covered is divided by the time it took the individual to walk that distance while limb length was calculated as distance covered divided by number of steps (Salbach *et al.*, 2001).

Measurement of Dynamic Balance: The Star Excursion Balance Test (SEBT) was used to evaluate dynamic balance as measured by maximum reach distance. It has shown ability to reveal loss of dynamic postural control consistently, with strong intra-rater reliability of [ICC (2, 1):0.67-0.87) (Kinzey and Armstrong, 1998) and [ICC (2, 1):0.81-0.96] (Hertel *et al*., 2006). The SEBT has shown sensitivity in screening for functional deficits related to musculoskeletal injuries (Earl, 002), Olmsted *et al*. (2002). It is a reliable and sensitive instrument for assessing dynamic postural control (Kinzey and Armstrong, 1998). It was conducted as prescribed by Gribble et al. (Gribble and Hertel, 2003). Participants started the test barefooted with 3 initial trials in three selected directions namely anterior, posteromedial and posterolateral directions before they underwent the formal testing. The order of the initial trials was right anterior reach (3 trials), left anterior reach (3 trials), right posteromedial reach (3 trials), left posteromedial reach (3 trials), right posterolateral reach (3 trials), and left posterolateral reach (3 trials). The formal testing trials were performed in the same order as the practice trials, with 3 trials performed in each direction. In each trial, participants were instructed to reach as far as they could and then return to the starting point while they maintained their balance on the stance limb. The maximum reach distance was recorded to the nearest 0.5 cm in each reach trial. The maximum reach distance of the 3 formal trials in each direction was used for the analysis. Reach distances were normalized to each participant's limb length by dividing the reach distance by limb length and then multiplying by 100 to account for the influence of the leg length on test performance. Normalized composite reach distance was computed for each leg as the sum of the maximum reach distances in the 3 directions, divided by 3 times the limb length, and then multiplied by 100.

Treatment-Core Strengthening Exercise: Participants in the experimental group received, in addition to conventional exercise, core strengthening exercises, 30 minutes per session, two times per week for six weeks. The core strengthening exercises were performed as prescribed by Lee *et al*. (2007) and Chung *et al*. (2013).It comprised three exercise components: bed exercises, wedge exercises and ball exercises using Swiss ball. In each exercise, position was maintained for 7 seconds followed by 10 seconds of relaxation; each set was repeated 10 times, and total of 2 sets were performed. The rest interval between sets was 60 seconds. Participants performed bed exercises in the first 2 weeks, followed by the wedge exercises in the third and fourth week and finally ball exercises in the fifth and sixth week. Bed exercises consisted of bridge exercise, bridge exercise with legs crossed, bridge exercise with one leg, curl-ups with straight reaching, curl-ups with diagonal reaching, bird dog exercise, and side bridge exercise. The wedge exercises consisted of curl-ups with straight reaching, curl-ups with diagonal reaching, and curl-ups with arms crossed. Finally, ball exercises comprised bridge exercise, bridge exercise to the side, bridge-ups, abdominal curl-ups, bird dog exercise, and push-ups.

Control- Conventional Exercise: Conventional exercises were performed as prescribed by Pang *et al.* (2006). They include shoulder exercises, weight cuff and dumbbell exercises, hand exercises. Lower extremity exercise involved: sit to stand exercises, walking through obstacles, standing on a wobble board, partial squatting, toe raises. All participants received 2 sets of 10 repetitions each of the exercises, which included upper extremity exercises such as shoulder exercises, weight cuff and dumbbell exercises and hand exercises. Lower extremity exercises performed were: sit to stand exercises, walking through obstacles, standing on a wobble board, partial squatting and toe raise.

Statistical Analysis: Data was analyzed using the statistical package for social sciences (SPSS) version 21 summarized using descriptive statistics of mean, standard deviation and frequency table. Independent T-test was used to determine differences in pre-test and post-test values of maximum reach (dynamic balance), gait speed and quality of life between experimental and control groups. Paired T-test was used to determine differences between pre-test and post-test values of maximum reach (dynamic balance), gait speed and quality of life for each of experimental and control group. Chi-square was used to test for between socio-demographic variables and group. Alpha level was set at $\alpha = 0.05$.

RESULTS

Forty eight stroke survivors, 30 males and 18 females, most (83.3%) married and modal age 48-57years participated in the study. Twenty six (54.6%) of them were graduates of tertiary institutions. Left side affectation comprised 30 (62.5%) of participants (Table 1).

Table 1: Socio-demographic characteristics and Dexterity of participants

Variables	**Frequency**	**Percentage (%)**
Sex		
Male	30	62.5
Female	18	37.5
Age (years):		
38-47	9	18.8
48-57	18	37.5
58-67	16	33.3
68-77	5	10.4
Marital Status:		
Single	2	4.2
Married	40	83.3
Widowed	4	8.3
Separated	2	4.2
Educational Background:		
No Formal Education	5	10.4
Primary Education	9	18.3
Secondary Education	8	16.7
Tertiary Education	26	54.6
Dexterity		
Left Side	18	37.5
Right Side	30	62.5

At baseline, result shows no significant difference in dynamic balance (as measured by anterior, posterolateral and posteromedial maximum reach distances), gait speed and quality of life between experimental and control groups (p>0.05 in each) (Table 2).

Table 2: Baseline values of Dynamic Balance, Gait Speed and Quality of Life

Variable	Mean ± SD (Exp. group)	Mean ± SD (Cont. Group)	t-value	P-value
Anterior	45.9 ± 16.1	41.2 ± 10.9	1.2	0.243
Posterolateral	47.8 ± 13.1	46.0 ± 11.0	0.5	0.587
Posteromedial	46.8 ± 12.1	47.0 ± 11.4	- 0.04	0.971
Gait Speed	0.49 ± 0.31	0.50 ± 0.33	- 0.10	0.922

This suggests that the experimental and control groups were comparable at baseline. Variables other than the independent variables had no significant confounding effect on the dependent variables. At the end of six weeks, result shows significant differences in dynamic balance (as measured by anterior, posterolateral and posteromedial maximum reach distances), gait speed and quality of life between pre-test and post-test values of each of experimental and control groups (p<0.05 in each) (Table 3).

Table 3: Paired Sample T-test showing effects of Core strengthening Exercise on Balance, Gait Speed and Quality of Life

Variable	Mean ± SD(Pre-test)	Mean ± SD(post-test)	t-value	P-value
Experimental Group				
Anterior	45.9 ± 16.1	50.5 ± 15.6	- 2.3	0.034
Posterolateral	47.8 ± 13.1	57.5 ± 14.9	- 6.9	<0.001*
Posteromedial	46.8 ± 12.1	57.3 ± 14.2	- 7.4	<0.001*
Gait Speed	26.8 ± 11.2	21.4 ± 9.3	9.3	<0.001*
Control Group				
Anterior	41.2 ± 10.9	45.3 ± 11.3	- 13.7	<0.001*
Posterolateral	46.0 ± 11.0	53.2 ± 12.4	- 10.6	<0.001*
Posteromedial	47.0 ± 11.4	54.5 ± 12.0	- 12.2	<0.001*
Gait Speed	27.0 ± 11.6	24.7 ± 11.7	6.7	<0.001*

Overall, there was no significant difference in dynamic balance, gait speed and quality of life speed between experimental and control groups (P>0.05 in each) (Table 4).

Table 4: Independent T-test showing comparative Effects of Core Strengthening Exercise on of Dynamic Balance, Gait Speed between Experimental and Control Group

Variable	Mean ± SD (Exp. group)	Mean ± SD (Cont. Group)	t-value	P-value
Dynamic Balance				
Anterior	50.5 ± 15.6	45.3 ± 11.3	1.3	0.192
Posterolateral	57.5 ± 14.9	53.2 ± 12.4	1.1	0.288
Posteromedial	57.3 ± 14.2	54.5 ± 12.0	0.7	0.473
Gait Speed	0.66 ± 0.42	0.58 ± 0.43	- 0.62	0.539

DISCUSSION

In this study, core strengthening exercises did not improve dynamic balance and gait speed. This is contrary to the findings of Kumaresan and Mahiba (2016), Cabanas-Valdes *et al.* (2015), Haruyama et al. (2017), in which clinical important differences in balance and gait were reported with core strengthening exercises. This conflict of findings could be attributed to inclusion of additional lateral flexion and rotation of the upper and lower parts of the trunk in the previous studies. It suggests that additional truncal exercise aimed at improving lateral flexion and rotation of the upper and lower parts of the trunk may improve dynamic balance and gait speed. It implies that weakness in any of the functional group of the core postural muscle group distorts ability of whole musculature to maintain spinal stability and balance thereby negatively impacting community ambulation (Dorsch *et al.*, 2017). It also supports the definition of the "core" as a box, with the abdominals in the front, para-spinal and gluteal muscles in the back, the diaphragm as the roof, and the pelvic floor and hip girdle musculature as the bottom (Billinger *et al*., 2014).

Omission of any musculature in the core will obviously affect the whole core. It may also reveal that conventional exercises targeting lower extremity muscle strength play essential role in balance and gait retraining: its effects may have sufficiently dominated the protocol. It also shows that core strengthening exercise may not be used as an independent treatment in balance and gait retraining, and conventional lower extremity exercises may achieve the purpose of balance and gait retraining (Chang *et al.* 2011), without including core strengthening exercise. Although strong core muscle strength is said to be necessary for postural alignment and stability (Obembe *et al*., 2014; Anong *et al.*, 2014), their role in retraining dynamic balance and gait is doubtful especially when combined with conventional lower extremity exercises. However, a holistic approach targeting all the core muscle groups and their corresponding motions should be adopted when executing core strengthening exercises as this may essentially contribute to effects of core strengthening exercise on gait and balance.

A recognized limitation in this study was lack of a third group receiving both core strengthening and conventional exercises, and this may limit the external validity of the findings of the study.

ACKNOWLEDGEMENT

The authors wish to acknowledge the cooperation of the patients and Federal Teaching Hospital Abakiliki for donating their facility for the study.

REFERENCES

Anong, T., Dannaovarat, C. (2014). S.B Multi-directional reach test. An investigation of the limits of stability of people aged between 20-79 years. *Journal of physical therapy science;* 26. 6: 877-880

Baek,M.J., Kim, K., Park, Y.H., Kim S.Y. (2016). The Validity and Reliability of the Mini-Mental State Examination-2 for Detecting Mild Cognitive Impairment and Alzheimer 's disease in a Korean Population. *PLoS One*; 11.9: e0163792.

Balasubramanian, C.K., Clark D.J., Fox E.J. (2014).Walking adaptability after a stroke and its assessment in clinical settings.*Stroke Research and Treatment*; *2014*:591013-15.

Batra, M., Sharma, V., Batra V., Malik, G., Pandey R. (2012).Neurofacilitation of Developmental Reaction (NFDR) approach: a practice framework for integration/modification of early motor behavior (primitive reflexes) in cerebral palsy. *Indian J Pediatr*; 79: 659–63.

Billinger S.A., Arena R., Bernhardt, J., Eng J.J., Franklin B.A., Johnson C.M., et al. (2014).Physical Activity and Exercise Recommendations for Stroke Survivors.A statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*; 45.8:2532-53

Birabi B.N., Oke K.I., Okafor U.C. (2012). Cost burden of post stroke condition in Nigeria. *Global Journal of Health Science;* 4.6: 17-22.

Cabanas-Valdes R., Bagur-Calafat B., Girabent-Farres M., Caballero-Gomez F.M., Hernandez-Valino M., Cuchi, G.U. (2015). The effect of additional core stability exercises on improving dynamic sitting balance and trunk control for subacute stroke patients: A randomized controlled trial. *Clinical Rehabilitation;* 10:1-10.

Centers for Disease Control and Prevention (2015).Stroke in the United States.Available at www.cdc.gov/stroke/facts.htm,march; Accesssed April 23, 2017.

Chung E J, Kim J A, Lee B H. 2013. The effects of core stabilization exercise on dynamic balance and gait function in stroke patients. *Journal of physical therapy science.*25:803-806.

Dobkin, B., Apple, D., Barbeau, H. (2006). Spinal Cord Injury Locomotor Trial Group: Weight supported treadmill versus Over-ground training for walking after acute incomplete Spinal Cord Injury. *Neurology*; 66:484-493.

Dorsch, S., Ada, L., Canning, C.G., Al-Zharani M., Dean, C. (2012). The strength of the ankle dorsiflexors has a significant contribution to walking speed in people who can walk independently after stroke: An observational study. *Archives of Physical Medicine and Rehabilitation;* 93:1072-1076.

Earl, J. (2002). Relationships among dynamic mal-alignment, neuromuscular rehabilitation, and patella -femoral pain syndrome.Unpublished doctoral dissertation, Pennsylvania State University, University Park.

Gribble, P.A., Hertel, J. (2003). Considerations for normalizing measures of the star excursion balance test. *Journal of measurement in physical education and exercise science;* 7.2:89-100.

Haruyama, K., Kawakami, M., Otsuka, T. 2017.Effect of core stability training on trunk function standing balance and mobility in stroke patients.*Neurorehabilitation and Neural Repair*.31.3:240-249.

Hertel, J., Miller, S., Denegar, C. (2006). Intratester and Intertester reliability during the Star Excursion Balance Test. *Journal of Sport Rehabilitation*. 9.2: 104-116.

Kinzey, S., Armstrong, C. (1998).The reliability of the Star Excursion test in assessing dynamic balance.*Journal of Orthopaedic and Sport Physical Therapy*; 27: 356-360

Ko, E.J., Chum, M.H., Kim, D.Y., Yi, J.H., Kim, W., Hong, J. (2016). The additive effects of core muscle strengthening and trunk NMES on trunk balance in stroke patients. *Annals of Rehabilitaiton Medicine;* 40.1:142-151.

Kumaresan, A., Mahiba, J.A. (2016). Effect of core muscle exercises in improving reaching activities in participants with hemiplegia.*International Journal of Pharma and Bio sciences;* 7.3:1096-1104

Lee, B.H., Baek, J.Y. (2007). The effects of core stability training on static and dynamic balance of stroke patients.*Journal of Korea Sports Health*; 18: 623-634.

Miyake, Y., Kobayashi. R., Kelepecz, D., Nakajima, M. (2013). Core exercises elevate trunk stability to facilitate skilled motor behavior of the upper extremities. *J Body MovTher*; 17: 259–265.

Morgan, C., Novak, I., Dale, R.C., Badawi, N. (2015). Optimising motor learning in infants at high risk of cerebral palsy: a pilot study.*BMC Pediatr*; 15: 30

Obembe, A.O., Olaogun, M.O., Adedoyin, R. (2014). Gait and balance performance of stroke survivors in south-Western Nigeria- A cross sectional study. *Pan African Medical Journal*; 17.1:6

Olmsted, L.C., Carcia, C.R, Hertel, J., Shultz, S.J. (2002). Efficacy of the Star Excursion Balance Test in detecting reach deficits in subjects with chronic ankle instability.*Journal of Athletic Training*; 37.4: 501-506

Owolabi, M.O., Arulogun, O.,Melikam, S., Adeoye, A.M., Akarolo-Anthony, S., Akinyemi. R. et al. (2015). The burden of stroke in Africa: a glance at the present and a glimpse into the future. *Cardiovasc J Afr*; 2015; 26**:** S27–S38.

Pang, M.Y., Harris, J.E., Eng, J. (2006). A community-based upper-extremity group exercise programme improves motor function and performance of functional activities in chronic stroke: A randomized controlled clinical trial. *Archive of Physical Medicine and Rehabilitation;* 87:1-9.

Park, E., Park, C., Lee, H., Cho, Y. (2001). The effect of electrical stimulation on the trunk control in young children with spastic diplegic cerebral palsy.*J Korean Med Sci*; 16: 347–50. 35.

Perera, S., Mody, S., Woodman, R.C., Studenski, S.A. (2006). "Meaningful change and responsiveness in common physical performance measures in older adults." *Journal of the American Geriatrics Society*; 54.5: 743-749.

Rosamond W, Flegal K, Furie K, Go A, Greenlund K, Haase N, et al. (2008). Heart disease and stroke statistics--2008 update: a report from the American Heart Association Statistics.

Salbach NM, Mayo NE, Higgins J, Ahmed S, Finch LE, Richards CL. (2001). Responsiveness and predictability of gait speed and other disability measures in acute stroke.*Arch Phys Med Rehabil*; 82: 1204-12.

Sanya, E.O, Desalu, O.O., Adepoju, F., Aderibigbe, S.A., Shittu, A., Olasebikan, O. (2015). Prevalence of stroke in three semi-urban communities in middle belt region of Nigeria: a door to door survey. *Pan African Medical Journal*; 20:33

Tyson, S., and Connell, L. (2009) "The psychometric properties and clinical utility of measures of walking and mobility in neurological conditions: a systematic review." *ClinRehabil*; 23.11: 1018-1033.

AUTHORS’ CONTRIBUTION

The conception and study design were done by Onwudiwe, C.O, Ezema, C.I and Okoye GC. Data was collected by Onwudiwe, C.O and Anukam, G.O. Data analysis, interpretation and manuscript preparation of manuscript was done by Nweke, MC.