Journal of Exercise Science & Physiotherapy, Vol. 12, No. 2, 2016
ISSN: 0973-2020 (Print) *ISSN: 2454-6089 (Online)*

Effects of Task-Oriented Circuit Class Training on Physical Fitness of Stroke Survivors

Emmanuel Frimpong, Charles Antwi-Boasiako, Edward Ababio, John Ahenkorah and Olajide A. Olawale

Abstract

Aim: The purpose of this study was to assess the effectiveness of task-oriented circuit class training on physical fitness of stroke survivors in the early stages of stroke rehabilitation. **Method:** This study involved twenty (20) hemiparetic stroke survivors with ten (10) participants each in the task-oriented circuit class training group (TCCTG) and the non-circuit class training group (NCCTG). Participants in TCCTG underwent supervised TCCT with duration of 80 minutes per session, three times per week for 8 weeks in addition to conventional physiotherapy. Assessments were done at baseline and week 8 using resting heart rate (RHR), 5-minute heart rate recovery (5-min HRR), blood pressure (BP), 6–minute walk test (6-MWT), 10-metre walk test (10-MWT) and functional ambulatory category (FAC) score as outcome measures. **Results:** There were significant reductions in RHR, 5-min HRR, SBP and DBP ($p<0.05$) with significant increases in 6-MWT, 10-MWT and FAC score ($p<0.05$) within the TCCTG. However, only the 6-MWT and 10-MWT showed significant differences ($p=0.0432$ and $p=0.0121$) in the NCCTG. The means of RHR, 5-min HRR, SBP and DBP were significantly lower in the TCCTG than the NCCTG ($p<0.05$). Also, at week 8, there weresignificant increases in 6-MWT, 10-MWT and FAC score ($p<0.05$) in the TCCTG compared to the NCCTG. **Conclusion:** Task-oriented circuit class training can improve both physical fitness and functional capacity in stroke survivors in the early stages of stroke rehabilitation.

Emmanuel, Frimpong,Assistant Lecturer
Department of Physiology, School of Biomedical and Allied health Sciences, College of Health Sciences, University of Ghana, Ghana
E-mail:frimemma@gmail.com/efrimpong@chs.ug.edu.gh.
Charles, Antwi-Boasiako,Senior Lecturer
Department of Physiology, School of Biomedical and Allied health Sciences, College of Health Sciences, University of Ghana, Ghana; E-mail: antwiboasiako@chs.edu.gh.
Edward, Ababio, Senior Physiotherapist
Department of Physiotherapy, Korle-Bu Teaching Hospital, Accra, Ghana
E-mail:edwardababio@yahoo.com
John, Ahenkorah, Lecturer
Department of Anatomy, School of Biomedical and Allied health Sciences, College of Health Sciences, University of Ghana, Ghana; E-mail:jahenkorah@ug.edu.gh; daajohnny@yahoo.com
Olajide, A., Olawale, Associate Professor
Department of Physiotherapy, College of Medicine, University of Lagos, Nigeria
Email:jideolawale@yahoo.com

Key Words: Task-oriented, Circuit Class Training, Physical Fitness, Stroke Survivors

Introduction

Stroke is one of the major and leading causes of impairment, disability and handicap in adults (Dean et al., 2000; Bonita et al., 2004; Dobkin, 2005). Following stroke, motor deficits in the upper and lower extremities of the affected body sideare the major noticeable impairments with associated limitations and alterations in functional mobility and task performance (Brazzelli et al., 2011; Danielsson et al., 2012). The primary neurological impairments consequently cause deconditioning and predisposition to a sedentary behaviour andphysical inactivitywhich adversely impact performance of activities of daily living (ADL), increased risk of falls, recurrent stroke and cardiovascular diseases as well as reduced cardiovascular reserves (Da Cunha et al., 2001; Billinger et al., 2014). Low levels of physical fitness have been reported in stroke survivors (Ivey et al., 2005; Saunders et al., 2013; Billinger et al., 2014). Research reports have demonstrated that cardiovascularfitness levels following stroke are onlyhalf of age-matched healthy counterparts (Ivey et al., 2005; Patterson et al., 2007). Moreover, the energy cost of ambulation is about twice the normative values of healthy controls (Bellinger et al., 2014). In addition to high energy cost of ambulation, declines in muscle strength and power (Saunders et al., 2008; Gerrits et al., 2009;Brazzelli et al., 2011) as well as post-stroke fatigue (Duncan et al., 2012) further encourage sedentary lifestyle, physical inactivity and decreased physical fitness.Generally, fitness training in stroke survivors has received little attention, particularly soon after stroke (Saunders et al., 2009).Although physical fitness decline with the associated post-stroke disabilities has been well highlighted in literature, most stroke rehabilitations do not emphasizefitness training (Saunders et al., 2009; Smith et al., 2012). However, improving fitness in stroke survivors can reduce fatigue, fall rates and fractures, energy cost of ambulation and functional limitations as well as improvedfunctional independence and quality of life (Saunders et al., 2013).Studies have employed either land-based and water-based exercises of different techniques to improve cardiovascular fitness (Macko et al., 2001; da Cunha et al., 2002; Katz-Leurer et al., 2003; Aidar et al., 2007; Lennon et al., 2008; Toledano-Zarhi et al., 2011), muscular strength (Bale and Strand, 2008; Sims et al., 2009), or both cardiovascular fitness and strength (Mead et al., 2007; Donaldson et al., 2009; Cooke et al., 2010).Outcome measures such as blood pressure (BP), resting heart rate (RHR) and heart rate recovery (HRR) (Da Cunha et al., 2002; Lennon et al., 2008; Toledano-Zarhi et al., 2011) have been used to evaluate cardiovascular fitness. The six (6)-minute walk test (6-MWT) and ten-metre walk test (10-MWT) have been employed to assess the efficacies of walking capacity and walking speed respectively in mobility studies (Olawale et al., 2011; Globas et al., 2012; Kang et al., 2012; van de Port et al., 2012; Ada et al., 2013). Also, functional ambulatory category (FAC) score has been used to assess functional capacity(Da Cunha et al., 2002; Pohl et al., 2002; Mead et al., 2007).Despite these advances in rehabilitation, emerging evidence suggests that therapy after stroke should focus on practice of functional tasks (van Peppen 2004; English and Hillier, 2010; Teasell and Hussein, 2014). Task-specific training principle is practised in mobility training and has been shown to improve ambulatory capacity (Ada et al., 2010; Duncan et al., 2011; Langhammer and Stanghelle; 2011; Teasell and Hussein, 2014). Task-specific training can be performed over-ground or organised into circuit format(Carr and Shepherd, 1998;Teasell and Hussein, 2014).Task-orientedcircuit class training (TCCT) is a type of task-specific training that utilises active exercises and activities that are functionally task-specific (English and Hillier, 2010). In this model of training, participants complete a series of workstations arranged in a circuit within a group setting (English et al., 2007; Wevers et al., 2009). Although many of the activities and exercises may be fitness-biased, the primary goal is to achieve repetitive practice of task-specific training of everyday motor tasks (English and Hillier, 2010).The TCCT has been investigated in many studies especially, to evaluate its effects on mobility or ambulatory functions in stroke survivors compared with conventional therapy (Salbach et al., 2004; Mudge et al., 2009; English and Hillier, 2010; Van de Port et al., 2012; Frimpong et al., 2014). However, whether or not TCCT would improve physical fitness of stroke survivors is unclear (English and Hillier, 2010) and has not been well studied. It is not known whether TCCT can improve physical fitness and functional capacityin the early stages of rehabilitation after stroke. Therefore, the primary aim of this study was to investigate the effectiveness of task-oriented circuit class training on physical fitness of stroke survivors in early stroke rehabilitation.The secondary aim was to evaluate the effects of task-oriented circuit training on functional capacity of stroke survivors. We hypothesised that task-oriented circuit class training would improve physical fitness and functional capacity in the early phase of stroke rehabilitation.

Materials and Methods

Study Site and Participants

The study was conducted at the Physiotherapy Department of Korle Bu Teaching Hospital, Accra, Ghana. This hospital is the largest referral hospital in Ghana with over 1600-bed capacity. The study recruitedtwenty (20) new hemiparetic stroke survivors referred for physiotherapy. To participate in the study, patients had to meet the following inclusion criteria: (1) first or second stroke resulting in right or left sided hemiparesis, (2)muscle power of at least grade threeand (3) functional ambulatory category (FAC) score of at least three. Patients were excluded from the study if they had (1) bilateral hemiparesis (2) FAC score of less than grade three(3) muscle power of less than grade three, (4) fracture in the lower limbs, (5) aphasia, (6) cardiac arrhythmias and any such conditions for which exercises are contraindicated (*Frimpong et al., 2014)*. The Ethical and Protocol Review Committee (EPRC) of University of Ghana School of Allied Health Sciences approved the study. All participants gave written informed consent after having understood explanations of the study protocol and any potential risk that could be encountered.

Procedure

The study participants were randomized into two groups: the task-oriented circuit class training group (TCCTG) and non-circuit class training group (NCCTG) or control group. Randomization was done using 20 cards bearing the names of the groups and participants' numbers. Thus, ten (10) participants were recruited into each group. Both groups received treatments three times per week for eight (8) weeks.

The Task-Oriented Circuit Class Training Group (TCCTG)

The TCCT intervention began with familiarization sessions for participants to acquaint themselves with the workstations in the circuit. Participants were introduced to and tested on all the workstations in the circuit to estimate the level of capacities of each participant in terms of sets, repetitions and times for the tasks and what they were supposed to do during the training (Frimpong et al., 2014*)*.

The intervention for the TCCTG involved warm-ups, circuit class training and cool-downs. The warm-up (5 minutes) involved passive and active range of motions of major joints of the body. The cool-down sessions (5 minutes) involved passive stretching of lower limbs and controlled breathing exercises. The circuit comprised ten (10) workstations namely: over-ground walking, sit-to-stand, treadmill walking, push-ups, squatting, straight leg raise (SLR), stairs walking (stairs ascents and descents), cycling, backward walking and bridging exercises. The tasks at each workstation were performed for 5 minutes. At least 20 repetitions of sit-to-stand, push-ups, squatting, straight leg raise and bridging within 5 minutes were encouraged from the beginning of the training. A 2-minute rest period was allowed between workstations. Therefore, the TCCT lasted for 80 minutes per session. The TCCT was performed three times per week for eight weeks.The intensity of the TCCT was targeted between 10 (light) and 15 (hard or heavy) of the Borg's scale of rating of perceived exertion (RPE) (Borg, 1982). Participants progressed through the study period by adjusting the duration, sets and repetitions of the workstations in the circuit. Thus, participants performed the TCCT at light intensity at the beginning and hard intensity towards the end of the study. The speed of the treadmill was between 0.9- 3.0kilometres per hour(km/hr). Participants were encouraged to train as hard as possible and were given verbal feedbacks for tasks improvements (Dean et al., 2000). The same circuit was used throughout the study period; though parameters were varied based on progress of participants and the order of performing tasks at the various workstations was varied throughout the study period. In addition, the TCCTG received the usual conventional physiotherapy as the NCCTG.

The Non-Circuit Class Training Group (NCCTG)

The NCCTG constituted the control group for the study. Participants in the group only received the usual conventional therapy of passive and active exercises. Participants performed upper limb strengthening exercises, walking re-education, as well as standing and balance retraining carried out between parallel bars. Participants performed walking re-education by starting in parallel bars and progressed to free over-ground walking with or without walking aids.

Assessments on Outcome Measures

Both the TCCTG and NCCTG were evaluated at baseline andat the end of the training (week 8).The outcome measures used were anthropometric parameters, heart rate recovery (HRR), blood pressure (BP), 6-minute walk test (6-MWT), 10-metre walk test (10-MWT) test and functional ambulatory category scores (FACS).

Anthropometric Parameters

Height (HT)was measured to the nearest metre with the participants shoeless using a stadiometer (Seca, model 202, Germany). Weight (WT)was measured to the nearest kilogram using a scale (Mettler, Model TE120 ME36400, Switzerland) with participants' shoeless and wearing light clothing. Body mass index (BMI) was calculated from the height and the weight (weight/square of height) for each participant.

Resting Heart Rate (RHR) and Heart rate recovery (HRR)

Resting heart rates (RHR) were measured at rest with an electronic monitor (Omron, UK) before the 6-minute walk test. Heart rates were also measured five (5) minutes after cessation of the walk test. This was done to assess whether heart rates of the participants would recover five minutes after the walk test to their resting heart rates.

Blood Pressure (BP)

Blood pressure of participants was measured at baseline and at the end of the 8-week training. Following 10 minutes of resting in seated position, blood pressure was measured using an aneroid sphygmomanometer at the brachial artery with the arm supported at the level of the heart. The blood pressure was recorded as a ratio of systolic blood pressure (SBP) mmHg to diastolic blood pressure (DBP) mmHg.

The 6-Minute Walk Test (6-MWT)

The 6-minute walk test was the test done to assess the muscular endurances and walking capacity of participants. Participants walked over a 40-metre walkway of the remedial therapeutic gymnasium for 6 minutes. The total distance covered during the 6 minutes was then calculated in metres. Prior to the test, subjects were told that they could rest but that was allowed only at their request and it could be either sitting or standing and they were again told they could walk with or without their walking aids (*Lord and Rochester, 2005*).

The 10-Metre Walk Test (10-MWT)

This test was done to assess the walking speed of participants over a ten-metre walkway. A 14-meter walkway was marked on the floor of the gymnasium. This was done to eliminate acceleration and deceleration during the test. Participants were told before the test that they could walk with or without walking aid and they were required to walk at their self-selected walking speeds (*Dean, et al., 2000*). A stop clock was used to record the time taken by the subjects to cover the ten-metre distance over the 14-metre walk way. The stop clock was started simultaneously with the initiation of movements by the participants. The time used over the 10-metre walkway was then recorded in seconds. Three recordings were made and the average time calculated.

The Functional Ambulatory Category (FAC)Scores

The functional ambulatory category scores were assessed while participants were walking to evaluate the level of dependency of participants in performing functional activities. FAC is a six-point hierarchical rating scale that reflects the assistance a person requires to walk. This scale allows easy classification of patients in respect of their walking ability, with maximum score signifying ability to ambulate independently on non-level surfaces (*Holden et al., 1984*).

The data were analysed using the Statistical Package for Social Sciences (SPSS) version-20. All data were presented as mean plus or minus standard deviation (mean ± SD). Paired and unpaired *t*- tests were used to find significant differences in the means of the outcome measures: HT, WT, BMI, RHR, HRR, DBP, SBP, 6-mWT, 10-MWTand FAC scores within and between the groups respectively. A p-value of less than 0.05 ($p<0.05$) was considered significant.

Results

The study involved twenty (20) participants comprising twelve (12) males and eight (8) females. The mean age of participants was (60.1 ± 3.5) years. The mean time since stroke was (5.4 ± 1.1) weeks. Fourteen (14) and six (6) of the participants had ischaemic and haemorrhagic strokes respectively. Thirteen (13) and seven (7) of the participants presented with left and right hemiparesis respectively. Table 1 shows the demographic and anthropometric parameters of the study participants.

Unpaired *t*-test analysis showed that the mean differences in age, height, weight and BMI between the TCCTG and NCCTG were not significant ($p>0.05$).

Journal of Exercise Science & Physiotherapy, Vol. 12, No. 2, 2016
ISSN: 0973-2020 (Print) *ISSN: 2454-6089 (Online)*

Table 1. Characteristics of study participants

Anthropometric Variables	TCCTG (n=10) (Mean ± SD)	NCCTG (n=10) (Mean ± SD)	P – value
Age (yrs)	59.1 ± 4.0	61.0 ± 2.7	**0.2347**
Height (m)	1.6 ± 0.1	1.6 ± 0.2	**0.3871**
Weight (kg)	69.2 ± 6.1	67.8 ± 7.3	**0.6474**
BMI (kg/m^2)	28.3 ± 4.3	26.0 ± 5.5	**0.3216**

TCCTG – task-oriented circuit class training group; NCCTG – non-circuit class training group; SD – standard deviation; BMI – body mass index; yrs – years; m – metres; kg – kilogram; kg/m^2 – kilogram per meters square; n – sample size.

Table 2. Treatment effects on Outcome Measures at baseline and week 8 within the TCCTG (n=10)

Outcome Measures	Baseline (Mean ± SD)	8 weeks (Mean ± SD)	P-value
RHR (bpm)	#80.3 ± 3.0	73.5 ± 3.1	**0.0004***
5 Min HRR (bpm)			**<0.0001***
SBP (mmHg)	#92.1 ± 4.3	76.1 ± 2.9	**0.0103***
DBP (mmHg)	131.3 ± 6.0	125.3 ± 3.5	**0.0004***
6-MWT (m)	90.0 ± 2.9	84.9 ± 2.0	**<0.0001***
	278.7 ± 20.4	360.2 ± 26.0	
10-MWT (s)	40.2 ± 2.9	19.5 ± 1.5	**<0.001***
FAC Score	3.8 ± 0.5	4.6 ± 0.5	**0.011***

RHR- resting heart rate; bpm – beats per minute; HRR – heart rate recovery; 5 Min HRR – heart rate recovery in 5 minutes; SBP – systolic blood pressure; DBP – diastolic blood pressure; mmHg – millimetres of mercury; 6-MWT – Six-Minute Walk test, 10-MWT – Ten-Minute Walk Test, FAC – Functional Ambulatory Category; n – sample size.

*****Indicates mean differences in RHR, 5 min HRR, SBP, DBP, 6-MWT, 10-MWT and FAC within the CTG between baseline and week 8 were significant (p<0.05).

#Indicates mean difference between RHR and 5 min HRR was significant (p=0.0001) at baseline within the TCCTG.

Table 3. Treatment effects on Outcome Measures at baseline and week 8 within the NCCTG (n=10)

Outcome Measures	Baseline (Mean ± SD)	8 weeks (Mean ± SD)	P-value
RHR (bpm)	#78.7± 1.8	§79.7± 1.2	**0.1582**
5 Min HRR (bpm)			**0.0634**
SBP (mmHg)	#91.2 ± 4.9	§88.3 ± 1.6	**0.1852**
DBP (mmHg)	131.1 ± 5.2	130.0 ± 3.6	**0.0656**
6-MWT (m)	89.8 ± 3.2	88.4 ± 1.9	**0.0432***
	251.6 ± 18.9	262.3 ± 17.9	
10-MWT (s)	46.3 ± 2.7	34.5 ± 3.1	**0.0121***
FAC Score	3.3 ± 0.5	3.4 ± 0.5	**0.5911**

RHR- resting heart rate; bpm – beats per minute; HRR – heart rate recovery; 5 Min HRR – heart rate recovery in 5 minutes; SBP – systolic blood pressure; DBP – diastolic blood pressure; mmHg – millimetres of mercury; 6-MWT – Six-Minute Walk test, 10-MWT – Ten-Minute Walk Test, FAC – Functional Ambulatory Category; n – sample size.
*Indicates mean differences in 6-MWT and 10-MWT within the NCTG between baseline and week 8 were significant (P<0.05).
#Indicates mean difference between RHR and 5 min HRR at baseline was significant (p<0.0001) within the NCCTG.§Indicates mean difference between RHR and 5 min HRR at week 8 was significant (p<0.0001) within the NCCTG.

Table 4. Comparing Treatment effects on Outcome Measures at baseline between the TCCTG and NCCTG (n=20)

Outcome Measures	TCCTG (Mean ± SD)	NCCTG (Mean ± SD)	P-value
RHR (bpm)	80.3 ± 3.0	78.7± 1.8	**0.1617**
5 Min HRR (bpm)			**0.6668**
SBP (mmHg)	92.1 ± 4.3	91.2 ± 4.9	**0.9374**
DBP (mmHg)	131.3 ± 6.0	131.1 ± 5.2	**0.7707**
6-MWT (m)	90.0 ± 2.9	89.8 ± 3.2	**0.0341***
	278.7 ± 20.4	251.6 ± 18.9	
10-MWT (s)	40.2 ± 2.9	46.3 ± 2.7	**0.0512**
FAC Score	3.8 ± 0.5	3.3 ± 0.5	**0.0651**

RHR- Resting Heart Rate; Bpm – Beats Per Minute; HRR – Heart Rate Recovery; 5 Min HRR – Heart Rate Recovery In 5 Minutes; SBP – Systolic Blood Pressure; DBP – Diastolic Blood Pressure; Mmhg – Millimetres Of Mercury; 6-MWT – Six-Minute Walk Test, 10-MWT – Ten-Minute Walk Test, FAC – Functional Ambulatory Category; N – Sample Size.
*Indicates Mean Difference In 6-Mwtbetween TCCTG And NCCTG At Baseline Was Significant (P<0.05).

There were no significant differences in mean RHR, 5 min HRR, SBP, DBP, 10-MWT and FACS at baseline between TCCTG and NCCTG (p>0.05).

Table 5. Comparing Treatment effects on Outcome Measures at week 8between the TCCTG and NCCTG (n=20)

Outcome Measures	TCCTG (Mean ± SD)	NCCTG (Mean ± SD)	P-value
RHR (bpm)	73.5 ± 3.1	79.7± 1.2	**0.0002***
5 Min HRR (bpm)			**<0.0001***
SBP (mmHg)	76.1 ± 2.9	88.3 ± 1.6	**0.0058***
DBP (mmHg)	125.3 ± 3.5	130.0 ± 3.6	**0.0005***
6-MWT (m)	84.9 ± 2.0	88.4 ± 1.9	**0.0130***
	360.2 ± 26.0	262.3 ± 17.9	
10-MWT (s)	19.5 ± 1.5	34.5 ± 3.1	**0.0285***
FAC Score	4.6 ± 0.5	3.4 ± 0.5	**0.0367***

RHR- resting heart rate; bpm – beats per minute; HRR – heart rate recovery; 5 Min HRR – heart rate recovery in 5 minutes; SBP – systolic blood pressure; DBP – diastolic blood pressure; mmHg – millimetres of mercury; 6-MWT – Six-Minute Walk test, 10-MWT – Ten-Minute Walk Test, FAC – Functional Ambulatory Category; n – sample size.
*Indicates mean differences in RHR, 5 min HRR, SBP, DBP, 6-MWT, 10-MWT and FAC were significant (p<0.05) between the TCCTG and NCCTG at week 8.

Discussion

This study explored the effectiveness of task-oriented circuit class training on improving physical fitness of stroke survivors. The major finding of this study was that, task-oriented circuit class training improved physical fitness of stroke survivors in the early stages of rehabilitation after stroke. The outcome measures assessed significantly improved at the end of the training period in the task-oriented circuit class training group as compared to the control group.

Cardiovascular fitness was assessed with resting heart rate (RHR), heart rate recovery after five (5) minutes (5 min HRR) and blood pressure (SBP and DBP). At the end of the training, the RHR, 5 min HRR, SBP and DBP significantly reduced in the TCCTG as compared to the NCCTG. These findings concur with other studies of stroke populations (Potempa et al., 1995; Macko et al., 2001; Da Cunha et al., 2002; Katz-Leurer et al., 2003; Lennon et al., 2008; Toledano-Zarhi et al., 2011). Thus, cardiovascular fitness improved significantly after the circuit class training with lower RHR, faster recovery of HR to pre-6-MWT and lower blood pressure. However, cardiovascular fitness did not improve in the NCCTG. Brazzelli et al. (2011) reported that physical fitness training may reduce blood pressure, improve vascular risk factors as well as reduce mortality in coronary heart disease. Cornelissen et al. (2013) demonstrated that endurance exercise beneficially affects ambulatory blood pressure. The cardiovascular fitness being the cornerstone of physical fitness may have improved due to improved fitness reserve or aerobic capacity and exercise tolerance (Saunders et al., 2013) gained during the training. Therefore, improved physical fitness levels may be beneficial in reducing fatigue, fall rates and fractures, high energy cost of ambulation as well as improving independence, mood and quality of life (Kluding et al., 2011).

The task-oriented circuit class training significantly improved walking capacity as measured by the 6-MWT. This finding supports reports of other studies utilising task-oriented circuit interventions for improving mobility after stroke (Dean et al., 2000; Salbach et al., 2004; Blennerhassett and Dite, 2004; Pang et al., 2005; Mudge et al., 2009; Wevers et al., 2009; van de Port et al., 2012).The improvement in walking capacity may stem from increased cardiovascular fitness at the end of the training. Studies have shown that walking improvements in stroke survivors after task-oriented cardiovascular training may occur due to an increased fitness reserve as well as facilitation of motor learning and improved gait performance (Saunders et al., 2009). Also, improvement in walking capacity may have resulted from the lower limb-biased workstations incorporated into the study which effectively improved strength and endurance. Dean et al. (2000) reported that task-related circuit class focused on improving strength and endurance of affected lower limbs effectively improved locomotor function in chronic stroke. English and Hillier (2010) observed that studies that recorded significant improvements in 6-MWT emphasised on continuous and consistent walking practices. Further, fitness training reduces disability mediated by improved mobility and balance after stroke (Saunders et al., 2013). Functionally, the improvement in the 6-MWT is relevant since it has been found to be a stronger predictor of community ambulatory capacity (Mudge et al., 2009). Hence, the improved walking capacity may suggest increased ability to perform prolonged activities.

The walking speed (as measured by 10-MWT) significantly increased in the TCCTG as compared to the NCCTG. This result is in agreement with findings of studies that investigated the efficacy of task-oriented circuit class training on walking or gait speed (Dean et al., 2000; Salbach et al., 2004; Mudge et al., 2009; Wevers et al., 2009; van de Port et al., 2012). The increase in walking speed by the task-oriented circuit training may be due to the improved cardiovascular fitness and walking capacity. Moreover, the design of the circuit favoured walking speed. As an important skill- or performance-related component of physical fitness, walking speed has been demonstrated to be a valid and responsive measure of improvement in walking ability in individuals after stroke (Salbach et al., 2001; Kollen et al., 2006). However, Pohl et al. (2002) asserted that walking speed must be specifically and aggressively trained in stroke survivors before it increases.

In this study, in addition to the 6-MWT, functional capacity was also assessed using the factional ambulatory category (FAC) score. The FAC score significantly improved in the TCCTG as compared with the NCCTG. Similar results were obtained from other task-oriented training interventions (da Cunha et al., 2002; Pohl et al., 2002; Mead et al., 2007). The FAC score gives an indication of the level of dependency a patient requires for ambulation (Saunders et al., 2009). The observed improvement in functional capacity may be due to a better motor function (Wevers et al., 2009; Rensink et al., 2009; Saunders et al., 2013). Moreover, improvements in cardiovascular fitness, walking capacity and walking speed are expected to translate into functional ambulatory independence. Furthermore, task-oriented based exercises are shown to be most effective in attaining optimal motor function and independence in daily activities in acute stroke rehabilitation (Rensink et al., 2009; Wevers et al., 2009). Thus, the task-oriented circuit training group showed significant improvement in functional capacity. Improving functional capacity in stroke survivors can reduce the physiologic burden of performing activity of daily living and instrumental activity of daily living (IADL), thereby increasing volume of daily physical activity accumulation (Kelly et al, 2003).

Engagement in task-oriented trainings has been speculated to be associated with improved fitness, mobility and physical function (Saunders et al., 2013).In agreement with other stroke rehabilitation studies employing task-oriented training, this study shows that improvements in fitness levels and functional capacity of participants were due to the task-related practices of the circuit training (Dean et al., 2000; Yocheved et al., 2001; Salbach et al., 2004; English and Hillier, 2010; Van de Port et al., 2012; Saunders et al., 2013). Given that, both study groups (TCCTG and NCCTG) received the same conventional therapy, the observed improvement in physical fitness of patients in the TCCTG was mainly due to the task-oriented circuit class training. The findings of this study further confirm that task-oriented circuit class training is safe and feasible soon after stroke (Blennerhassett and Dite, 2004) and could be used to concurrently improve physical fitness and physical functional performances. Thus, improving fitness in stroke survivors can reduce stroke-related disability if training is task-oriented. The observed positive effects of the task-oriented circuit training on physical fitness used in this study could be explained on the basis of components of the circuits, that is, the effects were specific to the training (Dean et al., 2000; English and Hillier, 2010). Thus, benefits reflect the principle of the specificity of training response (Saunders et al., 2013). It has been established that benefits observed in trainings for fitness, mobility and physical function are task-oriented (Saunders et al., 2013).

Conclusion

The present study demonstrates that task-oriented circuit class training can improve both physical fitness and functional capacity in stroke survivors. Improving fitness in stroke survivors can reduce stroke-related disability if training is task-oriented. The study further encourages the application of task-oriented circuit training in rehabilitation soon after stroke. Further trials of longer study duration with large sample size are required to confirm the effectiveness of task-oriented circuit class training on physical fitness in

ISSN: 0973-2020 (Print) ISSN: 2454-6089 (Online)

stroke survivors and the retention of fitness after the training.

Acknowledgements
The authors express sincere gratitude to the staff of Department of Physiotherapy, KorleBu Teaching Hospital, Accra, Ghana and all the patients who participated in this study. Emmanuel Frimpong conceptualized, designed the study, Collected data and drafted the manuscript, Charles Antwi-Boasiakoanalysed data, interpreted the analyses, Edward Ababio co-designed the study and data collection, John Ahenkorah co-drafted the manuscript and data interpretation, OA Olawale co-designed the study and critically revised the manuscript for important intellectual content. All authors read and approved the final version of the article.

References

Ada, L., Dean, C.M.and Lindley, R. 2013. Randomized trial of treadmill training to improve walking in community-dwelling people after stroke: the AMBULATE trial. *International Journal of Stroke;* **8**(6):436–44.

Ada, L., Dean, C.M., Morris, M.E., Simpson, J.M. and Katrak, P. 2010. Randomized Trial of Treadmill Walking With Body Weight Support to Establish Walking in Subacute Stroke. The MOBILISE Trial. *Stroke*; **41**:1237- 1242.

Aidar, F.J., Silva, A.J., Reis, V.M., Carniero, A. and Carniero-Cotta, S. 2007. A study on the quality of life in ischaemic vascular accidents and its relation to physical activity. *Revista de Neurología*;**45**:518–22.

Bale, M. and Strand, L.I. 2008. Does functional strength training of the leg in subacute stroke improve physical performance? A pilot randomized controlled trial. *Clinical Rehabilitation*;**22**(10-11):911–21.

Billinger, S.A, Taylor, J.M. and Quaney, B.M. 2012. Cardiopulmonary response to exercise testing in people with chronic stroke: a retrospective study. *Stroke Res Treat*; 2012:987637.

Blennerhassett, J. and Dite, W. 2004. Additional task-related practice improves mobility and upper limb function early after stroke: a randomised controlled trial. *Australian Journal of Physiotherapy*;**50**:219–24.

Bonita, R., Mendis, S., Truelsen, T., Bogousslavsky, J., Toole, J. and Yatsu, F. 2004. The global stroke initiative. *Lancet Neurol*; **3**:391–3. doi: 10.1016/S1474-4422(04)00800-2.

Borg, G.A.V. 1982. Psychophysical bases of perceived exertion. *Med Sci Sports Exerc***;14**:377-381.

Brazzelli, M., Saunders, D.H., Greig, A.C. and Mead, G.E. (2011). Physical fitness training for stroke patients. The Cochrane Collaboration. DOI: 10.1002/14651858.CD003316.pub4.

Cooke, E.V., Tallis, R.C., Clark, A., Pomeroy, V.M. 2010. Efficacy of functional strength training on restoration of lower- limb motor function early after stroke: phase I randomized controlled trial. *Neurorehabilitation and Neural Repair*;**24**(1):88–96.

Cornelissen, V.A., Buys, R. and Smart, NA. 2013. Endurance exercise beneficially affects ambulatory blood pressure: a systematic review and meta-analysis. *Journal of Hypertension*;**31** (4):639–48.

Da Cunha, F.T.I., Lim, P.A.C. and Huma, Q. 2001. A comparison of regular rehabilitation and regular rehabilitation with supported treadmill ambulation training for acute stroke patients. *Journal of Rehabilitation Research and Development*; **38**(2):243-2452.

Danielsson, A., Willen, C. and Sunnerhagen, K.S. 2012. Physical activity, ambulation, and motor impairment late after stroke. *Stroke Res Treat*;2012:818513.

Dean, C.M., Richards, C.L. and Malouin, F. 2000. Task-related circuit training improves performance of tasks chronic stroke. *Arch Phys Med Rehabil*;**81**:409-417.

Dobkin, B.H. 2005. Clinical practice: rehabilitation after stroke. *N Engl J Med*; **21**:1677–1684.

Donaldson, C., Tallis, R., Miller, S., Sunderland, A., Lemon, R. and Pomeroy, V. 2009. Effects of conventional physical therapy and functional strength training on upper limb motor recovery after stroke: a randomized phase II study. *Neurorehabilitation and Neural Repair*;**23**(4):389–97.

Duncan, F., Kutlubaev, M.A., Dennis, M.S., Greig, C. and Mead, G.E. 2012. Fatigue after stroke: a systematic review of associations with impaired physical fitness. *Int J Stroke*;7:157–162.

Duncan, P.W., Sullivan, K.J., Behrman,A.L., Azenet, S.P., Wu, S.S., Nadeau, S.E., Dobkin, B.H., Dorian,K.R., Tilson, J.K., Cen, S. and Hayden, S.K. 2011. Body-weight-supported treadmill rehabilitation after stroke. NEJM; **364**:2026-36.

English, C., Hillier, S., Stiller, K. and Warden-Flood, A. 2007. Circuit class therapy versus individual physiotherapy sessions during inpatient stroke rehabilitation: a controlled trial. *Archives of Physical Medicine and Rehabilitation*;**88**:955–63.

English, C. and Hillier, S.L. 2010. Circuit class therapy for improving mobility after stroke. Cochrane Database of Systematic Reviews (2). DOI: 10.1002/14651858.CD007513.pub2.

Frimpong, E., Olawale, O.A., Antwi, D.A., Antwi-Boasiako, C. and Dzudzor, B. 2014. Task- oriented circuit training improves ambulatory functions in acute stroke: a randomized controlled trial. *J. Med. Med. Sci*; **5**(8):169-175.

Gerrits, K.H., Beltman, M.J., Koppe, P.A., Konijnenbelt, H., Elich, P.D. and de Haan, A. 2009. Isometric muscle function of knee extensors and the relation with functional performance in patients with stroke. *Archives of Physical Medicine and Rehabilitation*;**90**(3):480-7.

Goulding, R., Thompson, D. and Beech, C. 2004. Caring for patients with hemiplegia in an arm following stroke. *Br J Nur*;**13**(9):534–9. doi: 10.12968/bjon.2004.13.9.12966.

Holden, M.K., Gill, K.M. and Magliozzi, M.R.d 1984. Clinical gait assessment in the neurologically impaired. Reliability and meaningfulness. *Phys Ther;***64**:35-40.

Ivey, F.M., Macko, R.F., Ryan, A.S. and Hafer-Macko, C.E. 2005. Cardiovascular health and fitness after stroke. *Top Stroke Rehabil*;**12**(1):1-16.

Kang, H.K., Kim, Y., Chung, Y. and Hwang, S. 2012. Effects of treadmill training with optic flow on balance and gait in individuals following stroke: randomized controlled trials. *Clinical Rehabilitation*;**26**(3):246–55.

Katz-Leurer, M., Carmeli, E. and Shochina, M. 2003. The effect of early aerobic training on independence six months post stroke. *Clinical Rehabilitation*;**17**(7):735.

Kelly, J.O., Kilbreath, S.L., Davis, G.M., Zeman, B. and Raymond J. 2003. Cardiorespiratory fitness and walking ability in subacute stroke patients. *Arch Phys Med Rehabil*; 84(12):1780–1785.

Kluding, P.M., Tseng, B.Y. and Billinger, S.A. 2011. Exercise and executive function in individuals with chronic stroke: a pilot study. *J Neurol Phys Ther*;**35**(1):11-17.

Kollen, B., Kwakkel, G. and Lindeman, E. 2006. Time dependency of walking classification in stroke. *Physical Therapy*;**86**(5):618–25.

Langhammer, B. and Stanghelle, J.K. 2011. Can physiotherapy after stroke based on the Bobath concept result in improved quality of movement compared to the motor relearning programme. *Physiother Res Int*; **16**(2):69-80.

Lennon, O., Carey, A., Gaffney, N., Stephenson, J. and Blake, C. 2008. A pilot randomized controlled trial to evaluate the benefit of the cardiac rehabilitation paradigm for the non-acute ischaemic stroke population. *Clinical Rehabilitation*; **22**(2):125–33.

Lord, S.E.and Rochester, L. 2005. Measurement of community ambulation after stroke: current status and future developments. *Stroke*; **36**(7), pp. 1457–1461.

Macko, R.F., Ivey, F.M., Forrester, L.W., Hanley, D., Sorkin, J.D. and Katzel, L. 2005. Treadmill exercise rehabilitation improves ambulatory function and cardiovascular fitness in patients with chronic stroke: a randomized, controlled trial. *Stroke*; **36**(10):2206-2211.

Macko, R.F., Smith, G.V., Dobrovolny, C.L., Sorkin, J.D., Goldberg, A.P. and Silver, K.H. 2001. Treadmill training improves fitness reserve in chronic stroke patients. *Arch Phys Med Rehabil*; **82**: 879–884.

Mead, G.E., Greig, C.A., Cunningham, I., Lewis, S.J., Dinan, S. and Saunders, D.H. 2007. Stroke: a randomised trial of exercise or relaxation. *Journal of the American Geriatrics Society;* **55**:892–9.

Mudge, S., Barber, P.A. and Stott, N.S. 2009. Circuit-based rehabilitation improves gait endurance but not usual walking activity in chronic stroke: a randomized controlled trial. *Archives of Physical Medicine and Rehabilitation*;**90**(12):1989–96.

Olawale OA, Jaja SI, Anigbogu CN, Appiah-Kubi KO, and Jones-Okai D 2011.Exercise training improves walking function in an African group of stroke survivors: a randomized controlled trial.*Clinical Rehabilitation***25**: 442–450

Pang, M., Eng, J., Dawson, A., McKay, H. and Harris, J. 2005. A community-based fitness and mobility exercise program for older adults with chronic stroke: a randomised controlled trial. *Journal of the American Geriatrics Society*;**53**:1667–74.

Patterson, S.L., Forrester, L.W., Rodgers, M.M., Ryan, A.S., Ivey, F.M. and Sorkin, J.D. 2007. Determinants of walking function after stroke: differences by deficit severity. *Archives of Physical Medicine and Rehabilitation*;**88**(1):115-9.

Pohl, M., Mehrholz, J., Ritschel, C. and Ruckriem, S. 2002. Speed-dependent treadmill training in ambulatory hemiparetic stroke patients. A randomized controlled trial. *Stroke*; **33**:553-558.

Potempa, K., Lopez, M., Braun, L.T., Szidon, J.P., Fogg, L., Tincknell, T. 1995. Physiological outcomes of aerobic exercise training in hemiparetic stroke patients. *Stroke*; **26**(1):101-5.

Rensink, M., Schuurmans, M., Lindeman, E. and Haf-steinsdo, T. 2009. Task-oriented training in rehabilitation after stroke: systematic review.*Journal of Advanced Nursing*; **65**(4):737–754.

Teasell, R. and Hussein, N. 2014. Stroke Rehabilitation Clinician Handbook. pp.1-20. Available @www.ebrsr.com. Retrieved on 10/01/2016.

Salbach, N., Mayo, N., Higgins, J., Ahmed, S., Finch, L. and Richards, C. 2001. Responsiveness and predictability of gait speed and other disability measures in acute stroke. *Archives of PhysicalMedicine and Rehabilitation*;**82**(9):1204–12.

Salbach, N.M., Mayo, N.E., Wood-Daphinee, S., Hanley, J.A. and Richard, C.L. 2004. A task-oriented intervention enhances walking distance and speed in the first year post stroke. A randomized controlled trial. *Clinical Rehabilitation*; **18**: 509-519.

Saunders, D.H., Greig, C.A., Mead, G.E. and Young, A. 2009. Physical fitness training for stroke patients. *Cochrane Database of Systematic Reviews*; DOI: 10.1002/14651858.CD003316.pub3.

Saunders, D.H., Greig, C.A., Young, A and Mead, G.E. 2008. Association of activity limitations and lower-limb explosive extensor power in ambulatory people with stroke. *Archives of Physical Medicine and Rehabilitation*;**89**(4):677-83.

Saunders, D.H., Greig, C.A., Young, A. and Mead, G.E. 2004. Physical fitness training for stroke patients. *Cochrane Database of Systematic Reviews*; DOI: 10.1002/14651858.CD003316.pub2.

Saunders, DH., Sanderson, M., Brazzelli, M., Greig, C.A. and Mead, G.E. 2013. Physical fitness training for stroke patients. *Cochrane Database of Systematic Reviews*; CD003316. DOI: 10.1002/14651858.CD003316.pub5.

Sims, J., Galea, M., Taylor, N., Dodd, K., Jespersen, S. and Joubert, L. 2009.Regenerate: assessing the feasibility of a strength- training programme to enhance the physical and mental health of chronic post stroke patients with depression. *International Journal of Geriatric Psychiatry*;**24**(1): 76–83.

Smith, A.C., Saunders, D.H. and Mead, G. (2012), Cardiorespiratory fitness after stroke: a systematic review. *International Journal of Stroke*; **7**:499–510.

Toledano-Zarhi, A., Tanne, D., Carmeli, E. and Katz-Leurer, M. 2011. Feasibility, safety and efficacy of an early aerobic rehabilitation program for patients after minor ischemic stroke: a pilot randomized controlled trial. Neurorehabilitation;**28**(2):85–90.

Van de Port, I.G.L., Wevers, L.E.G., Lindeman, E. and Kwakkel, G.2012. Effects of circuit training as alternative to usual physiotherapy after stroke: A randomised controlled trial. *BMJ*; 344,e2072.

van Peppen, R., Kwakkel, G., Wood-Dauphinee, S., Hendriks, H., Van der Wees, P., Dekker, J. 2004. The impact of physical therapy on functional outcomes after stroke: what's the evidence? *Clinical Rehabilitation*;**18**:833–62.

Wevers, L., van de Port, I., Vermue, M., Mead, G. and Kwakkel, G. 2009. Effects of a task-oriented circuit class training on walking competency after stroke. *Stroke*;**40**:2450–9.

Yocheved, L., Dickstein, R., Yael, C. and Marcovitz, E. 2001. The effect of treadmill training on the ambulation of stroke survivors in the early stages of rehabilitation: A randomized study. *Journal of Rehabilitation Research and Development*; **38**(1):69–78.

Conflict of Interest: None declared