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Overground walking exercise training reduces blood pressure in adult patients with stroke – a randomized controlled trial

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Summary
The use of exercise training to enhance functional outcomes and improve physiological parameters after stroke is now receiving great attention from clinicians. The aim of this study was to demonstrate the effects of overground walking exercise training on blood pressure of adult patients with stroke. 47 stroke survivors comprising 25 men and 22 women participated in the study. They were randomly assigned to an exercise training group (A) and a control group (B); with 23 subjects in Group A and 24 subjects in Group B. Forty (40) subjects (20 in each group) completed the study. All study subjects received conventional physiotherapy rehabilitation for 12 weeks. During the same period, subjects in Group A had overground walking exercise training (OWET) in addition to the conventional therapy. Changes in resting systolic and diastolic blood pressures were monitored throughout the period of the study. Results at weeks 0, 4, 8 and 12 were used for analysis. For each of the 2 groups, paired *t*-tests were used to evaluate the significance of the differences between the pre-intervention (week 0) mean scores on resting SBP/DBP and the mean scores at weeks 4, 8 and 12. Subjects in the OWET group had significant reductions in resting SBP and DBP with 12 weeks of training. Reductions in resting SBP and DBP were not statistically significant for the subjects in the control group. It was concluded that overground walking exercise training was highly effective for reduction of blood pressure in adult patients with stroke; and could be combined with conventional rehabilitation commonly used in most stroke-care units.

Keywords: *Stroke, blood pressure, exercise training, rehabilitation, walking*

Résumé
L'usage de l'exercice pour améliorer les résultats fonctionnels et améliorer les paramètres physiologiques après la survie a l'arrêt cardiaque reçoit une attention importante des médecins. Le but de cette et due était de démontrer les effets de l'exercice de marche sur la pression artérielle des patients adulte ayant eu un arrêt cardiaque. Quarante sept survivants (25 hommes et 22 femmes) participaient dans cette étude. Ils étaient groupes au hasard soit au groupe A (23 sujets) ou le groupe de contrôle B (24 sujets). Quarante (40) sujets (20 dans chaque groupe) ont complète l'étude. Tous les sujets ont reçu une réhabilitation physio thérapeutique conventionnelle pour 12 semaines. Durant cette même période, le groupe A faisaient de séances de marche en plus de la physiothérapie conventionnelle. Les changements au repos en systole et diastole de la pression artérielle étaient surveilles pendant la période. Les résultats des semaines 0, 4, 8 et 12 étaient analyses par groupe par les tests significatifs des moyennes des résultats de la pré-intervention (semaine 0) et les exercices de marche était très efficace pour la d'autres semaines 4, 8 and 12. Les sujets du groupe A avaient des réductions significatives de la pression systolique et diastolique âpres 12 semaines de séances de marche. Ces réductions des pressions systoliques et diastoliques n'étaient pas statistiquement significatives chez le groupe de contrôle. Il était conclu que les exercices de marche étaient très efficaces sur la réduction de la pression artérielle chez ces survivants et pourrait être combine à la réhabilitation conventionnelle dans les unités des soins des survivants de l'arrêt cardiaque.

Introduction

High blood pressure is a major risk factor for stroke in Africans [1,2]. Among Nigerians, hypertension consistently predominates as the most frequently encountered modifiable risk factor for stroke [3,4]. Rapid urbanization and transition from agrarian life to the wage-earning economy of city life continue to fuel increases in average blood pressure levels and prevalence of hypertension. Also, some studies suggest that excessive salt intake is an important actiological factor in hypertension [5,6]. Although the true burden of high blood pressure in sub-Saharan Africa remains largely unmeasured, compelling preliminary evidence suggests that it is the foundation for epidemic cardiovascular disease in Africa and already contributes substantially to death and

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disability from stroke in this region [7]. It has also been reported that, in some patients with stroke, blood pressure fluctuates extensively during medical rehabilitation [8]. Hence, reduction in blood pressure is considered a comprehensive stroke risk-reduction strategy [9] as well as a beneficial therapeutic intervention for patients with stroke.

The use of exercise training to enhance functional outcomes after stroke has been reported by many clinicians [10,11,12]. There is also evidence, albeit limited, that exercise trainability after stroke can be both feasible and safe, if appropriate screening and monitoring are used [13]. Exercise training is a relatively inexpensive and simple therapeutic approach which can bring about desirable effects in stroke survivors [14]. Many exercise training modalities are available for use during rehabilitation of stroke survivors. They include overground walking, treadmill walking, stair climbing and bicycle ergometry. Overground walking is a relatively cheap therapeutic modality that can be employed by many patients with stroke [15,16,17]. It is probably the only exercise training modality available for patients with stroke residing in communities where there are no facilities such as treadmill or bicycle ergometer.

The physiological and therapeutic effects of exercise training have been demonstrated. Both at rest and at any given level of exercise, trained individuals have lower heart rates, lower blood pressures, and larger stroke volumes than untrained individuals, and they tend to have larger hearts [18,19]. Health, endurance, nutrition and general well-being are all dependent on cardiorespiratory fitness which can only be maintained by a systematic method of exercises. These training effects can also be demonstrated in clinical studies. Hence, the aim of this study was to demonstrate the effects of overground walking (an exercise training modality) on blood pressure of adult patients with stroke.

Materials and methods

The subjects for the study were drawn from a population of patients with stroke referred for outpatient management at the Physiotherapy Department of Korle Bu Teaching Hospital, Accra, Ghana. All subjects were patients whose stroke occurred not less than 3 months and not more than 24 months before entering the study. Subjects were included if they were able to walk 10 metres independently with or without walking aid. Figure 1 is a flow chart showing the recruitment and allocation of the study subjects. A total of 54 subjects were screened for inclusion in the study. 47 subjects comprising 25 males and 22 females satisfied the inclusion criteria; and they gave written informed consent to participate in the study. They were randomly assigned (stratified random sampling) to an exercise training group (A) and a control group (B); with 23 subjects in Group A and 24 subjects in Group B. All study subjects received individual out-patient conventional physiotherapy rehabilitation {active and passive range of motion (ROM) exercises, strength training, and balance training, as applicable} 3 days a week for 12 weeks. During the same period, subjects in Group A had overground walking exercise training (OWET) in addition to the conventional therapy. Subjects in Group B had 12 weeks of conventional physiotherapy treatment only. Forty (40) subjects (20 in each group) completed the study. Seven (7) subjects (3 from Group A, 4 from Group B) did not attend all treatment/training sessions.

On each day of training / treatment, the subjects observed a pre-exercise rest period of 10 minutes after which the systolic and diastolic blood pressure measurements were made. Resting blood pressure was taken with the subject in the sitting position. The unaffected arm was exposed and the elbow extended. The cuff of the sphygmomanometer was wrapped around the arm about 2.5 cm above the antecubital fossa. The earpieces of the stethoscope were placed into the ears; and the diaphragm placed over the brachial artery at the elbow. The radial pulse was located and palpated over the wrist. With the valve of the blood pressure cuff closed, the cuff was inflated until the radial pulse disappeared [18]. The valve was released slowly and the manometer watched as it descended slowly. The point at which the first sound was heard was recorded as the systolic blood pressure (SBP). The point on the manometer when the sound disappeared (phase 5) was recorded as the diastolic blood pressure (DBP) [18].

After the resting blood pressure had been measured, subjects in Group A went through a 1-hour session of conventional physiotherapy *plus* overground walking exercise training while subjects in Group B went through a 1-hour session of conventional physiotherapy only. The exercise training involved walking overground at a natural safe speed (i.e. walking at own pace in order to cover as much ground as possible within the training period) on a 10x2 metre walk course marked out on the flat floor of a remedial gymnasium. The exercise training time was 25 minutes; although the exercise would be terminated anytime the subject reported symptoms of exertional intolerance i.e. outside the target zone on Borg's rate of perceived exertion (RPE) scale [20,21].

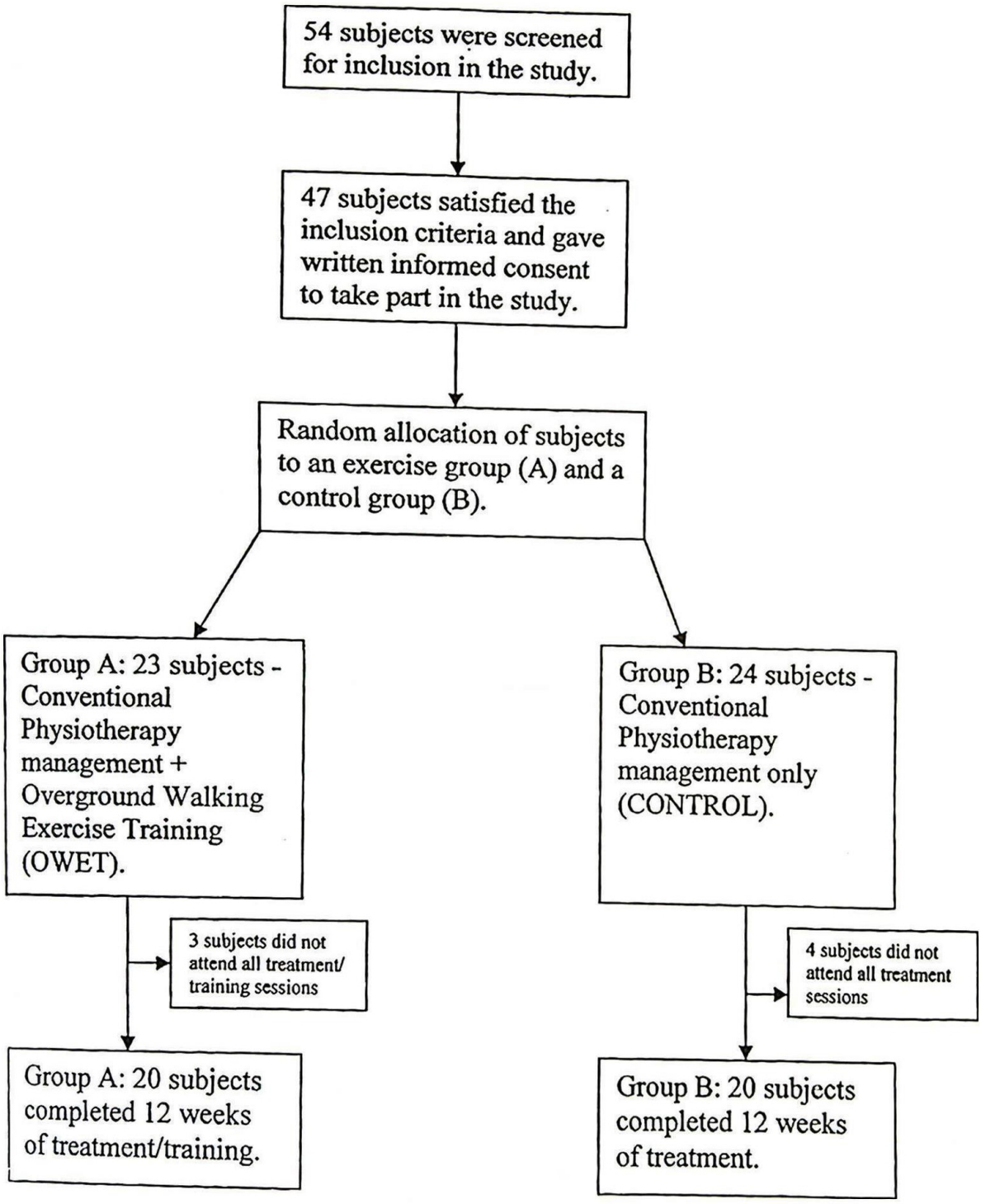

Fig. 1: Recruitment and allocation of study subjects

Resting blood pressures were monitored and recorded for the subjects on each day of treatment/ training. The data obtained at weeks 0, 4, 8 and 12 were used for analysis. All subjects were maintained on their drug prescriptions, including dosage, throughout the study. Also, they remained under medical surveillance at the Neurology Clinic of the hospital; and there was exchange of communication between the research team and the medical consultants in charge of each subject.

Ethical considerations

Informed consent was obtained from the subjects before they were enrolled in the study. The research protocol was approved by the Ethical and Protocol Review Committee of the University of Ghana Medical School.

Data analyses

Data were analyzed using SPSS version 10.0 for Windows (SPSS Inc, Chicago, IL) and Microsoft Excel 2003 version (Microsoft Corporation, Redmond, WA). Mean, standard deviation, standard error of means (SEM), and range were computed for each of the dependent variables. For each of the 2 groups, paired *t*-tests were used to evaluate the significance of the differences between the pre-intervention (Week 0) mean scores on resting SBP and DBP and the mean scores at weeks 4, 8 and 12.

Results

Demographic ata of the Subjects

The demographic data of the 40 subjects who completed the study are shown in Table 1. The subjects in Group A had overground walking exercise training (OWET) for 12 weeks in addition to conventional physiotherapy management. Subjects in Group B served as the control group; they received 12 weeks of conventional physiotherapy management without any structured exercise training.

Changes in resting SBP with overground walking exercise training (OWET)

The changes in resting systolic blood pressure (SBP) with overground walking exercise training are shown in Table 2. For the OWET group, reductions in resting SBP were significant at weeks 8 and 12; for the control group, the reductions were not significant at any point during the 12 weeks. The percent decreases in resting SBP are shown graphically in Fig 2.

Table 1: Demographic data of the subjects.

Group	Age (yrs) (Mean ± SD)	Sex M	F	Affected side R	L	Duration of stroke (months) (Mean ± SD)
A (OWET) (n=20)	56.8 ± 8.3 (range = 46-78)	11	9	10	10	10.7±6.8 (range = 3-22)
B (CONTROL) (n=20)	57.2 ± 5.9 (range = 45-66)	11	9	11	9	10.3±5.9 (range = 3-23)
∑=40			22	18	21	19

OWET= Overground walking exercise training (Group A)
CONTROL= Group B

Table 2: Changes in resting SBP with overground walking exercise training

		Week 0	Week 4	Week 8	Week 12
Group A (OWET)	X±SEM	120.5±3.0	117.5±2.3	114.3±2.4	113.0±2.2
	Δ(mmHg)	-	3.0±0.4	6.2±0.5	7.5±0.6
	t test (P-value)	-	0.110	0.05*	0.001*
Group B (CONTROL)	X±SEM	119.5±3.3	118.3±2.4	114.3±2.5	114.8±2.6
	Δ(mmHg)	-	1.2±0.3	5.2±0.4	4.7±0.5
	t test (P-value)	-	0.529	0.058	0.067

* *Significant*
OWET= Overground walking exercise training (Group A)
CONTROL= Group B

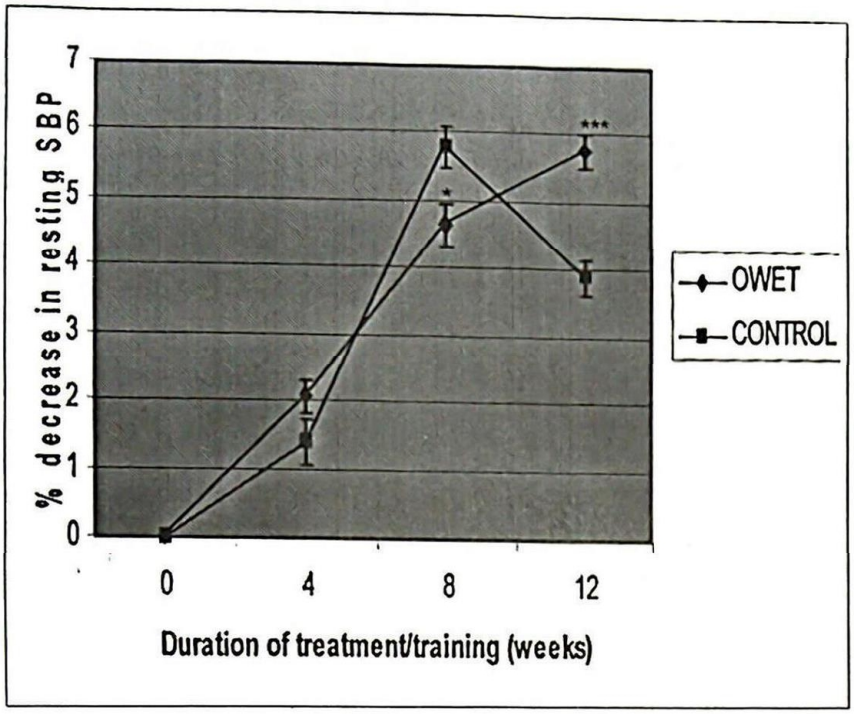

Fig. 2: Percent decrease in resting systolic blood pressure (SBP) with overground walking exercise training.

OWET = Overground walking exercise training
****P<0.001 (Comparisons were made against week 0)*
** P<0.05*

Table 3: Changes in resting DBP with exercise training

		Week 0	Week 4	Week 8	Week 12
Group A (OWET)	X±SEM	74.3±1.9	71.0±1.9	68.3±1.6	69.5±1.8
	Δ(mmHg)	-	3.3±0.2	6.0±0.4	4.8±0.5
	t test (P-value)	-	0.05*	0.001*	0.05*
Group B (Control)	X±SEM	72.0±1.9	70.5±1.8	70.5±2.0	70.0±2.0
	Δ(mmHg)	-	1.5±0.2	1.5±0.2	2.0±0.3
	t test (P-value)	-	0.285	0.379	0.288

** Significant*
OWET= Overground walking exercise training (Group A)
Control= Group B

Changes in resting DBP with overground walking exercise training (OWET)

The changes in resting diastolic blood pressure (DBP) with overground walking exercise training are shown in Table 3. For the OWET group, reductions in resting DBP were significant at weeks 4, 8 and 12; for the control group, the reductions were not significant at any point during the 12 weeks. The percent decreases in resting DBP are depicted graphically in Fig 3.

Discussion

The effects of overground walking exercise training on blood pressure in adult patients with stroke were evaluated in this study. The responsiveness of the study subjects to 12 weeks of exercise training was monitored in terms of changes in resting blood pressure. Overground walking exercise training over 12 weeks produced significant reductions in resting SBP and DBP. As for the subjects who had only

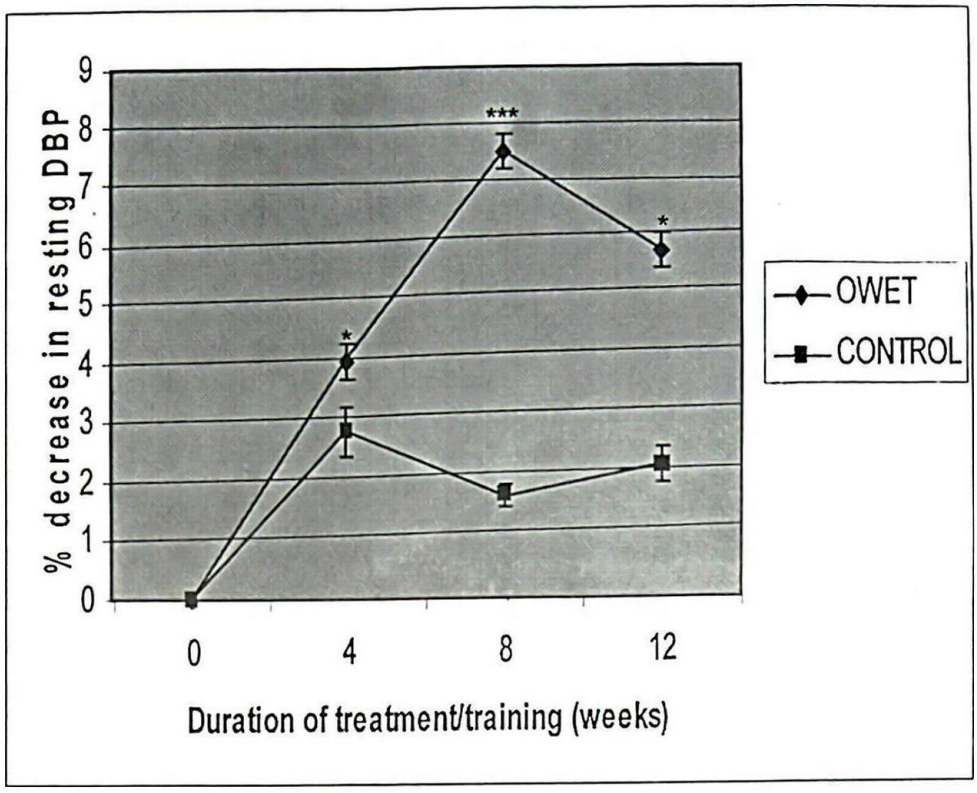

Fig. 3: Percent decreases in resting diastolic blood pressure (DBP) with overground walking exercise training

OWET= Overground walking exercise training
****P<0.001 (Comparisons were made against week 0)*
** P <0.05*

reductions in resting SBP and DBP were not statistically significant over the same period. It is of clinical significance that subjects in the control group had reductions in blood pressure (though not statistically significant) thereby demonstrating one of the beneficial effects of conventional rehabilitation. The influence of drug therapy was controlled by ensuring that subjects in the exercise and control groups were maintained on their drug prescriptions, including dosage, throughout the study period. The study subjects were drawn from the same population of stroke survivors and the only intervention variable that distinguished the exercise subjects from the control subjects was the additional overground walking exercise training. Hence, differences observed in their blood pressure response could be reasonably attributed to the additional effects of the exercise training.

The results of the present study support the well-known assertion that physical activity is an important part of an overall strategy to control blood pressure [22]. Studies have demonstrated that physical exercise reduces blood pressure levels in hypertensive subjects and improves control of several well-known risk factors for hypertension [23]. In the adult population, the beneficial effects of exercise on blood pressure have been demonstrated [24,25]. Multiple trials showed exercise interventions, such as walking/jogging, cycling or both, often lasting 45-60 minutes per session, for three days per week reduced blood pressure [25]. Compared with non-exercising control groups, aerobic exercise reduced SBP by 4.7 mmHg (95% CI 4.4 to 5.0 mmHg) and DBP by 3.1 mmHg (95% CI 3.0 to 3.3 mmHg) [25]. Also, Pinto *et al* [23] conducted a six-week programme of mobility exercise based on fast walking and concluded that physical exercise should be a part of lifestyle changes for the management of hypertension. The exercise subjects in this study demonstrated similar beneficial effects of exercise on blood pressure as they recorded significant reductions in both SBP and DBP.

Reduction in blood pressure is considered a comprehensive stroke risk-reduction strategy [9] as well as a beneficial therapeutic intervention for the patients. In this study, a simple exercise training modality was utilized and its beneficial effect on blood pressure was demonstrated. Most countries in Africa have limited rehabilitation resources. We are of the

opinion that it is necessary to make an objective evaluation of various therapeutic modalities so that those that are safe, inexpensive, effective and available can be used in the rehabilitation of our stroke patients, majority of who are poor and do not have easy access to facilities at tertiary hospitals and the high-brow private hospitals. This is why we employed a safe, simple, inexpensive and easily accessible therapeutic modality (overground walking) and evaluated its effect on blood pressure in adult patients with stroke. It would appear that, for the group of participants in this study, overground walking exercise training demonstrated the type of blood pressure responses similar to those reported in earlier studies. One limitation of this study is the fact that it was not possible to analyze differences in the effects of exercise training between subjects in terms of the nature of stroke (i.e. ischaemic or haemorrhagic). This was because not all the patients could afford or were even routinely required to go through neuro-imaging techniques such as computed tomography (CT) scanning or magnetic resonance imaging (MRI) needed for such analysis. Also, further studies may be needed to evaluate the effects of other exercise training modalities especially in community-based African rehabilitation setting.

Conclusion

The results of the present study showed that overground walking exercise training for 12 weeks produced significant reductions in resting SBP and resting DBP. Since comparable results were not obtained for subjects in the control group, it would appear that the use of overground walking as a therapeutic mode of exercise training enhanced desirable beneficial effects in terms of reduction in blood pressure of patients with stroke. Overground walking is particularly accessible and can be used on a long-term basis as part of a community-based rehabilitation programme. It does not require specialized training. Hence, it is a therapeutic intervention which may be employed in the rehabilitation of patients with stroke without imposing heavy costs on the patients.

References

1. Lisk DR. Stroke risk factors in an African population: A report from Sierra Leone. Stroke 1993; 24: 139-141.
2. Osuntokun BO. Epidemiology of stroke in the African. Afr. J. Med. Med. Sci. 1997; 6: 64-76.
3. Ayanniyi O, Akande O and Mustapha AF. Knowledge and perception of stroke among adults in Osogbo, Nigeria. Afr. J. Med. Med. Sci. 2006; 35: 447-452.
4. Danesi MA, Oyenola YA and Onitiri AC. Risk factors associated with cerebrovascular accidents in Nigerians (a case control study). East Afr. J. Med. 1983; 60: 190-195.
5. Sofola O, Knill A, Myers D, Hainsworth R and Drinkhill M. High-salt diet and responses of the pressurized mesenteric artery of the dog to noradrenaline and acetylcholine. Clin Exp Pharmacol Physiol. 2004; 31(10): 696-699.
6. Sofola OA, Knill A, Hainsworth R and Drinkhill M. Change in endothelial function in mesenteric arteries of Sprague-Dawley rats fed a high salt diet. J Physiol. 2002; 543 (Pt 1): 255-260.
7. Cooper RS, Amoah AG and Mensah GA. High blood pressure: the foundation for epidemic cardiovascular disease in African populations. Ethn Dis. 2003; 13 (2 Suppl 2): S48-52.
8. Nishioka Y, Sashika H, Andho N and Tochikubo O. Relation between 24-h heart rate variability and blood pressure fluctuation during exercise in stroke patients. Circ J. 2005; 69: 717-721.
9. Gordon NF, Salmon RD, Mitchell BS, *et al.* Innovative approaches to comprehensive cardiovascular disease risk reduction in clinical and community-based settings. Curr Atheroscler Rep. 2001; 3: 498-506.
10. Leroux A. Exercise training to improve motor performance in chronic stroke: effects of a community-based exercise program. Int J Rehabil Res. 2005; 28(1): 17-23.
11. Macko RF, Ivey FM and Forrester LW. Task-oriented aerobic exercise in chronic hemiparetic stroke: training protocols and treatment effects. Top Stroke Rehabil. 2005; 12: 45-57.
12. Olawale OA and Ogunmakin OS. The effect of exercise training on balance in adult patients with post-stroke hemiplegia. Int J Ther Rehabil 2006; 13(7): 318-322.
13. Holt R, Kendrick C, McGlashan, K, Kirker S and Jenner J. Static bicycle training for functional mobility in chronic stroke: case report. Physiotherapy 2001; 87: 257-260.
14. Kendrick C, Holt R, McGlashan, K, Jenner JR and Kirker S. Exercising on a treadmill to improve functional mobility in chronic stroke: case report. Physiotherapy 2001; 87: 261-265.
15. Hesse S, Konrad M and Uhlenbrock D. Treadmill walking with partial body weight support versus floor walking in hemiparetic subjects. Arch Phys Med Rehabil. 1999; 80(4): 421-427.
16. Peurala SH, Tarkka IM, Pitkanen K and Sivenius J. The effectiveness of body weight-supported

gait training and floor walking in patients with chronic stroke. Arch Phys Med Rehabil. 2005; 86(8): 1557-1564.
17. Yang YR, Yen JG, Wang RY, Yen LL and Lieu FK. Gait outcomes after additional backward walking training in patients with stroke: a randomized controlled trial. Clin Rehabil. 2005; 19(3): 264-273.
18. Bray JJ, Cragg PA, Macknight ADC and Mills RG. Lecture Notes on Human Physiology (4th Edition). Oxford, Blackwell Science, 1999.
19. Ganong WF. Review of Medical Physiology (22nd Edition). New York, McGraw-Hill, 2005.
20. Borg GA. Psychophysical bases of perceived exertion. Med Sci Sports Exerc. 1982; 14: 377–381.
21. Robbins G, Powers D and Burgess S. A wellness way of life (5th edition). New York, McGraw Hill, 2002.
22. American Heart Association. Heart disease and stroke statistics—2007 update. Circulation 2007; 115(5): e69–e171.
23. Pinto A, Di Raimondo D, Tuttolomondo A, Fernandez P, Arnao V and Licata G. Twenty-four hour ambulatory blood pressure monitoring to evaluate effects on blood pressure of physical activity in hypertensive patients. Clin J Sport Med. 2006; 16(3): 238-243
24. Jaja SI, Opesanwo O, Mojiminiyi FBO and Kehinde MO. Changes in blood pressure and pulse rate after submaximal exercise in sickle cell anaemia patients. Nigeria Quarterly Journal of Hospital Medicine 1999; 9: 288-292.
25. Mulroy CD (ed). Evidence-based hypertension. London: BMJ Publishing Group Limited, 2001.

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