Impact of Modified Game Based Activities in Motor Control and Functional Outcome of Stroke Patients

Nighat Tahir[1*], Sana Nauman[2], Shankar Ahuja[3], Dr Madiha Zia[4]

[1,2,3.4] *Dow University of Health Sciences, Karachi, Pakisthan*

[*]*Corresponding Author*

***Abstract*:**

***Background*: Stroke is one of the most common causes of physical disability, and early, intensive, and repetitive rehabilitation exercises are crucial to the recovery of stroke survivors. Unfortunately, research shows that only one third of stroke patients actually perform recommended exercises at home, because of the repetitive and mundane nature of conventional rehabilitation exercises. Thus, to motivate stroke survivors to engage in monotonous rehabilitation is a significant issue in the therapy process. Game-based rehabilitation systems have the potential to encourage patients continuing rehabilitation exercises**

***Objective:* The purpose of this study was to evaluate/explore the effect /impact of modified game based activity that improve hand functioning**

***Method:* This study was conducted at Institute of physical medicine and rehabilitation DOW University of health sciences. 15 patients those included were diagnosed as stroke through randomized control trial; patients having muscle grade 3, aged between 20-50, acute cases were included .All patients received conventional therapy and additional game based activities 4 days a week. Sports based therapy included Basket Ball, Balloon Bounce, Volley Ball, Cricket, and Football .These 5 activities covered with warm up and cool down exercises. Pre and post assessment is done by Fugal Mayer and Chadock scale.**

***Result:* There is significant difference in baseline pre and post assessment of fugal Mayer and CAHAI scoring Wilcoxon signed rank test was performed. Value of $p<0.05$ In fugal Mayer A Wilcoxon Signed-Ranks Test indicated that posttest score was significantly higher than pretest $Z = -3.413$, $p < .001$ total measure of upper extremity and lower extremity as well as shoulder external rotation ,wrist ability adduction, opposition of thumb ,and grip if individually measured it also showed significant value of $p<.001$**

***Conclusion:* Modified sports can turn the rehabilitation exercises more appealing and provide innate motivation to individual. The participants experienced increased quality of life, a greater propensity to use their affected arm and enhanced task performance**

***Keywords:* Modified sports, stroke rehab, sensor motor, Chadock scale, FMA-UE/LE**

I. INTRODUCTION

Globally one of the foremost causes of life long disability is stroke which leads a significant percentage of people to death. In Pakistan, there was a basic age stroke incidence of 95 per 100,000 persons per year for the years 2000 to 2016, it showed uppermost incidence in old age 75-85(1). Other population-based TIA incidence rates average25per 100,000 persons per year from 2014-2016 [18].. Mobility status from 1-3 years after stroke significantly deteriorates in 21% of patients, resulting in reduction of activities of daily living, loss of independence, and social isolation [2] . The most important thing is neuroplasticity of brain which increase brain function and automatic learning pattern will enhance and help in motor control.80% of stroke survivoe faced contralateral hemiparesis of upper extremity in acute phase while 40% or more suffered chronically. Hemiparesis one side of upper extremity is the most common issue faced by stroke survivor, (Cramer et al., 1997).

In an editorial written Ismail A. Khatri1 and Mohammad Wasay, describe Pakistan has high stroke incidence and to stop this figure they suggested active life style and healthy nutrition. Evidence showed, sports and Physical exercise is directly interlinked with cardiovascular fitness. It improves skill related fitness (like balance, coordination etc) and health related fitness (i.e., cardiovascular, endurance, strength).

However most work done on stroke patients was on physical exercises, virtual training. Less evidence or almost no evidence of individual sports training program. Existing clinical programs of stroke rehabilitation is the combination of various motor interventions such as the repeated practice of everyday tasks, constraint-induced movement therapy (CIMT), bilateral arm training (BAT), yoga, mirror therapy, mental practice/rehearsal, biofeedback, robot-assisted arm training, somatosensory approach, Bobath approach, etc. there are numerous type of task training select for stroke, (goal-directed, task-oriented, repetitive task training) and by their procedural features (duration, training load and type of feedback).these all are flexible program and can be modify or set according to patient condition.

General manifestation of upper limb somato sensory impairment include variable muscle tone, weakness, fixatin, poor spatial relationship, decreased motor regulation. These impairment influenced common performance level in simple task such as reaching, grasping objects and its handling or maintain balance in functional tasks.(Bleyenheuft and Gordon, 2014).

Based on Carr, J., and Shephard, guideline on Exercise and Training to Optimize Functional Motor Performance in Stroke, we developed and tested a progressive version of the adaptive game based activity that (a)develop basic range of motion activities to complex action (b) increased the self-motivated balance trials (c) bilateral coordination and unintentional participation from affected side enhanced the structure of action advancement, and (d) combined health related and skill related fitness..

The rehabilitation program included both modified sports and home exercise components. The exercises focused on range of motion and strength activity that commonly present in movements of daily life, such as walking, weight shifting, reaching, standing and sitting, and reach and hold object. We hypothesized that a flexible adaptive game based activity program would improve confidence, fitness, and balance. The specific aims of this study were (a) : Ascertain worth of game based activity to improve motor performance and skill related fitness in stroke survivor (b) neuroplasticity of brain which increase brain function and automatic learning pattern will enhance and help in motor control and (c) to determine whether adaptive adaptive game based activity program affects self-reported outcomes related to self-efficacy.

II. METHODOLOGY

It is qualitative study of 6 month. Fifteen adult patients of stroke (suffering from stroke between 1-5 years) selected from sensory motor facilitation unit of occupational therapy department. Those who have grade 3, 3+, ischemic attack, post stroke (6mon-5 years), having conventional therapy previously and continue age between 20- 50 years, able to stand without support and can walk were included while duration of stroke above 5 year, Below 3 grade or unable to stand, didn't receive any therapy, hemorrhagic, contracture and complication, postural hypertension, who has no sufficient cognition to comprehend the tasks were excluded.

All patients received conventional therapy and additional game based activities 4 days a week. Sports based therapy included Basket Ball, Balloon Bounce, Volley Ball, Cricket, and Football .These 5 activities covered with warm up and cool down exercises. Pre and post assessment is done by Fugal Mayer and Chadock scale to measure the motor control and change in quality of life of stroke patient. General observation and scoring of each session was entered on score sheet, which was used as reflection.

Description of modified game based activities

Modified game based activities sessions included sports activities such as, Basket Ball, Balloon Bounce, Volley Ball, Cricket, and Football .There was a proper score sheet formed according to population frequency and intensity. Patients were instructed about game rules beforehand such as using their affected arm/hand and lower limb in these activities. Devotion to standard rehabilitation and the tasks were monitored with a timer. Score sheet was formed for comparison of pre and post functional levels, achieved after six months of game based rehabilitation. Score sheet also provided evidence of incorporating modified game based activities along with standard rehabilitation therapy. Pre and post measures also gave fair comparison of average intensity at which game plan for stroke survivors was beneficial. These protocols follow reflexive, synergetic movement with alertness and coordination of stroke survivor. Adaptive sports during (16)

No	Mode Of Training	Major Goal	Intensity /Frequency
1	warm up exercise	REPARATORY PHASE	5 min
2	Cricket	• Strength (upper limb) • balance • bilateral /eye hand /hand hand coordination	5 min /10 balls
3	Volley ball (1. receiving phase 2. Service phase)	• Strength (upper limb) • balance • bilateral /eye hand /hand hand coordination • flexibility • ROM	5 min /10 hits
4	Basket ball	• Strength (upper & lower limb) • balance • bilateral /eye hand /hand hand coordination • flexibility • ROM • Attention/concentration	5 min /10 baskets
5	Football	• balance • Strength (lower limb) • balance • focusing • ROM	5 min /10 kicks
6	balloon bounce	• bilateral /eye hand /hand hand coordination • Attention/concentration • flexibility • ROM	5 min /10 bounce
7	Cool down exercise	• Relax and stretching	5min

III. RESULTS

Proper score sheet formed and measured changes in intensity and frequency of their participation in games. This explained in table1.

Table 1

No	Mode of training	Estimated mean time /frequency set	Mean of time of initial time/frequency	Mean of time after 72 sessions /frequency	Comments
1	Warm up exercise e	5 min	5min	5 min	
2	Cricket	5 min /10 balls	5min/6 balls	5 min /10 balls	Initially unable to complete 10 balls in 5 min. Bat grasp modified

3	Volley ball 1.Receiving phase 2.service phase	5 min /10 hits	1-2min/3 hits 2-5/7 hits	5 min /8 hits	Service phase is actively done, a lot of effort in receptive phase. Time reduce because patient exhaust so active time count only
4	Basket ball	5 min /10 baskets	5 min/3 baskets	5 min /8 baskets	Distance reduce to 3 foot and height is 5.5 feet
5	Football	5Min /10 kicks	5min/5 kicks	5 min /10 kicks	Balance interfere, some patients kick but there initial speed and posture correction count.
6	balloon bounce	5 min /10 bounce	5 min/4 bounce	5 min /10 bounce	Best coordination and balance skill promote in it. Once balance maintain bounce well.
7	Cool down exercise	Relax and stretching		5min	

The significant progress was gained in life style of stroke survivor. There is imperious response showed in pre and post assessment of fugal Mayer assessment and CAHAI measures. To compare the pre and post result Wilcoxon signed rank test was performed. Value of $p<0.05$ showed significant result in.fugal mayer A Wilcoxon Signed-Ranks Test indicated that posttest score was significantly higher than pretest $Z = -3.413$, $p < .001$ total measure of upper extremity and lower extremity. as well as shoulder external rotation ,wrist ability, adduction, opposition of thumb, and grip if individually measured it also showed significant value of $p<.001$ in table 2.

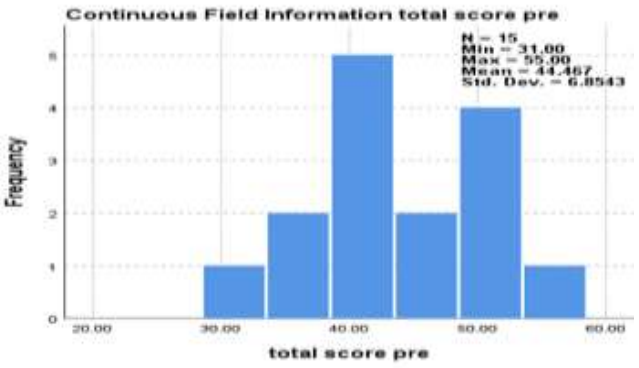
Table 2

Dimensions	Mean (sd	Z	2 tailed
Pre shoulder external rotation	1.07	-3.606	.000
Post shoulder external rotation	1.93		
Pre wrist stability	.87	-3.276	.001
Post wrist stability	1.80		
Pre opposition of thumb	.60	-3.357	.001
Post opposition of thumb	1.47		
Pre thumb adduction	.53	-3.276	.001
Post thumb adduction	1.47		
Pre spherical grip	.60	-3.071	.002
Post spherical grip	1.53		
Pre hand to lumbar spine	.8	-3.742	.000
Post hand to lumbar spine	1.80		
Pre fugal mayer Upper extremity	23.8000	-3.413	.001
Post fugal mayer Upper extremity	46.5333		
Pre fugal mayer Lower extremity	44.5000	-3.413	.001
Post fugal mayer Lower extremity	73.73		

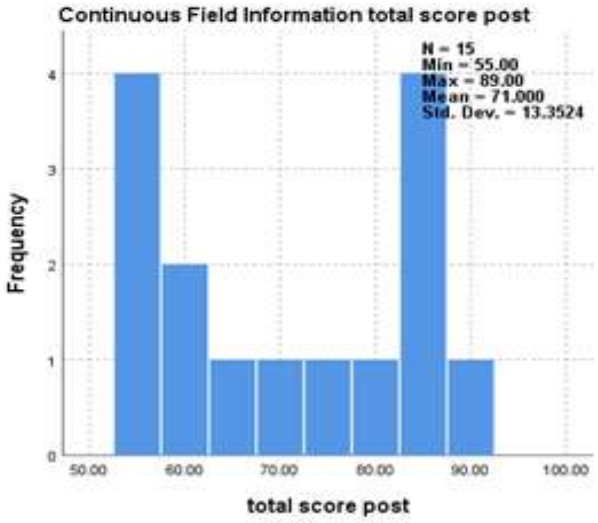
Functional activities also showed significant improvement measured by Chedoke Arm and Hand Activity Inventory (CAHAI-13) . it showed $p <0.001$ was the significance level for the test. The value of CAHAI-13 showed improvement in all 13 components ($p=0.001$). Refer to the table 3.

Dimensions	Z	2 tailed
open jar of coffe post - open jar of coffe pre	-3.461	.001
call 911 poat - call 911 pre	-3.457	.001
draw a line with ruler post - draw a line with a ruler pre	-3.453	.001
pour a glass of water post - pour a glass of water pre	-3.457	.001
wring out wash cloth post - wring out wash cloth pre	-3.325	.001
do up five buttons post - do up five buttons pre	-3.369	.001
dry back with towel post - dry back with towel pre	-3.443	.001
put toothpaste on toothbrush post - put toothpaste on toothbrush pre	-3.443	.001
cut medium resistance putty post - cut medium resistance putty pre	-3.462	.001
zip up the zipper post - zip up the zipper pre	-3.213	.001
clean a pair of glasses post - clean a pair of glasses pre	-3.342	.001
place a container on table post - place container on table pre	-3.882	.001
carry bag up the stairs post - carry bag up the stairs pre	-3.291	.001
total score post - total score pre	-3.408	.001

Graph 1 shows the total pre mean in CAHAI score



Graph 2 shows the total post mean in CAHAI score



IV. DISCUSSION

The findings from this preliminary study partially supported our hypothesis that an MISD training protocol would elicit greater improvements on selected coronary risk factors (ie, blood pressure, lipids) compared with LILD aerobic exercise and conventional nonaerobic TE. The results of this pilot study endorsed our hypothesis that sensory motor training program yield significant improvement in stroke patients with residual functional deficits. Adaptive sports activities provide sensory motor stimulation to post stroke patients involved in these tasks as a result motivation level boosts, balance and coordination improves and proprioceptive sense enhances.

Since last decade, there has been considerable increase in the concept of neuroplasticity specially virtual games appear to be effective for stroke survivors.[2,8]. Nonetheless, several literatures support that physical activity enhances endurance of stroke survivors thus enabling them to continue sports activities for longer duration. Apparently after stroke some individuals can walk and are also able to perform few activities of daily living with assistance but they may have low self-esteem, uncertainty in maintaining good balance and hesitation in normal occupational performance appropriate for age and gender as before the insult. Thus require supervision, adaptive or assistive equipment in order to complete the tasks.

Occupational Therapy incorporates various techniques to design purposeful activity plan to help the stroke patients with functional deficits achieve basic functional skills of daily living.[9,11] Thus the purpose of our study to involve the stroke survivors in sports-based activities was fulfilled by producing positive impact on their lives. When patients start exercises a mood elevating hormone endorphin is released that stabilizes mood, lessen depression and reduce pain perception[8,14] .In this study function level of daily skills is measured through Chedoke Arm and Hand Activity Inventory(CAHAI-13).CAHAI evaluated bilateral functioning through 7 –point scale. This scale explained effort of clients to complete a task in percentages, minimum effort is less than 25%, and client is fully dependent with 100 % performance in completing the given task, thus labeled as independent.9 Total score range between 13 to 91,Higher scores reflect high functional ability .CAHAI specifically measures upper limb function ,in context of daily living activities. Mean of Pre assessment of total score is 44.46 while post score mean is 71.0. Result of this research showed significant differences between pre and post scoring.

Fugal Mayer (FMA) is used to measure Motor function of hemiplegic patient. The FMA consists of 33 items for the upper extremity, 17 for the lower extremity, 2 items of sensory and 4 items to measure proprioception.6. Sensory motor information, like joint position, graded movement is also important for smooth motor function. Strategies used in this research are amalgam of upper limb and lower limb activities. Like in cricket, racket-balloon activity, kicking, basketball throw, upper extremity function is holding a bat (bat gripping is modified according to patient need), role of lower limb is to maintain balance of the body. The purpose of this activity is expressed in table 1.

To recapitulate our findings modified sports is determined to be beneficial for eye hand coordination, increase standing tolerance during activities, improve balance and bilateral upper and lower extremities coordination. Pre and post assessment scores are significant evidence of change in function of post stroke survivors.

Training program was initially tested on random patients and after observation a score sheet was designed for trial and to record maximum capacity, as reported in table2.

Patients were encouraged to take time and get comfortable with the activities. Sports increase motivations, thus goals are set so that the individual concentrate on achieving the target while therapist can focus on sensory motor function. At the end of this structured program we have undeniable therapeutic effects with p value=0.001representing significant improvement in occupational performance. Repetitive tasks influence the human motor cortex and increase neuroplasticity. Variable degree of movements used in playing produce more stability at different joints15. Result of FMA-UE clearly describe holding different sports goods for example bat, racket or holding a ball certainly effect on grasp ,wrist stability, opposition of thumb, and shoulder external rotation. Pre and post assessment score showed 0.001 which is a significant result. FMA –LE also indicates significant difference in pre and post assessments resulting in overall improvement in balance, eye-hand coordination and body coordination. When sensory motor function improves it enhances daily living function as evident by CAHAI-13 pre and post assessment which also revealed 0.001 values that is significant. Pre-treatment assessment like opening a jar, calling 911, drawing a line with ruler, drying back with towel is moderately difficult for patient with affected hand. While activities like pouring a glass of water, wringing out wash

cloth, doing up five buttons, putting toothpaste on toothbrush, cutting medium resistance putty, zipping up the zipper, cleaning a pair of glasses, placing a container on table, carrying a bag up the stairs relatively need mild effort with some patients. However total mean score of pre score - 44.467 and post score - 71.00 exhibited major differences which stimulate survivors to complete their tasks efficiently.

Scientific evidences recommended that the nature of these games encourage the bilateral coordination and balance, as non-dominant limb activity was significantly greater during bat ball, volleyball and basketball activities. Our participants were limited in kicking from lower limbs while upper and lower limbs coordination was well paced in balloon bouncing activity.

Future Scope --Repetitive tasks result in learning and restoration of functional activities due to changes in motor cortex. Mind mapping continuously changes due to sequential practice. Outcome of this research has proven valid significance of purposeful activity that is modified game on patients' functional skills.

Findings of this study clearly imply that sensory motor stimulation has vital impact on functional Daily living skills. In order to get the maximum benefit from the outcome of this research it is crucial to further explore the impact of modified games by increasing the sample size and duration of activities to achieve sustainability. Compilation of modified game based therapy plans will help in creating guidelines to make proper adaptive sports unit.

V. CONCLUSION

This study identifies positive outcomes of modified game-based activities in the rehabilitation of stroke survivors through purposeful activity, powerful input in the form of sensory motor combination to boost bilateral coordination, postural balance, motivation level, social participation and confidence. These innovative interventions foster the competitive nature of participants to complete their tasks leading to restoration of lost functional skills essential to perform daily activities.

REFERENCES

[1] .Heart and Stroke Foundation of Ontario. Management of the Post Stroke Arm and Hand: Treatment Recommendations of the 2001 Consensus Panel. Available at: http://209.5.25.171/ClientImages/1/ PostStrokeArmandHandFinal2002.pdf. Accessed April 20, 2005.

[2] .Khealani BA, Hameed B, Mapari UU. Stroke in Pakistan.Journal of the Pakistan Medical Association. 2008;58(7):400.

[3] .M Ishaq khan1*, Junaid I Khan2*, Sheikh I Ahmed3 and Umer ul Haq4 1 Walden University, USA 2 George Mason University, USA 3 Yusra Medical College, DHA Islamabad, Pakistan 4 Department of Neurology, AMC Rawalpindi, Pakistan,The Epidemiology of Stroke in a Developing Country (Pakistan). Volume 8 Issue 1 - 2018 , Seymour J. The Aftermath of Stroke: The Experience of Patients and Their Families. 1993; 449–450.

[4] .Henri L Hurkmans, 1 Gerard M Ribbers,1,2 Marjolein F Streur-Kranenburg,1 Henk J Stam,1 andRita J van den Berg-Emons1 Energy expenditure in chronic stroke patients playing Wii Sports: a pilot study, J Neuroeng Rehabil. 2011; 8:

[5] .Stroke Rehabilitation: Guidelines for Exercise and Training to Optimise Motor Skill

[6] .Fugl-Meyer AR, Jaasko L, Leyman I, et al. The post-stroke hemiplegic patient, 1: a method for evaluation of physical performance. Scand JRehabil Med.

[7] .Kennon T.francis,The role of endorphins in exercise:Areview of current knowledge.the journal of orthopaedic and sports physical therapy.096-6011/83/0403-

[8] .Susan R Barreca, Paul W Stratford, Lisa M Masters, Cynthia L Lambert, Jeremy GriffithsComparing 2 Versions of the Chedoke Arm and Hand Activity Inventory With the Action Research Arm Test,Physical Therapy . Volume 86 . Number 2 . February 2006

[9] .Barreca SR, Gowland CA, Stratford PW, et al. Development of the Chedoke Arm and Hand Activity Inventory (CAHAI): theoretical constructs, item generation, and selection. Top Stroke Rehabil. 2004

[10] .Tennille J. Rowland, Deirdre M. Cooke1, Louise A. Gustafsson, Role of occupational therapy after stroke, Ann Indian Acad Neurol 2008;11:S99-S107

[11] .Laurie Lundy-Ekman Relationship between lower extremity muscle strength and dynamic balance in people post-stroke Article in Medicina (Kaunas, Lithuania) •

[12] .Shanta Pandian, Kamal Narayan Arya, and Dharmendra Kumar ,Does Motor Training of the Nonparetic Side Influences Balanceand Function in Chronic Stroke? A Pilot RCT, Hindawi Publishing Corporation ,Scientific World Journal Volume 2014, Article ID 769726, 8 pag

[13] .Arya KN, Pandian S, Verma R, et al. Movement therapy induced neural reorganization and motor recovery in stroke: a review. J Bodyw Mov Ther 2011; 15:528–537. [PubMed]

[14] .Sandra A. Billinger, PT, PhD, FAHA, Chair; Ross Arena, PT, PhD, FAHA, Co-Chair;Julie Bernhardt, PT, PhD; Janice J. Eng, BSc, PT/OTPhysical Activity and Exercise Recommendations for Stroke Survivors, http://stroke.ahajournals.org

[15] .Robert Teasell MD, Norhayati Hussein MBBS,Background Concepts in Stroke Rehabilitation,Evidence based review of stroke rehabilitation.

[16] .Abbott RD, Rodriguez BL, Burchfiel CM, Curb JD. Physical activity in older middle-aged men and reduced risk of stroke: the Honolulu Heart Program. American journal of epidemiology. 1994; 139(9): 881–893. [PubMed]

[17] .Agnarsson U, Thorgeirsson G, Sigvaldason H, Sigfusson N. Effects of leisure-time physical activity and ventilatory function on risk for stroke in men: the Reykjavik study. Annals of Internal Medicine. 1999;130(12):987–990. [PubMed]

[18] .Ellekjær H, Holmen J, Ellekjær E, Vatten L. Physical activity and stroke mortality in women: ten-year follow-up of the Nord-Trondelag Health Survey, 1984–1986. Stroke. 2000;31(1):14–18. [PubMed]

[19] .Hu FB, Stampfer MJ, Colditz GA, et al. Physical activity and risk of stroke in women. JAMA. 2000;283(22):2961–2967. [PubMed]

[20] .American Journal of Epidemiology. 1994;140(7):608–620. [PubMed]

[21] .Gillum RF, Mussolino ME, Ingram DD. Physical activity and stroke incidence in women and men: the NHANES I epidemiologic follow-up study. American Journal of Epidemiology. 1996;143(9):860–868.[PubMed]

[22] .Haheim LL, Holme I, Hjermann I, Leren P. Risk factors of stroke incidence and mortality: a 12-year follow-up of the Oslo study. Stroke. 1993;24(10):1484–1489. [PubMed]

[23] .Wannamethee G, Shaper AG. Physical activity and stroke in British middle aged men. British Medical Journal. 1992;304(6827):597–601. [PMC free article] [PubMed]

[24] .Sacco RL, Gan R, Boden-Albala B, et al. Leisure-time physical activity and ischemic stroke risk: the Northern Manhattan Stroke Study. Stroke. 1998;29(2):380–387. [PubMed]

[25] .Shinton R, Sagar G. Lifelong exercise and stroke. British Medical Journal. 1993;307(6898):231–234.[PMC free article] [PubMed]

[26] .You R, McNeil JJ, O'Malley HM, Davis SM, Donnan GA. Risk factors for lacunar infarction syndromes. Neurology. 1995;45(8):1483–1487. [PubMed]
[27] You RX, McNeil JJ, O'Malley HM, Davis SM, Thrift AG, Donnan GA. Risk factors for stroke due to cerebral infarction in young adults. Stroke. 997;28(10):1913–1918. [PubMed]
[28] Hu G, Sarti C, Jousilahti P, Silventoinen K, Barengo NC, Tuomilehto J. Leisure time, occupational, and commuting physical activity and the risk of stroke. Stroke. 2005; 36(9):1994–1999. [PubMed]
[29] Williams PT. Reduction in incident stroke risk with vigorous physical activity: evidence from 7.7-year follow-up of the national runners' health study. Stroke. 2009; 40(5):1921–1923. [PMC free article] [PubMed] Published online 2011 Jul 14.
[30] Evenson KR, Rosamond WD, Cai J, et al. Physical activity and ischemic stroke risk: the atherosclerosis risk in communities study. Stroke. 1999; 30(7):1333–1339. [PubMed]