ORIGINAL RESEARCH

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EFFECTIVENESS OF SUPERVISED FITNESS AND MOBILITY EXERCISE PROGRAM ON FITNESS, MOBILITY AND MUSCLE STRENGTH IN YOUNG ADULTS WITH STROKE

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ABSTRACT

Background: Stroke is a major disabling health problem in developing countries like India & causes long term disability. Long term disability furthers leads to global burden and other psychological problems.The FAME i.e., fitness and mobility exercise program has been designed to improve mobility, fitness and muscle strength. This protocol is community based protocol and helps in patients independent lifestyle.Objective is to examine the effect of supervised FAME protocol on fitness with 6minutes walk test, on mobility with timed up go test & on hamstrings muscle strength measured as hamstrings peak torque with isokinetic analyzer.

Methods: Stroke participants were recruited into the study as per the inclusion and exclusion criteria and randomized into intervention group (n = 15) and control group (n = 15).The intervention group underwent supervised fitness and mobility exercise program & the control group underwent home exercises with printed FAME material (telugu & English version).This program was designed for 8 weeks (3 sessions / week). 6MWT- used to evaluate cardio respiratory fitness, TUG test- used to evaluate mobility, Isokinetic analyzer- used to evaluate hamstrings peak torque. Base line measurements are taken prior to the intervention and post intervention values taken after the 8 weeks of intervention.

Results: Variables within the groups were compared by using paired t test and between the groups by using independent t test. According to obtained values, the pre & posttest values of 6MWT, TUG test & hamstrings peak toque had a significant effect on p-values <0.05 in experimental group.

Conclusion: After 8 weeks of intervention program, the present study concludes that the supervised FAME protocol had showed statistically significant improvement in fitness, mobility & leg muscle strength in intervention group.

Key word: stroke, FAME protocol, fitness, mobility, hamstring's muscle torque.

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INTRODUCTION

World Health Organization (WHO) defines the clinical syndrome of "stroke" as 'rapidly developing clinical signs of focal (or global) disturbance of cerebral function with symptoms lasting 24 hours or longer or leading to death, with no apparent cause other than vascular origin.[1]It is the third commonest cause of mortality[2] and the fourth leading cause of disease burden.[3] In 2005, stroke accounted for nearly 5.7 million deaths and 16 million cases of first ever strokes worldwide.[3] In 2001, pooled estimates for India showed that the prevalence of stroke was 203 per 100,000 population above 20 years (resulting in about 1 million cases) and contributing for 1.2 per cent of the total deaths (approximately 102,000 deaths).[4] The Indian Council of Medical Research (ICMR) estimates indicated that amongst the non-communicable diseases (NCDs), stroke contributes for 41 per cent of deaths and 72 per cent of disability adjusted life years (DALYS).[5] The economic loss due to heart disease, stroke and diabetes between the years 2006 to 2015 is estimated to be approximately 9 billion international dollar loss of national income in India. Literature is available suggesting that risk of coronary artery disease (CAD) is higher in Indians especially in the young population.[6]

Stroke is the leading cause of serious, long-term, adult disability.[7]The absolute numbers of individuals with stroke are increasing as a result of an aging adult population, coupled with an ever-improving survival rate following stroke. Stroke affects cognitive, social, communicative, emotional, and physical domains of function.[8]

Each year, 15 million people suffer a stroke. Of this number of people, 5.5 million die (10% of the deaths in the world are caused by strokes), and another 5 million people become invalids. Stroke is the third most common cause of death in the western world and the most common cause of long term adult disability.[9] Stroke is the leading cause of serious, long-term disability among American adults. Each year in the United States, approximately 730,000 people have strokes, and nearly 400,000 survive with some level of neurologic impairment and disability. Stroke is also a major cause of disability and economic cost.[10]An analysis of Canada's National Health Population Survey found that 87% of people with stroke had restriction in their activities of daily living (ADLs) and that 42% had mobility problems.

Over activity of the quadriceps was considered disabling when inducing inability to flex the knee during the swing phase, over activity of the triceps surae was considered to be disabling when heel strike was not possible. Due to this over activity, the opposite muscle group knee flexors and dorsiflexors undergone weakness.[11] The weakened muscles are exposed to different activities and functions which causes type II fibers atrophy and predominance of type I are seen in paretic limb[13].The strength deficit further leads to reduction in muscle fiber number and increase fatigability and decreased motor unit recruitment. Due to over activity of quadriceps and dorsiflexors over activity, altered muscle fiber composition and impaired neural drive the rate of torque development is more deteriorated in paretic muscles.[12]

Low cardio respiratory fitness is related to poor functional performance[13] and increased risk of stroke and cardiovascular disease (CVD).[14,15] Indeed, cardiac events and recurrent stroke are major occurrences in stroke survivors.[16, 17]

The secondary complications commonly observed after stroke are poor cardiorespiratory fitness which is related to poor functional performance, balance and muscle weakness which may increase incidence of falls and poor mobility etc.[18] Due to the all above health domain impairments, the patient become disabled and burden to family. Every patient may not have effort to participate in institutional rehabilitation. So, there is a need for new community based approaches which makes the patient stable and independent.

The FAME Program has been designed in Vancouver, Canada by Janice Eng., PhD, PT/OT to improve mobility, fitness and gait disorders. The FAME program includes the exercises which are all done by participant itself on complete weight bearing. These exercises increases muscle strength and increases aerobic capacity and improves mobility which makes participant independent in the community.[19] The FAME program was developed as a group program to minimize resources. In addition, the participants reported that the group setting was motivating, socially stimulating and a key aspect that enhanced their adherence to the program. However some centers have utilized the FAME program as an inpatient or an outpatient based group program and as an adjunct to regular one-on-one therapy.

In present study the objective is to find out the effectiveness of supervised FAME program in young adults with stroke on cardiorespiratory fitness by using 6 minutes walk test (6MWT), functional mobility by using timed up go(TUG) test and muscle strength(hamstrings torque) by using peak torque in isokinetic analyzer.

The 6-minute walk test (6MWT) was used to assess mobility. The distance walked in 6minutes was recorded. The 6MWT has been shown to be a reliable method of assessing walking performance in individuals with stroke. The interrater intraclass correlation coefficients (ICCs) for 6minute walk test were 0.85($p < 0.0007$). The intrarater ICCs were ($p < 0.0003$).[20]

The timed up and go test is a simple and quick functional mobility test that requires the subject to stand up, walk three meters, turn, walk back and sit down.The TUG test showed excellent reliability (ICC>.95). The TUG scores were reliable, were able to differentiate the patients from the healthy elderly subjects, and correlated well with plantar flexor strength, gait performance, and walking endurance in subjects with chronic stroke.[21]

Isokinetic analyser is a valid and reliable tool to asses muscle's peak torque at different angles. Concentric knee muscle strength measurements in chronic stroke patients has also been found to be highly reliable (intraclass correlation coefficient, ICC2,1, .89 to .94; the standard error of measurement, SEM%, 7% to 12%; the smallest real difference, SRD%, 26% to 48%).[22]

METHODOLOGY

Participants were recruited from out patient's physiotherapy department and inpatients in neurology and general wards in SVIMS hospital. All potential participants were first screened based on the following inclusion criteria : Stroke subjects single time stroke; Stroke subjects first episode of infarct or haemorrhage stroke confirmed with CT and MRI scan; Stroke duration ≥ 6 months; Stroke subjects with age 30 – 45 years; Stroke subjects with both the genders; Stroke subjects with both sides hemiplegia; Stroke subjects with grade ≤ 2 spasticity of modified ashworth scale (mainly in lower limbs).Exclusion criteria were Stroke subjects with Perceptual and Visio-spatial disorder; Stroke subjects with Serious cardiac disease (eg; myocardial infarction);Subjects with Musculoskeletal and neurological conditions other than stroke. Stroke subjects who are non co – operative patients. The participants were undergone simple randomized sampling by giving a block number to each patient & randomized into two groups that is intervention and control group. Then there were required to provide informed and written consent.

Study design: A randomized controlled trail, prospective experimental design with pre-test and post-test design.

Study sample: 30 stroke subjects who are fulfilling with inclusive criteria.

Materials: Arm rest chair, stepper, stop watch.

Duration of the study: 6 weeks (5 days in a week)

Outcome measures: All the three outcome measurements are measured initially before the intervention and 6 weeks of intervention in both the groups.

- 6Minutes walk test was used to evaluate the cardio respiratory fitness.
- Timed up go test to measure functional mobility
- Isokinetic analyzer to asses' peak torque of hamstrings muscle.

Picture-1

Boidex isokinetic

INTERVENTION:

Experimental group: Conventional physiotherapy, followed by supervised FAME protocol. (In the presence of therapist or caregiver) for 8 weeks (3 sessions per week). FAME Protocol includes Warm-up for 5 minutes: slow marching, slow marching and swinging arms, knee circles, ankle circles. Stretching's for 5 minutes & 3 stretches on each side; Trunk side stretch, Trunk and head rotation stretch, Calf muscle stretch, Thigh muscle stretch, Buttocks muscle stretch, Hamstrings muscle stretch. Functional strengthening for 15 minutes: Start with 2 sets of 5 reps and increase gradually to a maximum of 3 sets of 10 reps, Heel-toe raises, Chair push-ups, Sit-to-stand, sit to stand and walking around the chair, wall pushups, wall sits. Balance exercises for 15 minutes: Slow weight-shifts, Forward reach, Heel to toe standing, Heel to toe walking, Standing on one leg. Agility and Fitness for 15 minutes: Front stepper to back stepper, Side Stepper, Traveling side & forward step, Fast Marching, Quick weight-shift & followed by Cool-down – 5 minutes: Can repeat any of the warm-up or stretching exercises.

Conventional physiotherapy includes Stretching's to spastic group of muscles of lower limb – Quadricep's, Hamstring's, Calf muscle. Electrical stimulations to weaker group of muscles of lower limb–Dorsiflexor's muscles. Strengthening exercises to lower limbs- Quadricep's, hamstrings, abductors, adductors, dorsiflexor's. Free exercises and active movements to lower limbs – flexion, extention, abduction, adduction movements of hip, flexion, extension of knee, dorsiflexion, plantarflexion of ankle. Weight bearing exercises to lower limb – squats, single leg standing.

Control group: conventional physiotherapy with Home program exercises with printed FAME material.

Evaluation of cardio respiratory fitness: By the 6 Minutes Walk Test (6MWT).

The subject was taken into an enclosed, quiet hallway which had a 30 meters corridor. The cones were placed at the beginning and end of the 30 meter boundary to indicate turns. The subject was asking to walk in the corridor in his or her own speed. Distance was measured in meters over 6 minutes. If subject felt any discomfort, he or she was instructed to stop the walk and take rest. Normal 6 minute walk distance in healthy adults had been reported to range from 400 – 700 meters.

Evaluation of functional mobility: By the Timed up Go test (TUG test)**.**

The subject were instructed to sit correctly in a chair with arms, the subject's back should rest on the back of the chair. The chair was made to be stable and positioned such that it will not move when the subject moves from sitting to standing. Place a piece of tape or other marker on the floor 3 meters away from the chair so that it is easily seen by the subject. Before starting the test, the subject was given clear explanation about the test. "On the word *GO* you will stand up, walk to the line on the floor, turn around and walk back to the chair and sit down. Normal healthy elderly usually complete the task in ten seconds or less. Very frail or weak elderly with poor mobility may take 2 minutes or more. Interpretation < 10 seconds = normal. < 20 seconds = good mobility, can go out alone, mobile without a gait aid. < 30 seconds = problems, cannot go outside alone, requires a gait aid. A score of more than or equal to fourteen seconds has been shown to indicate high risk of falls.[23]

Evaluation of hamstrings peak torque:

The subject was to sit comfortable on the seat of isokinetic analyzer, adjusted the chair according to subjects height. The stroke subjects were asked to place the hip and knee in 90^0 flexion ensuring to place the lateral condyle of femur in horizontal to the axis of isokinetic analyzers. The supporting straps are applied to thigh and calf muscle. In the monitor, the active knee eccentric and concentric protocol at the angular velocity of 60^0 and 90^0 was selected. The subjects were do active knee extension and flexion. First session was the trail session and it was followed by 3 sessions. Peak torque of hamstrings was noted during all the 3 sessions. The maximum peak torqueses are recorded as baseline values. After 6 weeks of intervention, again the peak torque values are recorded.

STATISTICAL ANALYSIS & RESULTS

Statistical analysis was done using "SPSS" version software. For this purpose the data was entered into Microsoft Excel spread sheet, tabulated and subjected to statistical analysis.

Out of 30 subjects, 15 were randomized into experimental group and 15 were randomized into control group. All the subjects completed the entire study protocol as defined as 8 weeks in training sessions.

Pre and post-test values of 6MWT were measured for cardio respiratory fitness. Pre and post-test values of TUG test were measured for functional mobility. Pre and post-test values of hamstring's muscle peak torque were measured for hamstrings muscle strength.

Variables within the groups were compared by using paired t test and between the groups by using independent t test. The difference between the pre-test and post-test scores and 95% confidence intervals for each outcome variable was reported.

A demographic characteristic of subjects with stroke is shown in Table-1. The mean age of subjects in control group (n= 15) was 43.4 and experimental group was 44.5. The statistics shown that there were no statistical significance between control and intervention group.

Table -1
Demographic data of control and experimental group results

Variable	Control group (n = 15)	Experimental group (n = 15)
Sex, n	9M/6F	7M/8F
Age (mean), yrs	43.4	44.5
Side of paresis, n	8R/7L	10R/5L
Modified Ashworth Scale (mean ± SD)	1.8(0.25)	1.4(0.35)

M – Male, F – Female, R – Right, L – Left, SD – Standard Deviation, 6MWT – 6 Minute Walk Test.

Control group:

Table-2

Analysis of control group with pre and post intervention

parameter	N	Mean	S.D	t – value	Df	P – value
6MWT pre **Post**	15 15	91.667 98.4667	11.44344 11.46963	12.75884	14	<0.001
TUG test pre **Post**	15 15	30.3333 25.8667	6.286796 5.80476	12.75984	14	<0.001
Peaktorque-60 **Pre** **Post**	15 15	13.98 14.90667	1.22951792 1.58901	3.60583123	14	<0.001
Peaktoque-90 **Pre** **post**	15 15	11.56 12.1267	1.028036 1.168923	6.310534	14	<0.001

6MWT – 6 Minute Walk Test, TUG test – Timed up Go test, SD- Standard Deviation, DF – Degrees of Freedom.

6MWT result: pre & post intervention values of 6MWT were compared by using paired sample t-test. The p-value is <0.001 which shows there is a extremely significant difference. The t- test value is 12.75884 with 14 degrees of freedom. It is observed that the post intervention had significant impact on the subjects.

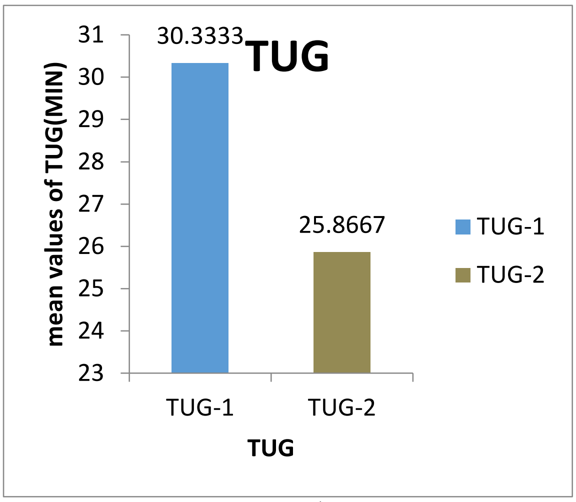
TUG test result: pre & post intervention values of 6MWT were compared by using paired sample t-test. The p-value is <0.001 which shows there is a extremely significant difference. The t- test value is 12.75984 with 14 degrees of freedom. It is observed that the post intervention had significant impact on the subjects.

Peaktorque-60^{o}: pre & post intervention values of 6MWT were compared by using paired sample t-test. The p-value is <0.001 which shows there is a extremely significant difference. The t- test value is 3.60583123 with 14 degrees of freedom. It is observed that the post intervention had significant impact on the subjects.

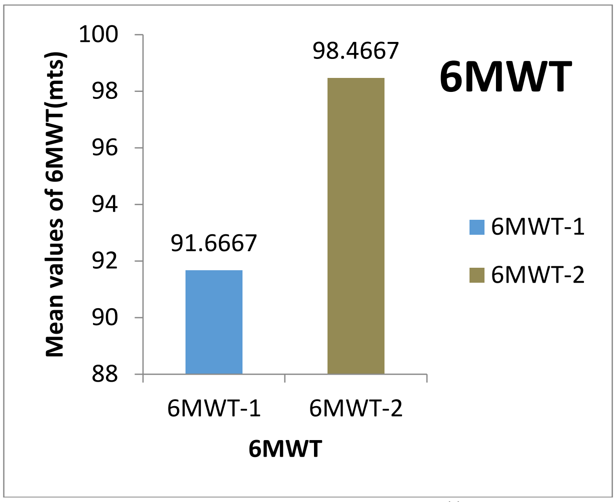
Peaktorque-90^{0}: pre & post intervention values of 6MWT were compared by using paired sample t-test. The p-value is <0.001 which shows there is a extremely significant difference. The t- test value is 6.310534 with 14 degrees of freedom. It is observed that the post intervention had significant impact on the subjects.

Graph-1

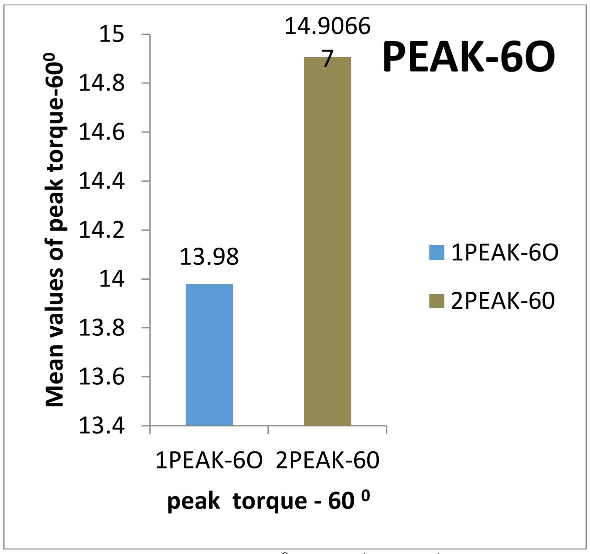
Graphical representation of pre and post-test values 6MWT, TUG, PEAK TORQUE-60^0,90^0 of control group.



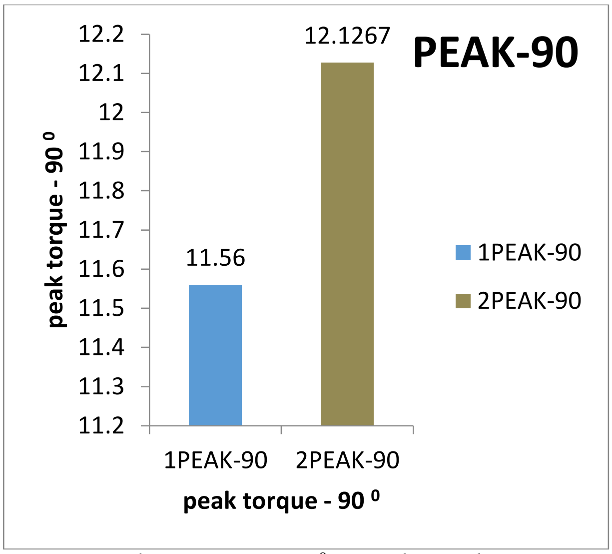
TUG- timed up go



6MWT- 6 minutes' walk test



torque at 60^0 angular velocity



peak torque at 90^0 angular velocity

Experimental group:

Table- 3

Analysis of experimental group with pre and post intervention.

parameter	N	mean	S.D	t-value	Df	p-value
6MWT						
pre	15	103.333	12.3427	14.2125	14	< 0.001
Post	15	147.6667	19.35262			
TUG test						
pre	15	31.5333	4.340287	23.06707	14	< 0.001
Post	15	16.1333	2.79966			
Peaktorque 600						
Pre	15	16.5733	1.842152	6.090221	14	< 0.001
Post	15	21.14	2.898719			
Peaktorque 900						
Pre	15	13.3733	1.854518	16.23491	14	< 0.001
post	15	15.9067	2.077934			

6MWT – 6 Minute Walk Test, TUG test – Timed up Go test, SD- Standard Deviation, DF – Degrees of Freedom.

6MWT result: pre & post intervention values of 6MWT were compared by using paired sample t-test. The p-value is <0.001 which shows there is a extremely significant difference. The t- test value is 14.212514 with 14 degrees of freedom. It is observed that the post intervention had significant impact on the subjects.

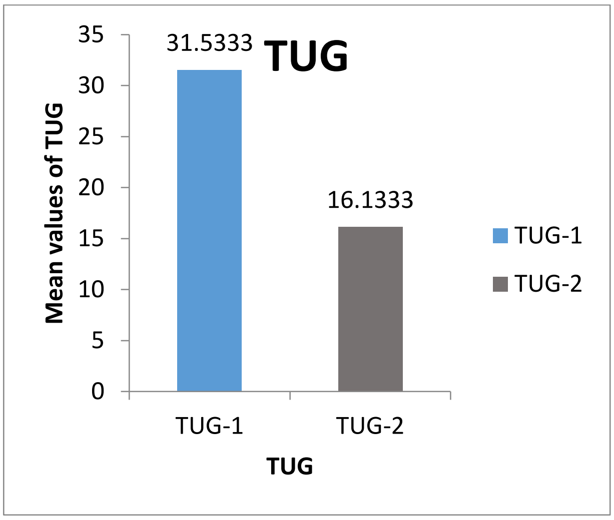
TUG test result: pre & post intervention values of 6MWT were compared by using paired sample t-test. The p-value is <0.001 which shows there is a extremely significant difference. The t- test value is 23.06707 with 14 degrees of freedom. It is observed that the post intervention had significant impact on the subjects.

Peaktorque-60^o: pre & post intervention values of 6MWT were compared by using paired sample t-test. The p-value is <0.001 which shows there is a extremely significant difference. The t- test value is 6.090221 with 14 degrees of freedom. It is observed that the post intervention had significant impact on the subjects.

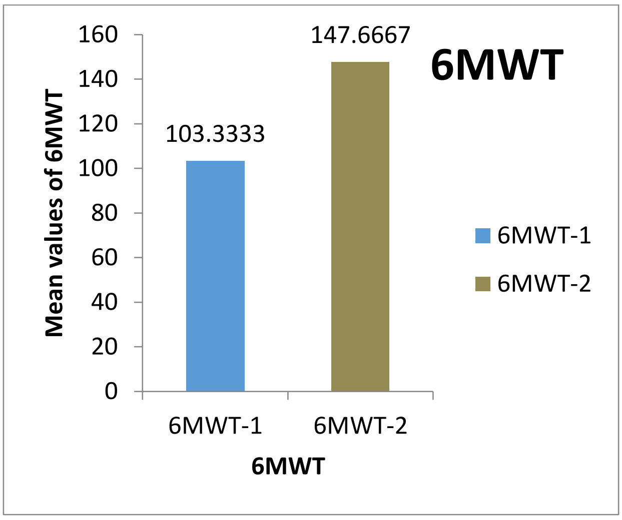
Peaktorque-90^0: pre & post intervention values of 6MWT were compared by using paired sample t-test. The p-value is <0.001 which shows there is a extremely significant difference. The t- test value is 16.23491 with 14 degrees of freedom. It is observed that the post intervention had significant impact on the subjects.

Graph-2

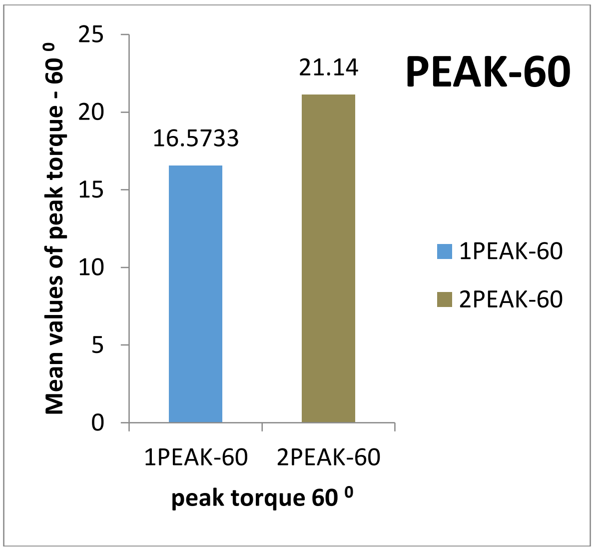
Graphical representation of pre and post values of experimental group:



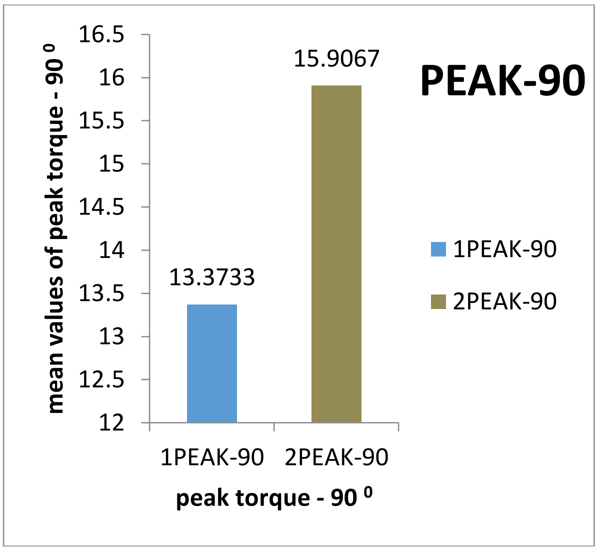
Timed up go test



6MWT – 6 minutes walk test



Peak torque at 60^0



peak torque at 90^0

Table- 4

Comparison of between the groups of control and experimental group

parameter	N	Mean	S.D	t- value	DF	p-value
6MWT						
Exp	15	44.3333	12.08108	11.836	28	< 0.01
C0ntrol	15	6.8000	2.21037			
TUG						
Exp	15	15.4000	2.58567	14.504	28	< 0.01
Control	15	4.4667	1.35576			
Peaktorque-60^0						
Exp	15	4.5567	2.90410	4.592	28	< 0.01
Control	15	0.9267	0.99532			
Peaktoque-90^0						
Exp	15	2.5333	0.60434	10.924	28	< 0.01
Control	15	0.5667	0.34778			

6MWT – 6 Minute Walk Test, TUG test – Timed up Go test, SD- Standard Deviation, DF – Degrees of Freedom.

6MWT Results: To compare the results of between the group of control & experimental groups, the unpaired t- test was selected. The p-value is 0.0030, the difference is considered very significant. The values of 6MWT are improved in control group as well as experimental group, but the improvement is more in experimental group.

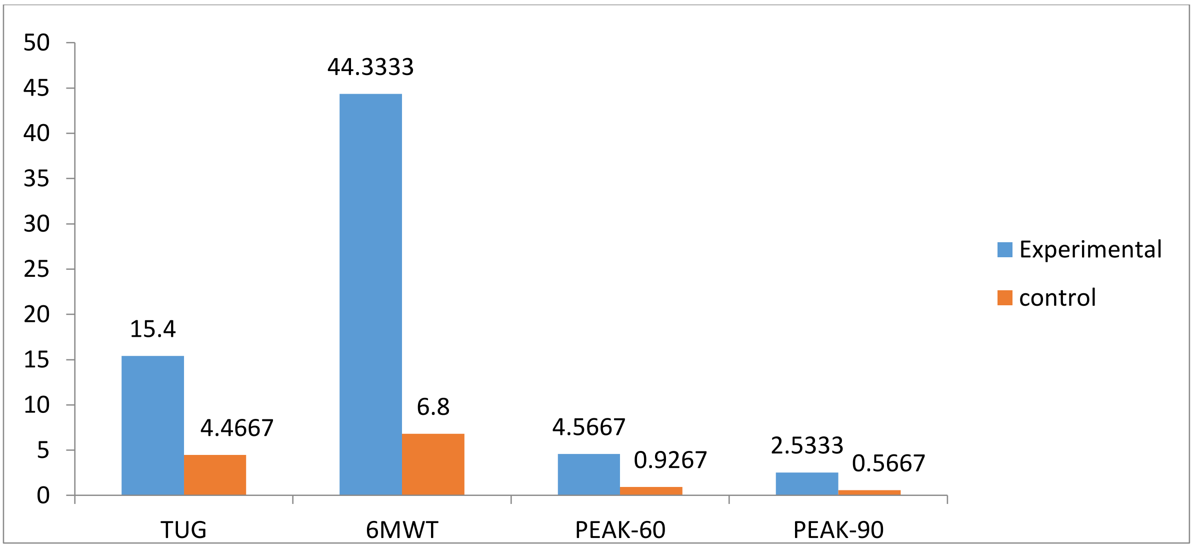
TUG test Results: The p- value is 0.0020, the difference is considered very significant. The values of TUG test are improved in control group as well as experimental group, but the improvement is more in experimental group.

Hamstring's peak torque-60^0: The p- value is 0.0005, the difference is considered very significant. The values of peaktorque-60^0 are improved in control group as well as experimental group, but the improvement is more in experimental group.

Hamstring's peaktorque-90^0: The p- value is 0.0005, the difference is considered very significant. The values of peaktorque-90^0 are improved in control group as well as experimental group, but the improvement is more in experimental group.

Graph- 3

Mean differences between experimental & control groups



TUG-Timed Up go, 6MWT-6Minutes Walk Test, peak-60^0,90^0-hamstrings peak torque.

DISCUSSION

The results of present study revealed that there is a significant difference in both control and experimental group which indicates that FAME protocol is effective in improving cardio respiratory fitness, functional mobility & hamstrings muscle peak torque. The proposed FAME program is feasible & beneficial for improving cardio respiratory fitness, functional mobility & lower limb muscle torque. FAME program provides a good model for community based fitness program for young adults with stroke.

Janice j.eng (2010) et al, In their clinical trail on FAME program, 5 month duration is needed to improve cardio respiratory fitness, functional mobility in stroke patients**.** The results of present study revealed that there is a statistical significant improvement in cardio respiratory fitness, functional mobility in young adults with stroke in 8 weeks duration. Young adults have fast gain in cardio respiratory fitness, functional mobility & hamstring's peak torque than compared to older adults.

A. Yelnik et al done an observation study on 155 stroke patients, the over activity of quadriceps & planter flexors leads to gait disorders during stance & swing phase. These gait disorders further leads to make patients dependent on others & sudden falls, totally stroke patients functional capacity is decreased. The present study results in statistically significant improvement in hamstrings torque which decreases the over activity of quadriceps & improves gait.

All the available studies on the FAME program reveals that this program is meant for older adults with chronic stroke. This present study gave an evidence that FAME program is more feasible and effective in improving cardio respiratory fitness, functional mobility & muscle torque in young adults with stroke.

In the supervised group, the extrinsic feedback was used. The extrinsic feedback was provided to the subjects with knowledge of result (KR) and knowledge of performance (KP) by therapist's verbal and tactile cuing during intervention. KR is the information, usually verbal, and it is about the response outcome (or) outcome of the movement. KP is the information about the movement pattern.

For example, in supervised group all the exercises in the protocol all the stroke subjects asked to do independently but they do the exercises with trick movements. At that time therapist was given verbal & tactile cues to avoid that trick movements. So, with the help of extrinsic feedback (KP & KR), the supervised group had a greater statistically improvement in all outcomes.

In supervised group, due to fatigue and pain during intervention, proper resting time and changing of exercises are advised. But the modifications of exercises are also done by the therapist when patient is not able to perform the protocol. In FAME protocol, subjects felt hard to do self stretchings and agility exercises.

In unsupervised group, due to poor adherence, (participating in less than half required time), there is no therapist or family member to explore the reasons behind the problems and lack of solutions for the problems.

The result of FAME protocol is better with the involvement of therapist of caregiver or who can assist with the exercise like track the amount of exercise, motivation to the patient, helping counting the repetitions, assist with positioning equipment.

Researchers noted that the motor cortex (M1) changes occurred (motor learning) when (a) New or novel task were used, (b) when movements were practiced together, (c) when movements were frequently and (d) when movements were important to the individual.

Our intervention program (FAME PROTOCOL), meets the above criteria which play a important role in motor learning. The supervised group, play a major role in motor learning and neural plasticity.

Hence, the use of verbal and tactile cues, verbal guidance, motivation, rewards and with proper feedback by the therapist helps in process of motor learning. Hence, this motor learning enhances the neural plasticity of the brain

The improvement in present outcomes in young adults with stroke makes them functionally independent in the community and reduces the disease burden on family.

CONCLUSION

Community based fitness program has been proven one of the effective methods of management for stroke related disabilities.

The present study aimed to assess whether there is any significant difference in the effectiveness of FAME protocol between supervised and un supervised in cardio respiratory fitness, functional mobility & hamstrings peak torque. On the above discussed & tabulated data & results after 8 weeks of intervention , it is concluded that both the supervised and unsupervised FAME protocol shown greater improvement in fitness, mobility & leg muscle strength in both intervention and control group but statistically significant improvement is seen in intervention group than compared to control group**.**

LIMITATIONS

- The sample is small
- This study was not done with acute patients.
- Homogeneity of the sample is compromised. i.e., due to incorporation at different stages of recovery.
- Time after onset of stroke of the clients is not similar.
- Carryover effect is not known.

RECOMMENDATIONS

- Further studies can be tried with acute stroke subjects.
- It can be done with large sample.
- Further studies need to investigate for the long term effects.

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