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A cross sectional study on dynamic balance in healthy young adults undergoing strength training at the gym and those not engaged in any form of exercise using star excursion balance test

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Abstract
Introduction: Balance is an integral component of almost every activity of daily living. And we also know resistance/weight training is said to improve muscle strength. The purpose of this study is to find if any non- specific protocol of strength training at the gym can further enhance dynamic balance in young adults with no balance impairment as compared to those who do not engage in any form of exercises.
Methodology: A cross- sectional study was carried out in various gyms on subjects who went to the gym for atleast 6 months and non-exercising subjects using Star Excursion Balance Test.
Procedure: Excursion values of 35 gym going individuals and 35 non-exercising individuals were recorded. Limb length were taken. Data analysis of calculated relative distances was done using unpaired t-test.
Results: Inter group comparison showed no statistical difference in the dynamic balance of both the groups.
Conclusion: According to this study, statistically no difference was revealed among both the groups however, clinically it was observed that individuals strength training at the gym had better dynamic balance in Posterior and Posteromedial directions than those not engaged in any form of exercise.

Keywords: dynamic balance, strength training, gym, young adults, star excursion balance test, reach distance, relative distance, limb length, muscle strength

1. Introduction

Balance is the key to all functional movement. This is an integral component of almost every activity of daily living. From standing on toes to reach something on the top shelf, walking up and down the stairs or walking on an irregular surface, running, swimming, bike riding and in many other daily activities balance is essential. Any impairment in balance will lead to decrease in performance and increases the risk of injury and fractures as a result of which daily activities may be impaired. Thus balance is of key clinical relevance to any rehabilitation/prophylactic physiotherapy program [1].

Strength training is a type of physical exercise specializing in the use of resistance to induce muscular contraction. During a workout, intense lifting causes microscopic tears to form in fiber and connective tissue of muscles. These tears fatigue the muscles and accumulate in large number. With proper rest and sufficient nutrients the muscles are slowly rebuilt over the following days. The ability of body to rebuild its muscles also increases size, strength, tone and muscle capacity. Ordinary old tissue is discarded before new tissue is used to synthesize new muscle [2] Underlying motors systems such as strength, flexibility and coordination are major components of balance.

Muscle strength, the force generation capacity of an individual reaches its peak in a second and third decade of life, shows an imperceptible decline later life [3] Humans lose 5 pounds of muscle every decade after the age of 30 [4] Also, postural sway increases with aging [3]. Hence, strength training administered during early adulthood can delay the degenerative effects on balance.

Gym is defined as a club, building, or large room, usually containing special equipment, where people go to do physical exercise and get fit [5]. Most gyms contain equipments for aerobic training like treadmill, elliptical/ cross trainer, static cycle or bike, etc. And equipments like dumbbells, barbells, kettlebells, lat pull-down, cable biceps bar, cable triceps bar, chest press, machine fly, bench press, horizontal seated leg press, leg extension, leg curl machine, seated calf machine, standing calf raise machine, back extension machine, etc. for weight training. Strength training exercises like barbell squats, dumbbell lunges, leg press, lying leg curls, leg extensions, standing calf raises barbell, deadlift, seated calf raises, back extensions, close grip barbell bench press, lat pull down, bicep curls with dumbbell or barbell, hammer curls, preacher curls, triceps cable extension, french curls, lateral upright, crunches, etc. are performed at the frequency of 3-4 days/week depending on one's capacity. And aerobic training is generally done for 30-90 minutes with frequency 2-4 days/week. Any gym protocol is not specifically designed for balance training.

In a study [6] titled "Effects of core stability training on dynamic balance in healthy young adults – A randomized control trial" there was statistically significant difference noted post intervention between the experimental and control group in all 8 directions. This improvement in reach

distance verifies the possibility & scope of improvement in dynamic balance of young adults who have no balance impairment.

There are many outcome measures to assess the balance but number of tests for evaluating the dynamic balance is very less. The standardized tests that are present for examining balance clinically, mostly put emphasis on the static balance, whereas many activity of daily living require dynamic balance. The majority of dynamic balance assessment tools e.g. functional reach tests and the berg balance scale, were developed specifically for pediatrics, geriatrics and neurological patients .There are very few practical methods like force plate analysis, modified bass test etc. for evaluating dynamic balance but due to the space and cost requirements associated with these devices, they are not affordable or practical for many clinical settings. Thus, a simple, reliable and valid method is needed to assess lower extremity functional performance [1].

Star Excursion Balance Test (SEBT) is a simple, reliable, cost effective screening test which is used to evaluate the dynamic balance in 8 selective directions to determine potential risk of injury. Reach distance values of SEBT can be used as an index of dynamic postural control.

The purpose of this study is to find if any non- specific protocol of strength training at the gym can further enhance dynamic balance in young adults with no balance impairment as compared to those who do not engage in any form of exercises.

2. Need of Study

- Studies agree that strength training leads to balance enhancement in neurologically intact adults.[3]
- Studies have revealed the positive effect of core stability training on dynamic balance in young healthy adults.[6]
- Any gym protocol is not specifically designed for balance training.
- No study has been done on healthy young adults undergoing strength training at the gym.
- The purpose of this study is to find if any non- specific protocol of strength training at the gym can further enhance dynamic balance in young adults with no balance impairment as compared to those who do not engage in any form of exercises.

3. Aim

To find the difference in dynamic balance in healthy young adults undergoing strength training at the gym and those not engaged in any form of exercise.

4. Objectives

1. To find the dynamic balance in healthy young adults undergoing strength training at the gym using Star Excursion Balance Test (SEBT).
2. To find dynamic balance in healthy young adults not engaged in any form of exercise using Star Excursion Balance Test (SEBT).
3. To find the difference in dynamic balance of healthy young adults undergoing strength training at the gym and those not engaged in any form of exercise using Star Excursion Balance Test (SEBT).

5. Review of Literature

1. Lilima Patel, Bibhuti Sarkar, Pravin Kumar *et al* (Aug, 2018) conducted a study on "Normative values of star excursion balance test in young adults: a cross sectional study."

Reach distance values of SEBT can be used as an index of dynamic postural control. However, despite its global use, there are currently no normative values available for the SEBT in healthy young adults.

Total 228 number of volunteers (114 male and 114 female) with mean age of male 21.45 ±2.37 and mean age of female 21.19 ± 2.02 were selected for the study and according to height and BMI normative values were recorded in both gender.

This study provides the normative values for SEBT of young adults for different gender, height and BMI strata. SEBT excursion values in young adults increases with increase in height in both male and female. It can be also concluded from the result of this study the values of SEBT excursion is more on right stance leg as compared to left stance leg in different heights in both gender. The SEBT excursion values in underweight volunteers have highest excursion values followed by normal, overweight and obese volunteers respectively.

2. Dhvani N Shah, Annamma Varghese (2014) conducted a study on "Effect of Core Stability Training on Dynamic Balance in Healthy Young Adults - A Randomized Controlled Trial".

The purpose was to study the effects of the core stability training on dynamic balance in healthy, young adults.

It was an interventional study, in which 60 healthy young adults were selected. They were randomly divided into two groups of 30 each, one being experimental group and other control group. Measurement of their height, weight, BMI and leg length was taken. Subjects in both the groups were assessed for core stability with pressure biofeedback unit (PBU) and dynamic balance using Star Excursion Balance Test (SEBT) pre and post intervention. Subjects in the experimental group underwent progressive core stability training program for six weeks (3days/week) and control group was refrained from any type of structured training program.

There was statistically significant improvement in core stability and dynamic balance of the experimental group after six weeks of intervention.

It is concluded that core stability training of six weeks duration is effective in improving dynamic balance in healthy, young adults.

3. In-Hee Lee, Sang-young Park (Jun, 2013) conducted a study on "Balance Improvement by Strength Training for the Elderly".

The purpose of this study was to investigate whether lower limb strengthening exercise leads to improved lower limb strength and balance function for the elderly.

From a total of 74 respondents, 50 subjects were randomly assigned to either a training group (n = 30) or a control

group (n = 20). The subjects ranged in age from 65 to 82 years. A randomized controlled trial compared the effects of strengthening exercise and balance function. Leg extension and lower curl exercises were performed during the 12-week study.
After training, the lower limb strength and balance of the individuals in the training group had significantly improved compared to the baseline.
Improvement in lower limb strength may lead to balance enhancement in neurologically intact older persons.

4. V. Mohammadia, M. Alizadehb, A. Gaieni (2011) conducted a study on "The Effects of six weeks strength exercises on static and dynamic balance of young male athletes"

This study was conducted to examine the effects of six weeks of strength training on static and dynamic balance in young male athletes.
Thirty 15-17 young male athletes with mean and SD (62.79±3.62 kg ∞171.1±4.46 cm) were divided into two groups (15 subjects for each group). SEBT and Romberg adjusted balance test was used before and after exercise programs to test balance. Strength exercise consisted, including: squat, leg extension, and calf raise, lunge, curl up.
The results showed a significant increase in static and dynamic balance in the group (P=0.001). A possible reason for increased balance in the experimental group maybe increasing strength muscle in lower extremity after exercise program, the process of decreasing disinhibition and stimulating of muscles' spindles during strength training.

6. Methodology
1. Study design Cross sectional study
2. Study type Observational study
3. Sample size 70
4. Sampling method Purposive sampling
5. Study population Young adults (18-25 years) undergoing strength training at the gym [Group A] and those not engaged in any form of exercise [Group B].
6. Study setting Gyms and houses in and around Pune.
7. Study duration 6 months

7. Criteria
Inclusion criteria (For Group A)
1. Consistently strength training at the gym for atleast 6 months.[7]
2. Berg balance score: 56.
3. Age:18-25 years.[6]
4. Both males and females.

Inclusion criteria (For Group B)
1. Not involved in any form of exercise.
2. Berg balance score: 56.
3. Age:18-25 years.[6]
4. Both males and females.

Common Exclusion criteria
1. Recent trauma or accident.
2. History of any lower limb injury (fracture/sprain/tear).
3. Undergone surgery involving lower limb.
4. History of dizziness/vertigo or pre-diagnosed inner ear disorder.
5. Visual impairment.
6. Any neurological, musculoskeletal or cardiovascular disorders affecting mobility.
7. Pregnant females.

8. Materials and Tools
1. Data collection sheet
2. Pen
3. Consent form
4. Sticking tape
5. Measuring tape
6. Coloured chalk
7. Protractor
8. Watch
9. Calculator

9. Outcome Measure
Star Excursion Balance Test (SEBT)
The Star Excursion Balance Test (SEBT) is a relatively simple, but somewhat time intensive, test used to measure dynamic balance, otherwise known as dynamic postural control. It measures dynamic balance by challenging subjects to balance on one leg and reach as far as possible in eight different directions.
Before the SEBT can be performed, a small amount of setup is required. Four strips of tape will be needed to be cut to a length of 6-8 feet each. Two pieces will be used to form a '+', with the other two being placed over top to form an 'x' so that a star shape is formed. It is important that all lines are separated from each other by a 45° angle. The goal of the SEBT is to maintain single leg stance on one leg while reaching as far as possible with the contralateral leg.
The person performing the test must maintain their balance on one leg, while using the other leg to reach as far as possible in 8 different directions. The person (standing on his/her left leg for example) must reach in 8 different positions, once in each of the following directions: anterior, anteromedial, medial, posteromedial, posterior, posterolateral, lateral and anterolateral.
The reliability of the SEBT ranges between r = 0.85-0.96 and intra-class correlation coefficients ranging from 0.67-0.87.[8]

10. Test Procedure

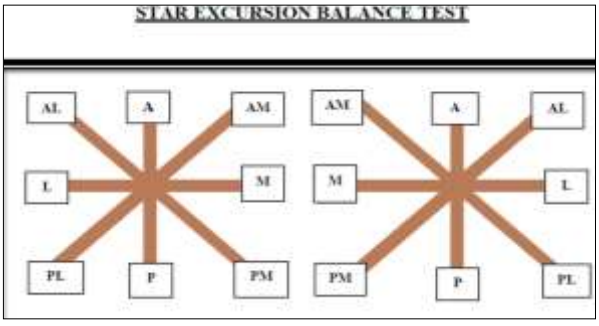

Fig 1: Sebt

- The subjects were asked to wear lightweight and non-restrictive clothing and no footwear. The subjects were supervised to perform warm up exercises in the form of 5 min walk at a self-determined pace around research venue. A star like pattern was drawn on the floor in eight directions i.e. anterior (A), posterior (P), medial

(M), lateral (L), anteromedial (AM), anterolateral (AL), posteromedial (PM), posterolateral (PL) and each of the line is 45º apart from each other by a protractor. The evaluator demonstrated the test to all the subjects. The subjects had to place one foot in the middle of the star pattern and with another foot reach as far as possible and lightly touch the line with their big toe before returning back to the starting position. With a chalk, the researcher marked the spot at which the subject touched the line. Data was collected by measuring the length of reach (linear distance) with a measuring tape in all eight directions. The linear distance was measured to the nearest 0.5 cm from the center spot after the test to calculate the reach distance of each reach direction. When using the right foot as the reaching foot and the left leg to balance, the subject completes the circuit in a clockwise fashion and when balancing on the right leg, the volunteer performs the circuit in an anti-clockwise fashion. The subjects were instructed to repeat this process for a total of 3 times in each direction by both feet. They were given 15 seconds of rest between the reaches. The average of the 3 reaches for each leg in each of the 8 directions was calculated. Trial was discarded and repeated when the subject- a) Does not touch the line with the reach foot while maintaining weight bearing on the stance leg. b) Lifts the stance foot from the center grid. c) Loses balance at any point in the trial. d) Is not able to maintain start and return positions for one full second. e) If a subject judged by the examiner touches the ground with the reach foot in a manner that caused the reach leg to considerably support the body.

- After completion of the test all reach distance of SEBT performance were measured for both the right and left leg and average reach distance was calculated by using the following simple equation:
  Average distance in each direction (cm) = Reach 1 + Reach 2 + Reach 3 / 3[9]
- Leg length was taken.
- Calculation of dynamic balance was done in all 8 directions by the formula :

Relative (normalized) distance in each direction (%) = (average distance in each direction / leg length * 100). [9]
These calculations should be performed for both the right and left leg in each direction, providing a total of 16 scores per subject.

11. Study Procedure

The study began after the approval from the ethical committee of Pes Modern College of Physiotherapy, Shivajinagar Pune -5.

- Study was conducted in and around Pune. Subjects were selected based on inclusion and exclusion criteria and divided into two equal groups (A & B).
- The subject were explained about the study in detail and consent was taken from the subjects who wish to participate in the study.
- Data of SEBT values was recorded in all subjects.

(a) (b)

Fig 2: (a) and (b) Subject performing SEBT

12. Data Analysis

- Dynamic balance in 8 directions of both limbs was assessed using Star Excursion Balance Test.
- Limb length was taken.
- Relative distances of each leg in 8 directions was calculated.
- Data was entered in Microsoft excel 2016, tabulated and analyzed using Primer software.
- The data passed the normality test.
- The data was then subjected to statistical analysis using unpaired t-test.

Table 1: Mean age of the subjects, number of males and females in each group.

	Group A	Group B
Mean age	21.86	22.23
Males	15	3
Females	20	32

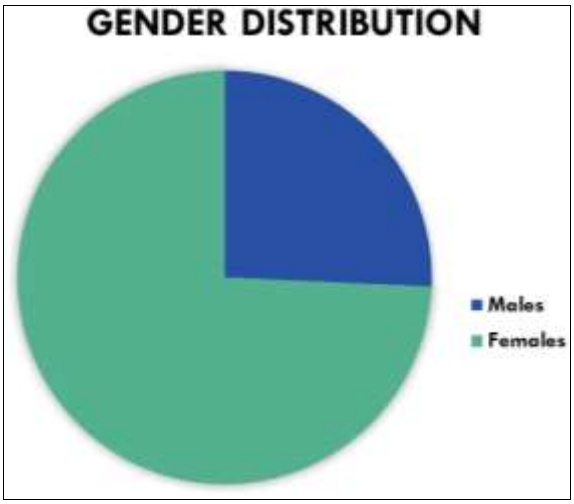

Fig 4: Gender distribution of subjects.

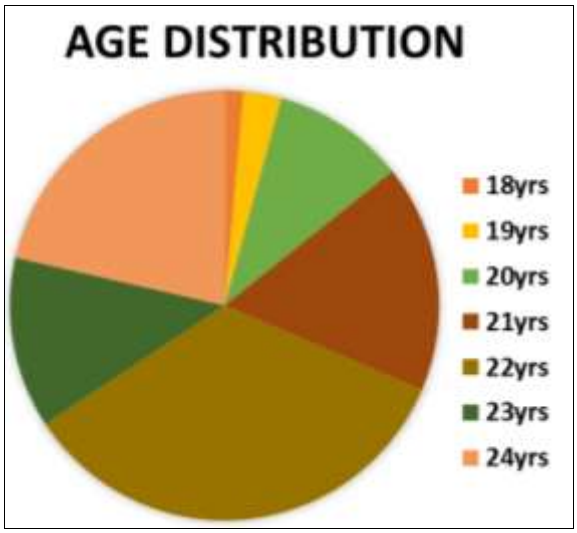

Fig 5: Age distribution of subjects.

13. Statistical Analysis

- The data was collected for group A and group B using outcome measure Star Excursion Balance Test.
- The data passed the normality test.
- The relative distances in 8 directions of right leg of group A with right leg of group B was compared and analysed using unpaired t-test.
- Similarly, the relative distances in 8 directions of left leg of group A with left leg of group B was compared and analysed using unpaired t-test.

Table 2: Intergroup comparison of excursion values of right side.

RIGHT	group	mean	SD	T value	P value	significance
A	A	75.55	8.555	1.361	0.178	Non- significant
	B	72.68	9.088			Non- significant
AL	A	79.17	8.899	0.748	0.457	Non- significant
	B	77.51	9.696			Non- significant
L	A	78.19	9.085	0.705	0.483	Non- significant
	B	76.56	10.27			Non- significant
PL	A	79.83	10.73	1.135	0.261	Non- significant
	B	76.84	11.32			Non- significant
P	A	74.53	12	1.583	0.118	Non- significant
	B	69.92	12.37			Non- significant
PM	A	69.35	12.39	1.556	0.124	Non- significant
	B	64.78	12.17			Non- significant
M	A	57.51	9.105	0.906	0.368	Non- significant
	B	55.4	10.37			Non- significant
AM	A	67.99	8.008	0.598	0.552	Non- significant
	B	66.72	9.719			Non- significant

Table 3: Intergroup comparison of excursion values of left side.

LEFT	group	mean	SD	T value	P value	significance
A	A	74.61	10.07	0.277	0.783	Non- significant
	B	73.97	9.367			Non- significant
AL	A	79.17	10.03	0.396	0.694	Non- significant
	B	78.23	9.817			Non- significant
L	A	78.56	10.24	1.225	0.225	Non- significant
	B	75.73	9.058			Non- significant
PL	A	78.21	11.93	0.982	0.33	Non- significant
	B	75.61	10.16			Non- significant
P	A	72.39	11.55	1.073	0.287	Non- significant
	B	69.42	11.58			Non- significant
PM	A	68.8	10.85	1.067	0.43	Non- significant
	B	63.28	11.49			Non- significant
M	A	56.23	8.982	0.264	0.793	Non- significant
	B	55.64	9.926			Non- significant
AM	A	66.97	8.606	0.664	0.509	Non- significant
	B	65.52	9.616			Non- significant

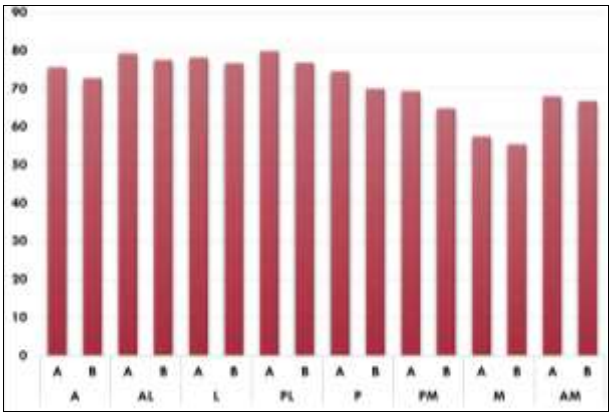

Fig 6: Mean of Right Limb

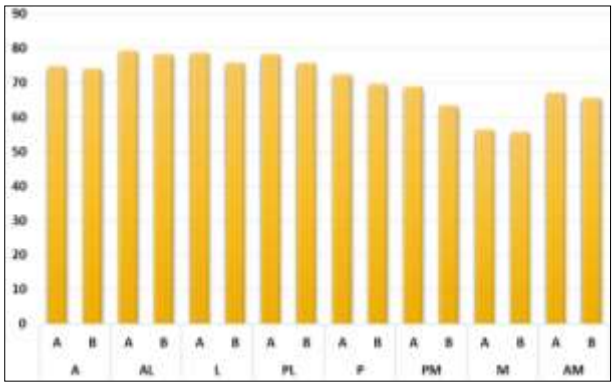

Fig 7: Mean of Left Limb

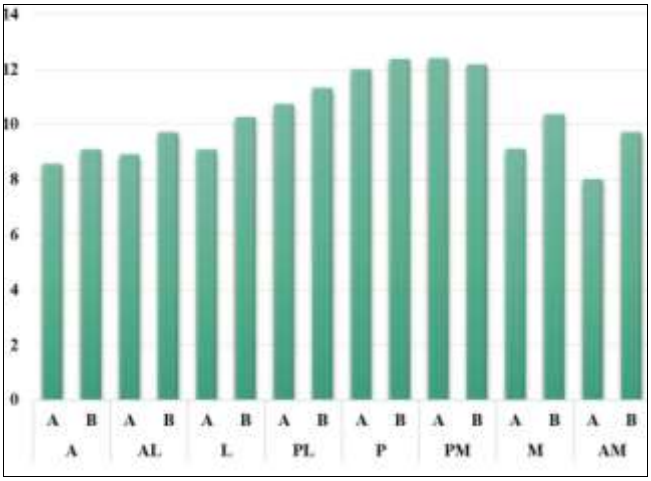

Fig 8: Standard Deviation of Right Limb

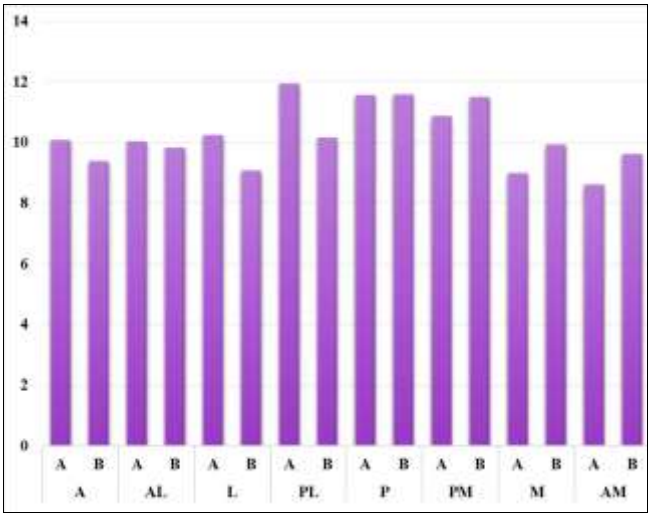

Fig 4: Standard Deviation of Left Limb

14. Result

The statistical analysis reveals no significant difference of dynamic balance among those undergoing strength training at the gym and those not engaged in any form of exercise.
The p value of relative distance in all 8 directions is > 0.1

15. Discussion

- The objective of this study was to find the difference in dynamic balance of healthy young adults undergoing strength training at the gym and those not engaged in any form of exercise using Star Excursion Balance Test (SEBT).
- 35 participants going to gym and fulfilling the inclusion criteria were assessed for their dynamic balance using star excursion balance test. Similarly, 35 participants not undergoing any form of lower limb strength training after fulfilling the inclusion criteria were assessed for their dynamic balance using star excursion balance test. The maximum distance reached by the subject was noted. Each subject performed same test for 3 times and an average reading was noted. This average distance reached by the subject was then divided by the leg length of the subject and a relative distance was calculated. Relative distances of each leg in 8 different directions were calculated similarly for every subject.
- The results of the study shows that there is no significant difference in dynamic balance of healthy young adults undergoing strength training at the gym and those not engaged in any form of exercise.
- Postural alignment, static balance, dynamic balance and reactive control highly depend on:

a. Underlying sensory systems such as vision, vestibular, sensation
b. Underlying motor systems such as strength, flexibility, co-ordination
c. Underlying cognitive contributions attention, fear, confidence

- The other factors were not assessed during the study which could be majorly influencing dynamic balance owing to which significant difference may not be noted.
- Studies have shown improvement in strength training in individuals with neurological impairment, geriatrics[3]. But the population studied was healthy young adults (18-24 years) & as a research suggests the force generation capacity of an individual reaches its peak in a second decade of life, shows an imperceptible decline later life. Humans lose 5 pounds of muscle every decade after the age of 30.
- According to this study, strength of muscle isn't large contributor in dynamic balance of young adults.
- The significant result may also be due to ineffective dose of the training programme or inadequate compliance with the training programme.

16. Conclusion

The study states that there is no significant statistical difference in dynamic balance of healthy young adults undergoing strength training at the gym and those not engaged in any form of exercise.
However, clinically it was observed that individuals strength training at the gym had better dynamic balance in Posterior and Posteromedial directions than those not engaged in any form of exercise.

17. Limitations

- Small sample size.
- Gender distribution not equal.
- Gym protocol not monitored.

18. Future Scope

- Other age groups can be considered.
- Difference between dominant and non-dominant leg was not considered.
- Different exercise groups like endurance training or resistance training can be considered.
- BMI can be considered in future study.

19. References

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