



# EFFECT OF PLYOMETRIC PUSH-UP EXERCISE ON UPPER LIMB PERFORMANCE AMONG PHYSIOTHERAPY STUDENTS

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**Abstract: BACKGROUND:** Push up is simple and widely use exercise for the human body. The name "plyometric" is a combination of the Greek words "Plio" and "Metric," which mean "to access" and "repeated sequence of stretch-shortening cycles". The physiotherapist job requires them to participate in activities that involve a lot of strength and endurance like passive or resisted exercise, transferring from bed, gait training etc. Also work with sports teams and players. More than 72 % of students they were suffering from musculoskeletal issues and poor endurance. **AIM AND OBJECTIVES:** To check the effect of Plyometric push-up exercise on strength, endurance, power, and dynamic stability among physiotherapy students. **METHOD:** An interventional study. The ethical approval was taken from KPGU, Vadodara. Total 34 participants were enrolled in the study based on inclusion and exclusion criteria. Written informed consent was taken. To assess muscle strength the 1RM bench-press and muscular endurance measured by counts the maximum number of push-ups. Power measured by SMBT, and dynamic stability measured by UQYBT. Pre outcome measure was taken. Warm-up and cool down exercises were done (5min stationary cycle, stretching exercise) after that plyometric push-up exercise done. Total 3 sets per week for 6-weeks duration. Then post outcome measure was taken. **RESULT:** Paired 't' test was applied to find statistical difference between 'Pre' and 'Post' reading of outcome variables (One min maximum push-up, 1RM, SMBT, UQYBT) using MedCalc software. P value of <0.05 consider statically significant. **CONCLUSION:** There is significant effect of upper extremity plyometrics push-up exercise on upper extremity strength, endurance, and dynamic stability among physiotherapy students. But there was no significant difference of power in plyometrics push-up pre and post-test.

**KEYWORDS:** Plyometric Push-up, Strength, Endurance, SMBT, UQYBT, Physiotherapy students

## INTRODUCTION

Push up is simple and widely use exercise for the human body. This exercise is popular because it can be done without any additional equipment and the intensity can be adjust through a variety of variations. Additionally, push-up can be used to test upper-body physical endurance<sup>2,3</sup>. Push-up is used to increase upper-extremity muscular strength and hypertrophy. Push-ups are good for the triceps, pectoralis major and minor, serratus anterior, abdominals, torso, and chest. Push-up enhance upper-body physical endurance, strength of muscles and bones, as well as build lean muscular mass, which boosts metabolism<sup>1,4</sup>.

Push-up with or without modifications, as well as quadruped, prayer, and tripod stances are examples of upper limb weight bearing exercises. These exercises designed to increase proprioception, joint stability, and strength<sup>5</sup>. The motion of the shoulder joint is a mix of extension and horizontal extension adduction, downward rotation, and decrease of lateral tilt during the eccentric phase push up. During the concentric phase is mix of shoulder flexion and horizontal flexion, with abduction, upward rotation, and lateral tilt at the shoulder girdle<sup>6</sup>.

Plyometric exercise, commonly known as the stretch-shortening cycle (SSC), uses rapid eccentric loading to create more concentric force<sup>7</sup>. The name "plyometric" is a combination of the Greek words "Plio" and "Metric," which mean "to access" and "repeated sequence of stretch-shortening cycles," which gives athletes the maximum amount of muscle force. For athletes participating in sports requiring quick, explosive movements, plyometric activities that target the stretch-shortening cycle can be employed as specialized training<sup>8,9</sup>. When elastic loading through an eccentric muscle contraction is supplied, a burst of concentric muscular contraction is noticed as a result of the stretch-shortening cycle<sup>9</sup>.

The plyometric concept is used in lower extremity (LE) and upper extremity (UE) sports as a component of practical movement patterns and ability when playing the sport. By using an eccentric (lengthening) action that is quickly followed by a concentric (shortening) movement, plyometric training makes use of the stretch-shortening cycle (SSC)<sup>10</sup>.

**Phase:****1. Eccentric Pre-Stretch:**

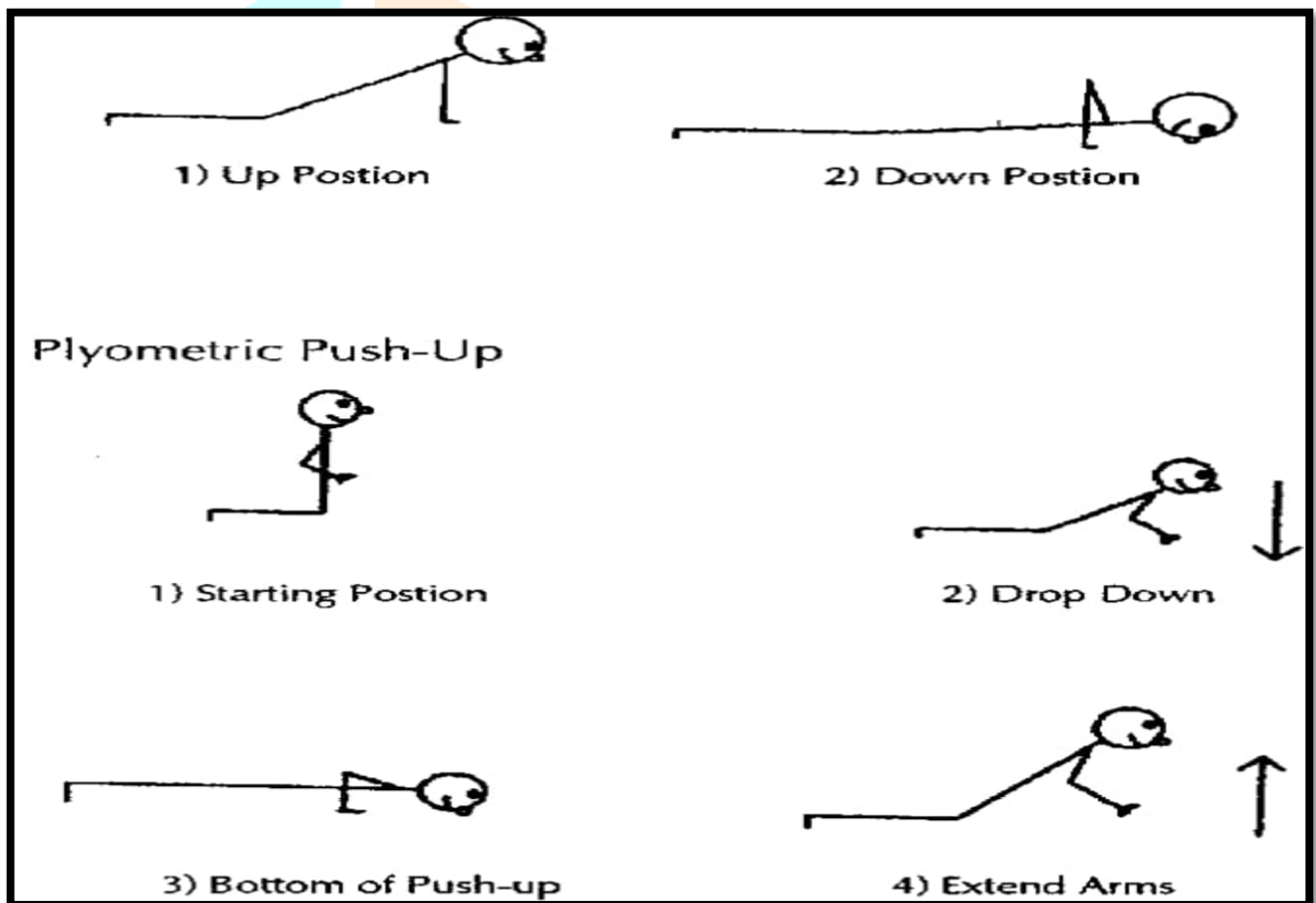
The preparation, pre-loading, pre-setting, preparatory, facilitatory, ready, potentiation, counterforce, or counter-movement phases have also been used to refer to the eccentric pre-stretch phase. The muscle spindle of the muscle-tendon unit and the non-contractile tissue within the muscle (series elastic components [SEC] and parallel elastic components [PEC]) are stretched during the eccentric pre-stretch phase of a plyometric exercise. The neurophysiological biomechanical response is a term that is frequently used to describe this activation of the muscle's structural elements. This eccentric pre-stretch increased the following concentric muscle contraction.

**2. Amortization (Time to Rebound):**

The interval between the end of the eccentric pre-stretch and the start of the concentric muscle activity is known as amortisation. The term "time to rebound" is preferred. This stage of plyometrics is also frequently referred to as the electro-mechanical delay stage. The amortisation phase is the interval between generating force and increasing muscular contraction and elastic recoil in the direction of the plyometric movement pattern and overcoming the negative effort of the eccentric pre-stretch. The effectiveness of plyometrics depends on this phase; the shorter the amortisation phase, the more powerful and effective the plyometric movement is because the stored energy is used. The stretch reflex is not engaged, the stored energy is lost as heat, and the concentric contraction's subsequent positive work is less efficient if the amortisation phase is delayed. Reduction of the time to the rebound phase is one of the main objectives of plyometric training.

**3. Concentric Shortening:**

The resultant power production performance phase is another name for the concentric phase. It is phase of plyometrics has sometimes been referred to as the facilitated or augmentation phase. These phases accurately explain what occurs during plyometric exercise. The biomechanical reaction, which makes use of the elastic qualities of the pre-stretched muscles, contributes to the final phase of the plyometric movement. To improve the muscle's ability to generate power, these three phases are combined to accomplish a plyometric movement<sup>10</sup>.



For athletes who throw overhead, upper extremity plyometrics have also been recommended as an important determinant of terminal recovery<sup>11</sup>. Plyometric push-up exercise necessary for optimizing stretch-shortening cycle-induced upper-body adaptations<sup>12</sup>. Increased foot heights in push up exercise enhance the good effect on shoulder complex stabilizer muscles such as the serratus anterior and the upper trapezius<sup>13</sup>.

The Upper Quarter Y-Balance Test (YBT-UQ) is design to evaluate stability in the upper quarter of the body. Examine the upper body's performance the YBT-UQ is a reliable test for unilateral upper limb in a position one of the closed chain<sup>14,15</sup>.

For a wide range of people, being able to move quickly with the upper body is important, and it helps considerably with daily tasks like reaching, pushing, and pulling, stabilizing, lifting, and pulling. The Seated Medicine Ball Throw (SMBT) has been used frequently in the studies to measure upper body explosive power<sup>15</sup>. In order to compare individuals to normative data and track changes over time in healthy, aged, and wounded populations, it is critical to be able to accurately measure upper body explosiveness<sup>16</sup>.

The maximal bench press strength test (1-RM) was use to assess upper body muscular strength, while the one-minute push-up test was use to assess muscular endurance counts the maximum number of push-ups<sup>15</sup>.The term "1RM" refers to the maximum

weight that can be lifted effectively using the whole range of motion. The approach is regularly used to assess upper body strength using fundamental such as the bench press<sup>17,18</sup>.

The physiotherapist job requires them to participate in activities that involve a lot of strength and endurance. Physiotherapists transferred patients from beds to wheelchairs, performed gait training, and provided passive and resistance exercise to patients of various shapes and sizes. Also work with sports teams and players. According a study by Mak et al. more than 50 percent of students reported to have musculoskeletal problems and low endurance. About 23 percent were underweight, according to their fitness levels<sup>19</sup>. According a study by Kapadia Sabnam et al. more than 72 percent of overall of students at KSPR, KPGU, Vadodara experience musculoskeletal problems<sup>33</sup>. Endurance is essential for physiotherapists during practical sessions and clinical training, even academic pursuits necessitate long periods of standing<sup>19</sup>.

## PURPOSE OF STUDY:

There are few studies on the effect push-up training on strength and endurance. The purpose of this study was to check the effect of Plyometric push-up exercise on the upper limb performance like strength, power, endurance, and dynamic stability among the physiotherapy students.

## METHOD

**STUDY SITE:** Krishna School of Physiotherapy & Rehabilitation (KSPR), Vadodara.

**STUDY POPULATION:** Physiotherapy students

**SAMPLE SIZE:** Sample size calculation was done by using G power software version 3.1.9.4 based on previous study concluded by Sadzali Hassan et al main outcome variable 1 min push up was taken into ( $X_1=33.82$ ,  $X_2=43.52$  AND  $SD_1=4.28$ ,  $SD_2=5.18$ ) the effect size came out to be 0.5 keeping  $\alpha$  error of 0.05 (95% confidence level)  $\beta$  error of 0.2 (80% power of study) the calculated sample size was<sup>34</sup>.

**SAMPLING METHOD:** Convenient sampling

**STUDY DURATION:** Study was conducted a period of 10-12 months after obtaining ethic approval.

**STUDY DESIGN:** Interventional study

### MATERIALS:

1. Consent form & Assessment form
2. Mat
3. Medicine ball
4. Bench press machine
5. Pen/Paper
6. Stopwatch / Measure tape/Chalk

### INCLUSION CRITERIA:

1. Students who willingly participate in study
2. Healthy College student
3. Male and female
4. Age between 18-25

### EXCLUSION CRITERIA:

1. A history of past shoulder pathology or surgery (Scapular Stabilization surgery, Impingement, Pain)
1. Shoulder or back region injury
2. Bone disease or joint disease (Juvenile arthritis, juvenile osteoporosis)
3. Any gymnastic activity (last 1 year)

### PLYOMETRIC PUSH-UP TRAINING PROTOCOL:

- Total 18 training sessions over a 6-week period.
- Three sets per week and with at least 48 hours rest between sessions.
- Each set 10 repetition for 3 sets. One push-up completes every 4 seconds.

### PROCEDURE:

- Plyometric push-up was from the kneeling position, with the knees and feet remains contact with the floor.
- Participants starts with their trunk vertical, and arms relaxed, hanging at their sides.
- From this position they fall forward, extending their arms forward with slight elbow flexion, in preparation for contact, then flexing the elbows and gradually stop the movement with the chest nearly touching the floor.
- Immediately reverse the action by rapidly extending her arms and propelling her trunk back to the starting position.
- If unable to return to the starting position a quadruped position use. It is like a clap push-up (without the hand clap).

**OUTCOME MEASURE:**

**1.1RM- BENCH PRESS**<sup>12</sup> (Reliability- 0.99):

**Purpose:**To assess strength of upper limb.

**2.1-MIN ENDURANCE**<sup>3,6</sup> (Reliability-0.48-0.99):

**Purpose:** To assess endurance of upper limb.

**3.SEATED MEDICINE BALL THROW(SMBT)**<sup>18</sup>(Reliability-0.97-0.99):

**Purpose:** To assess Power of upper limb.

**4.UPPER QUADRTER Y BALANCE TEST(UQYBT)**<sup>11,16</sup> (Reliability- 0.80-0.99):

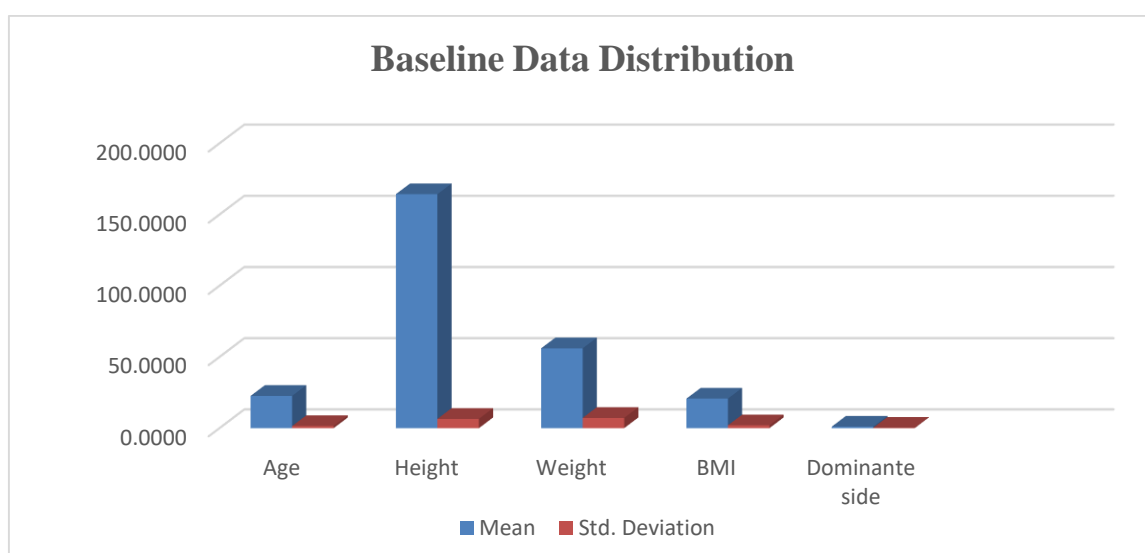
**Purpose:** To assess Dynamic stability of upper limb.

**RESULT****STASTICAL ANALYSIS:**

- Paired “t” test was applied to find statistical difference between ‘Pre’ and ‘Post’ reading of outcome variables (1RM Bench press, one min maximum push up, SMBT, UQYBT) using MedCalc software.
- P value of <0.05 was considered statistically significant

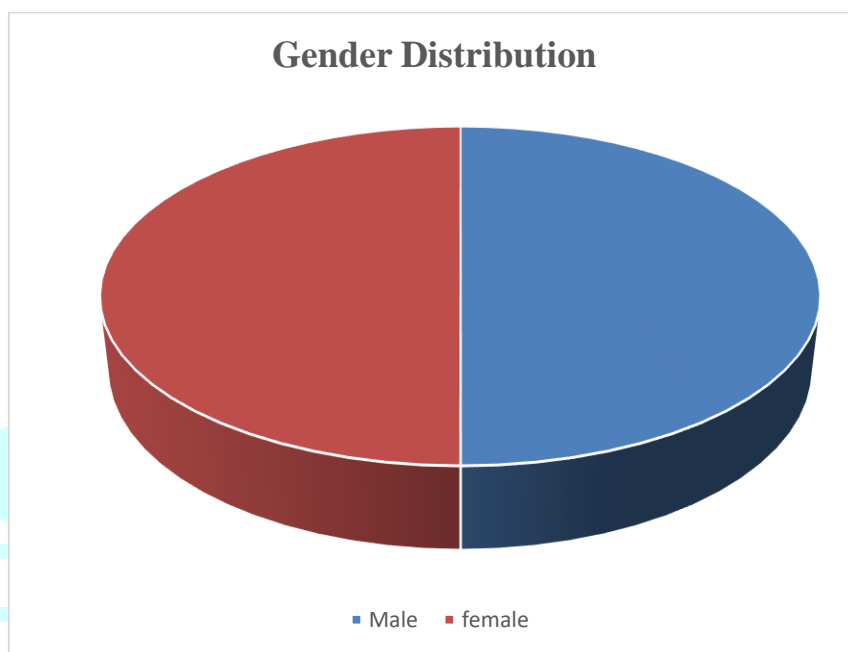
In this study, physiotherapy students at KSPR, KPGU, Vadodara were examined how plyometric push-up training influenced their capacity to use their upper extremities. A total of 34 people participated in the six-week study. The distribution of the participants' age, height, weight, and BMI is shown in Graph 1.1 and Table 1.1.

	Mean (n=34)	Standard deviation(n=34)
<b>Age (Years)</b>	22.64	0.24
<b>Gender</b>	1.50	0.50
<b>Height (cm)</b>	56.05	7.16
<b>Weight (kg)</b>	56.05	7.16
<b>BMI</b>	20.79	2.003



**Graph 1.1: Distribution of Baseline data of participants**

Graph 1.2 below shows the gender distribution of the 34 students who participated in the plyometric push-up exercise. Overall, there were 17 men and 17 women in this gender distribution.

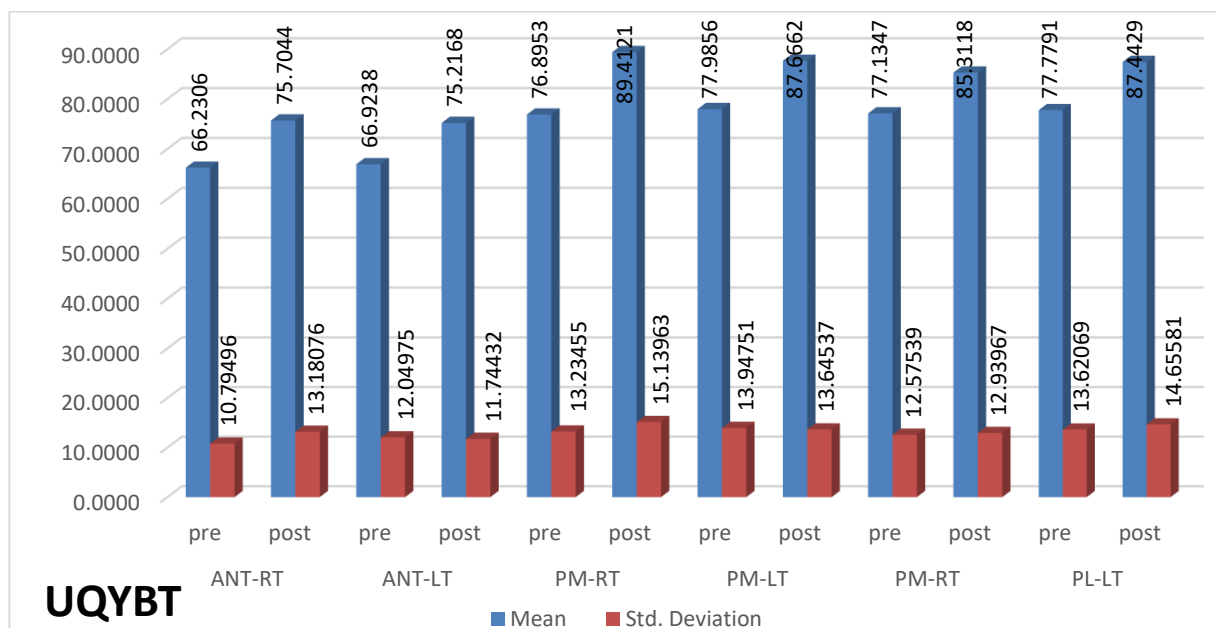


Graph 1.2: Gender distribution among Physiotherapy students

Table 1.3: UQYBT, SMBT, STRENGTH AND ENDURANCE DATA

		Mean	SD	t Value	P Value	Result
Anterior Right	Pre	66.2306	10.79496	7.361	0.0001	Significant
	Post	75.7044	13.18076			
Anterior Left	Pre	66.9238	12.04975	6.012	0.0001	Significant
	Post	75.2168	11.74432			
Posteromedial Right	Pre	76.8953	13.23455	6.665	0.0001	Significant
	Post	89.4121	15.13963			
Posteromedial Left	Pre	77.9856	13.94751	4.983	0.0001	Significant
	Post	87.6662	13.64537			
Posterolateral Right	Pre	77.1347	12.57539	5.904	0.0001	Significant
	Post	85.3118	12.93967			
Posterolateral Left	Pre	77.7791	13.62069	3.354	0.002	Significant
	Post	87.4429	14.65581			
SMBT	Pre	9.0364	23.03534	1.503	0.142	Not Significant
	Post	9.4317	22.91281			
Imin	Pre	19.6471	8.73822	11.592	0.0001	Significant

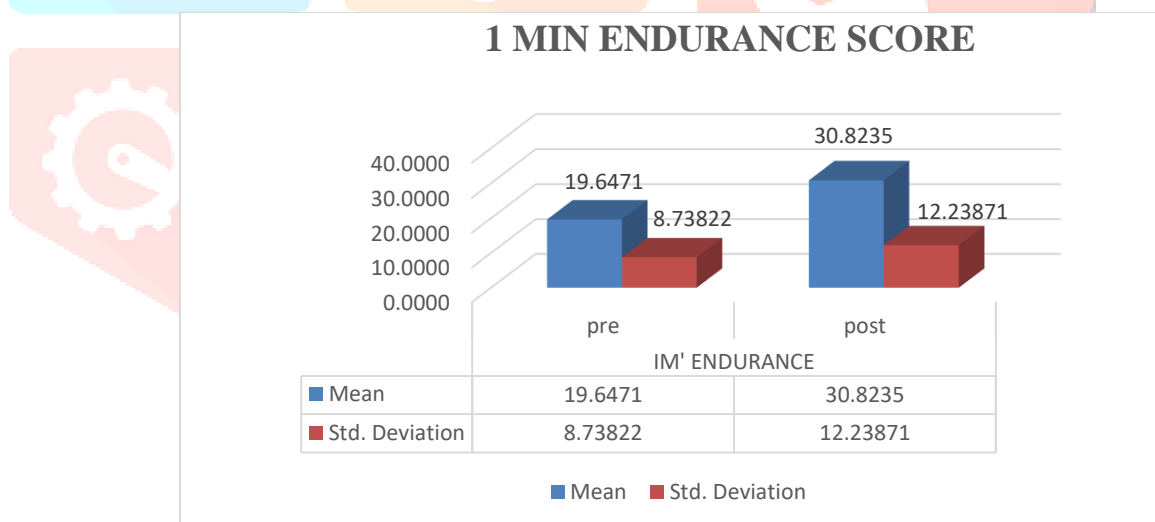
<b>Endurance</b>	<b>Post</b>	30.8235	12.23871			
<b>1RM</b>	<b>Pre</b>	37.7329	10.14864	8.744	0.0001	Significant
	<b>Post</b>	45.6544	10.74397			



**UQYBT**

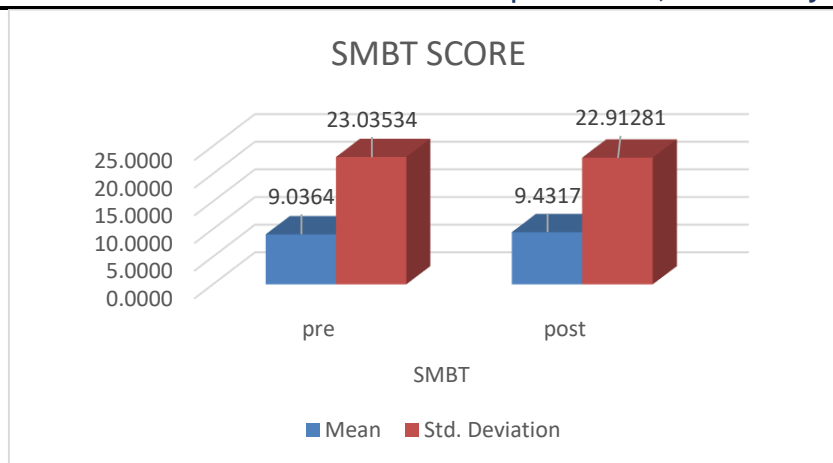
**Graph 4.1.4: UQYBT Pre-Post Score**

Graph 4.1.5 shows the results of a 1-minute push-up endurance test before and after the test, showing a significant difference.



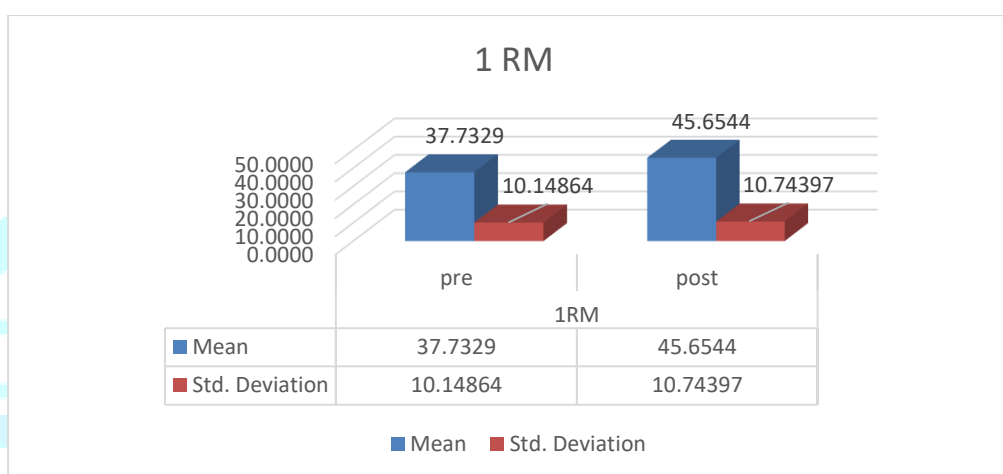
**Graph4.1.5: 1-Min Endurance test Pre - Post Score**

Graph 4.1.6 shows the score of SMBT, there is no significant difference between pre-post scores.



**Graph 4.1.6: SMBT pre-post score**

Graph 6 shows the 1RM score, which is significance difference between pre post data.



**Graph 4.1.7: 1RM Pre - Post Score**

## DISCUSSION:

The participants had to perform plyometric push-ups over the duration of eighteen training sessions, three per week, with rest of at least 48 hours. Each set consisted of ten repetitions and one push-up that was completed in under four seconds.

Thirty-four individuals were engaged in the study before receiving ethical permission from Krishna School of Physiotherapy & Rehabilitation (KSPR), KPGU, Vadodara. The study was based on inclusion and exclusion criteria. The average age was  $22.5 \pm 0.24$ . In this study, males and females made up fifty percent of the gender distribution. The average BMI was  $20.7 \pm 2.00$ . Written, informed consent was obtained. Participants were given information about the plyometric push-up intervention. A pre-outcome evaluation was done. There was warm-up exercise (5min stationary cycle, stretching exercise). Plyometric push-up exercise was given following post-outcome measures were taken for a period of six weeks.

The objectives of this study were to evaluate the effects of plyometric push-up exercise on the strength, endurance, power, and dynamic stability of physiotherapy students. In this study, strength was evaluated using a 1RM bench press machine, while endurance was evaluated using a 1-minute maximum push-up test. The power of the upper limb was measured using the UQYBT (Upper Quadrant Y Balance Test), and the dynamic stability of the upper limb was measured using the SMBT (Seat and Medicine Ball Throw) test.

### Effect of 1RM bench press test:

The main objective of this research was to evaluate upper limb strength using the bench press machine's 1RM test. A study by **Kevin Mccurdy et al. (2008)**<sup>21</sup> conducted two familiarisation sessions with both male and female athletes, chain-loaded resistance was used in the study to examine the validity and reliability of the 1RM bench press score, and it was found that scores between (0.90-0.99) were found as both valid and reliable. In the 1RM test, participants attempt a weight they were able to lift once while using their full effort. The participant then gradually raises the weight by 2.2 to 4.5 kg until they can lift the heaviest load possible, rest for 3-5 minutes between each attempt.

The pre-plyometric push-up exercise mean value in this study was 37.73 with a standard deviation of 10.14, and the post-plyometric push-up exercise mean value was 45.65 with a standard deviation of 10.74. As a result, this research showed that the bench press significantly increased strength and muscle size after a six-week plyometric push-up training period ( $p=0.0001$ ).

### Effect of Endurance test:

A study by **Lynn Fielitz et al. (2016)**<sup>3</sup> on the reliability of the test across and within assessors. The push-up test has been used by military groups since it is simple to administer and doesn't require any special equipment. The push-up test was thus employed in this study since it was a more effective method of evaluating endurance because of the lack of equipment.

### Effect of Dynamic stability test:

A study by **Paul Gorman** et al. (2012)<sup>14</sup> on upper quarter Y balance test: reliability and performance comparison across genders in active adults. The study showed that, when performance on the test was standardised to limb length, there was no difference in gender or side performance on the UQYBT (0.80 to 0.99), which measures upper extremity reach distance in a closed-chain position. Hence, in our study, this test was used to assess the dynamic stability for upper limb performance among physiotherapy males and females. 34 participants (17 men and 17 women) were tested three times for our study, and the average was calculated. Due to the difficulties of maintaining the plank position for many female participants and obese participants, UQYBT has difficult to do. Moreover, difficulties with stance arm were reported.

### Effect of SMBT test:

The study on the seated medicine ball throw as a test of power in the upper body in older persons was done by **Harris, Wattles**, et al. (2011)<sup>16</sup>. It may improve from a low-cost, simple-to-use field test of power in the upper body. The validity and reliability of the sitting medicine ball throw (SMBT), which measures the power on upper limb performance in physiotherapy students, were examined in this study (Reliability-0.97-0.99). 34 participants undertook 6 SMBT trials over the course of two testing days with two different ball masses (1.5 and 3.0 kg). In this study, men used a 1.5 kg medicine ball and women a 3 kg medicine ball. During this test, the 1.5 kg was likewise challenging for the female to throw. It demonstrates how little power women had. The SMBT values before ( $9.03 \pm 23.03$ ) and after ( $9.43 \pm 22.9$ ) and after have no differences. Hence, even after six weeks of plyometric push-up training, there was no visible difference in power ( $p=0.142$ ).

In present study, plyometric push-up exercise produced significant improvement in UQYBT, 1RM, 1min push up test in pre-post-test ( $p<0.001$ ). This suggest plyometric push was more effective in improvement upper limb Dynamic stability, strength, endurance. But there is no significant improvement in power (SMBT).

### Fitness among Physiotherapy students:

A study on physical activity level and physical fitness factors in physiotherapy study was carried out by **Belim Zishan Khan** et al. (2019)<sup>32</sup>. At Gujarat University, 100 male and female physiotherapy students between the ages of 18 and 24 participated in observational research (Ahmedabad). The amount of physical activity among students studying physiotherapy ranged from low to moderate. Hence, with the aid of this study, increase physical activity among physiotherapy students for the improvement of their quality of life, occupational injury prevention, and fitness for health.

The physiotherapist job requires them to participate in activities that involve a lot of strength, endurance, power, and the dynamic stability. Physiotherapists must do transferring patients, gait training work, Passive and Resistive exercise to patients of different BMI. Also work with sports teams', practical sessions and clinical training, even academic pursuits necessitate long periods of standing<sup>19</sup>. Most of students were suffering from musculoskeletal issues. To help physiotherapy students, improve their upper limb performance and prevent other musculoskeletal disorders caused by poor fitness and enhances their quality of life and productivity at work. They may employ this technique as part of their routine.

### CONCLUSION:

There is significant effect of plyometric push-up exercise on upper limb performance among physiotherapy student after six-week duration. Plyometric push-up exercise is effective in improve strength, endurance, and dynamic stability among physiotherapy students. This help to improve in upper limb performance among various population and different sports.

### LIMITATION

- Study was done with small sample size.
- Short-term Plyometric effect seen only.

### FUTURE SCOPE

- Study can be done individually in male and female.
- Study can be done in large sample size.
- Comparison can be done by including different games.
- Study can be conducted with variable sets and longer duration.

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