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Effectiveness of Plyometrics Versus Resistance Training Using Multigym on Lower Limb Musculature and Jump Performance Among Recreational Volleyball Players

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Abstract: ***Purpose**: The aim of this study was to compare the effects of plyometric training versus multigym resistance training on lower limb strength (measured by 1RM quadriceps and 1RM hamstrings) and jump performance (measured by the Sargent jump test) among recreational volleyball players. **Background**: Volleyball demands strong and explosive lower limb performance due to frequent jumping and rapid movements. Plyometric and resistance training are commonly used to enhance lower limb power and strength, yet limited research directly compares their effects in recreational volleyball players. This study seeks to address this gap by evaluating both training methods over a structured intervention period. **Participants**: Ninety male recreational volleyball players aged 18-25 years were recruited and equally divided into two groups: 45 players in the plyometric training group and 45 players in the multigym resistance training group. **Methodology**: The plyometric training group performed a program consisting of a 10-minute warm-up, 30 minutes of lower limb plyometric exercises, and a 5-minute cool-down. The multigym resistance training group followed a similar structure with resistance exercises targeting the quadriceps and hamstrings. Both groups trained regularly for 12 weeks, after which post-test measurements were recorded. **Analysis**: Pre- and post-training assessments were conducted to evaluate improvements in lower limb strength (1RM quadriceps and hamstrings) and jump performance (Sargent jump test). Comparative analyses between the two groups determined the relative effectiveness of each training program. **Results**: The plyometric training group showed significantly greater improvements in jump performance compared to the multigym resistance training group. In contrast, the multigym resistance training group demonstrated significantly greater gains in lower limb strength. **Conclusion**: Both training methods enhanced physical performance in recreational volleyball players. Plyometric training was superior for improving jump performance, while multigym resistance training was more effective for increasing lower limb strength. Training programs should therefore be tailored to match the specific performance goals of athletes.*

Keywords: Plyometrics, multi-gym, recreational volleyball players, 1 RM leg press, vertical jump test, jump performance.

1. Introduction

Volleyball has rapidly grown in popularity, with professional leagues and more intensive training schedules across many countries, involving hundreds of millions of players globally and making it an important focus for health and sports performance research [1, 2]. Injury rates range from 1.7 to 10.7 per 1000 player-hours, with lower-limb injuries—especially ankle sprains and knee problems—being the most common, and match play posing a greater risk than training sessions [3–6]. Similar patterns are observed in Asian countries like Japan and Iran, though differences in study methods limit comparisons [7, 8]. In India, limited data suggests an incidence of 2.6 injuries per 1000 hours, with ankle sprains accounting for 41% of cases [9, 10]. Although recreational players have fewer injuries than elite athletes, their large numbers create a substantial overall injury burden, often caused by non-contact jump-landings, highlighting the need for preventive training strategies [4–7].

Volleyball requires complex movements such as jumping, blocking, and passing, which demand strength and flexibility in joints including the shoulders, hips, knees, and ankles [11, 15]. Resistance training improves force production and reduces injury risk, while assessments such as the one-repetition maximum (1RM) and vertical jump are effective measures of muscle strength and power [12, 15]. Plyometric training further enhances speed, explosive power, and neuromuscular coordination by utilizing the stretch-shortening cycle, improving reflexes and reducing the likelihood of injuries [16–20].

Given these factors, structured training programs that focus on developing lower-limb strength and explosive power are essential for improving performance and minimizing injury risks in recreational volleyball players, who often engage in the sport for fitness, enjoyment, and social interaction [12].

2. Need of the Study

Recreational volleyball players often do not follow systematic, structured training protocols compared with professional players, making them more prone to injuries. The lower limbs account for 71.4% of all injuries, including those affecting the knee (23.1%), ankle (18.1%), thigh (17.0%), leg (10.4%), and spine (9.9%). Preventing such injuries requires strengthening the muscles in addition to routine plyometric exercises. While some studies have examined the effects of plyometric and resistance training in volleyball players, limited research has specifically focused on the impact of resistance training in recreational players. Hence, the purpose of this study was to compare the effectiveness of plyometric training and multigym-based resistance training on lower limb strength

and vertical jump performance in recreational volleyball players.

Aim of the study

To determine the effectiveness of plyometrics versus resistance training using multigym on the strength of lower limb musculature and jump performance among recreational volleyball players.

Objectives of the study

- To evaluate the pre and post values of lower limb strength by using "1 RM" in plyometrics training group and multigym resistance training group in recreational volleyball players.
- To evaluate the pre and post values of vertical jump performance by using "Sargent jump test" in plyometrics training group and multigym resistance training group in recreational volleyball players.

3. Materials and Methodology

Materials used

- Multi-gym
- Stopwatch
- Measuring tape
- Paint brushes,
- Wooden box
- Paints (Black and White)

Study design: Experimental study design

Sampling design: Convenience sampling

Sample setting: S.V. University playground, SVIMS – College of Physiotherapy, Fitness clinic.

Study duration: 12 weeks, 3 sessions per week, 45 minutes per session.

Sample size: 78

Ethical Aspects: The study was cleared by the Institutional Ethics Committee and written informed consent was obtained from everyone.

Inclusion criteria:

- Male recreational volleyball players.
- Players between 18 to 25 years of age.

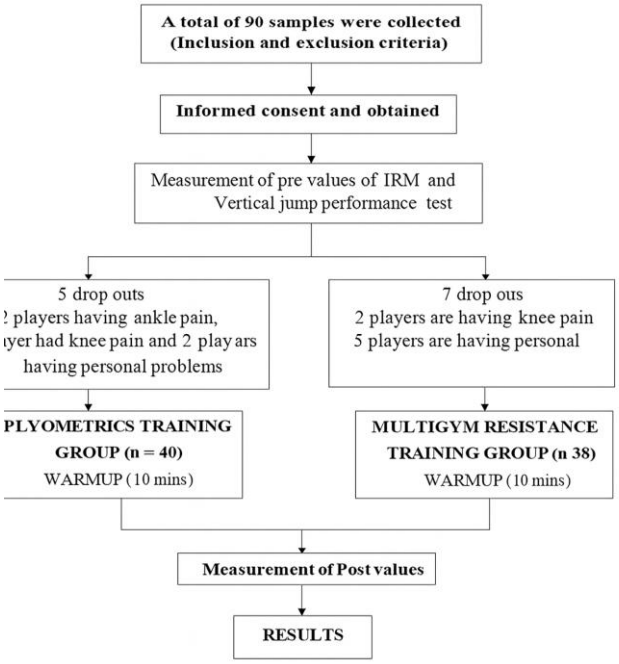
Exclusion criteria:

- Players below 18 and above 25 years of age.
- Female players.
- Elite volleyball players.
- Players with musculoskeletal, neurological, respiratory and cardiovascular problems.
- Players with psychological imbalance.

Outcome measures

- Strength was measured using 1RM (including leg press, leg extension, leg curl)[26].
- Jump performance was evaluated by the vertical jump test.
- Agility assessment was performed using the agility T test[27].
- Balance was assessed by recording single-leg stance measurement by using a SEBT.

Study Algorithm



Treatment Protocol

A total of 90 male recreational volleyball players were randomly assigned to two groups of 45 each: a plyometric training group and a multigym resistance training group. Both groups trained three times per week for 12 weeks, with each 45-minute session including a 10-minute warm-up, 30 minutes of specific exercises, and a 5-minute cool-down. The plyometric group performed exercises such as squat jumps, box jumps, tuck jumps, lateral bounds, zigzag jumps, single-leg tuck jumps, and depth jumps to enhance explosive lower limb power and vertical jump performance, while the resistance training group used multigym equipment for exercises including leg presses, leg extensions, leg curls, seated calf raises, hip abduction and adduction, lateral step-ups, and core strengthening to target major lower limb and core muscles. Training loads and repetitions were progressively adjusted every two weeks to ensure safe and effective performance improvements.

4. Results

Statistical analysis:

- The Statistical analysis was done by using the statistics software "**IBM SPSS Statistics 19.0 version**". The data was entered into Microsoft excel spreadsheet, tabulated and subjected to statistical analysis.
- **Statistical Tools used:** The data in tables were paired samples t-test; Independent Samples t-test, descriptive statistics, Line-Whisker plots
- All the 78 players completed the entire study protocol as defined, by 12 weeks in the training sessions. To observe the training impact before and after, within the group and between the groups, analysis was carried out by using paired t-test outcome measures were 1RM and Vertical jump test.

Demographical statistics:

1) Table.: Mean values of variables in plyometrics and multigym training groups

	Plyometric Group		Multi-Gym Group	
Variable	Mean	SD	Mean	SD
Age	22.77	1.22	22.86	1.31
Height (cms)	168.82	5.03	166.89	4.94
Weight (Kgs)	63.82	5.73	63.28	5.42
BMI	22.36	1.3	22.69	1.28

Interpretation of results: The table presents statistical data comparing the plyometric training group and the multigym resistance training group across the variables, including age, height, weight, and BMI. Mean values and standard deviations (SD) are provided for each variable within the groups. The results indicate that the groups are well matched in their baseline characteristics, supporting their suitability for comparative analysis in this study.

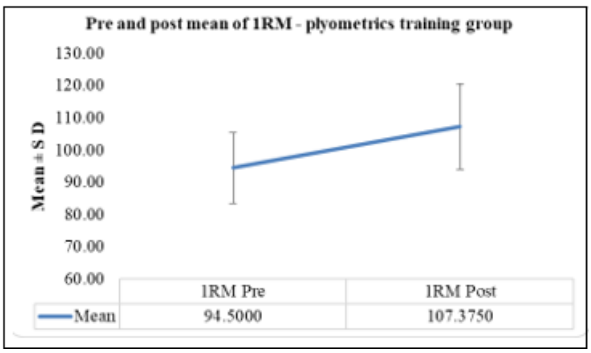
Descriptive statistics

2) Table.: Pre and post values of 1RM in plyometric group

Parameters	Mean	Std. Deviation	t-test	Sig. (2-tailed)
Pre	94.5	10.96	-18.63	0.0000
Post	107.37	13.2		

Interpretation of results shows that the average score increased from 94.50 before the training to 107.37 after the training. It shows a significant difference between the two, with the t value of -18.63 and a p-value of 0.0000. This shows that the plyometric training was effective.

Graphical representation showing pre & post values of 1RM plyometrics training group

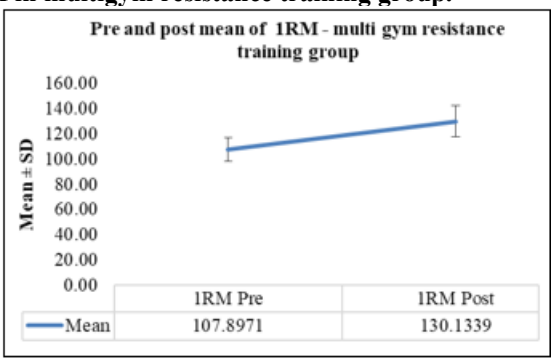


3) Table.: Pre and post values of 1RM multigym resistance training group

Parameters	Mean	Std. Deviation	t-test	Sig. (2-tailed)
1RM Pre	107.89	9.35	-22.82	0.0000
1RM Post	130.13	12.65		

Interpretation of results shows that the average score increased from 107.89 before the training to 130.13 after the training. It shows a significant difference between the two, with the t value of -22.82 and a p-value of 0.0000. This shows that the multigym resistance training was greatly improved in strength.

Graphical representation showing pre and post values of 1RM in multigym resistance training group.

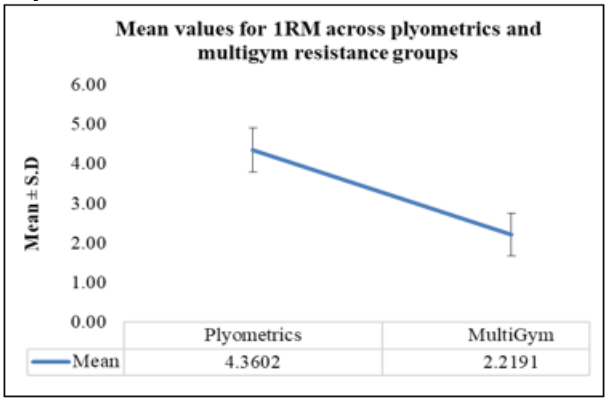


4) Table.: Mean difference of 1RM between plyometric and multigym resistance training groups

Parameters	Groups	Mean	Std. Deviation	T	Sig. (2-tailed)
1RM Difference	Plyometrics	12.87	4.36	-7.90	0.0000
	Multigym	22.23	6.00		

Interpretation of results shows that the 1RM difference after training was 12.87 in the plyometrics training group and 22.23 in the multigym training group. It shows a significant difference between the groups with a t value -7.90 and a p value of 0.0000. This shows that multigym training group had a greater improvement in strength than plyometric training group.

Graphical representation showing the mean values of 1 RM on plyometrics and multigym resistance training groups.

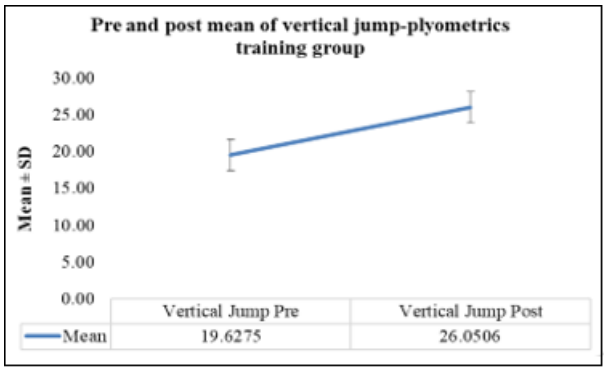


5) Table.: Vertical jump in plyometrics training group.

Parameters	Mean	Std. Deviation	T	Sig. (2-tailed)
Pre	19.62	2.11	-50.27	0.0000
Post	26.05	2.11		

Interpretation of results shows that the average score increased from 19.62 before the training to 26.05 after the training. It shows a significant difference between the two, with the t value of -50.27 and a p-value of 0.0000. This shows that the plyometric training had a strong positive effect.

Graphical representation showing pre and post values of vertical jump in plyometrics training group.

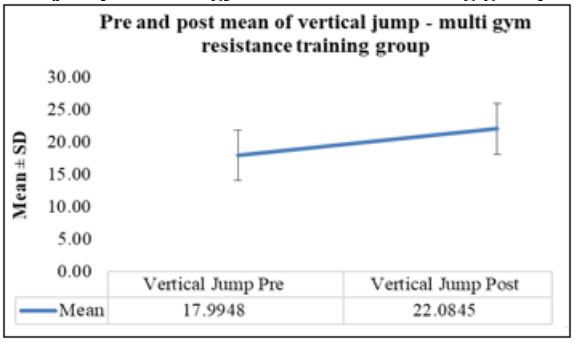


6) Table.: The vertical jump in multigym training group

Parameters	Mean	Std. Deviation	T	Sig. (2-tailed)
Vertical Jump Pre	17.99	3.83	-46.85	0.0000
Vertical Jump Post	22.08	3.94		

Interpretation of results shows that the average score increased from 17.99 before the training to 22.08 after the training. It shows a significant difference between the two, with the t value of -46.85 and a p-value of 0.0000. This shows that the multigym training had significantly improved.

Graphical representation showing pre and post values of vertical jump in multigym resistance training group.

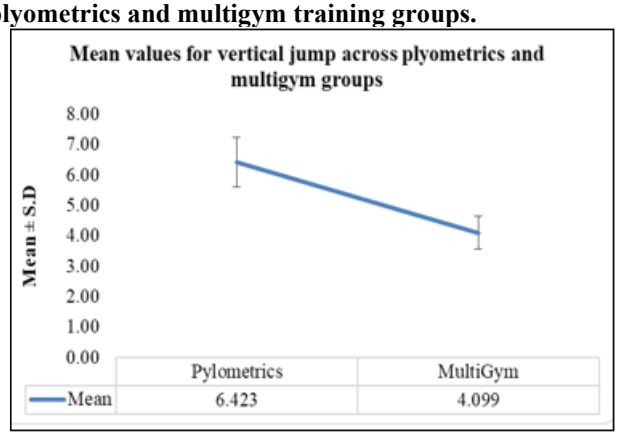


7) Table.: Vertical jump differences in plyometrics versus multigym training groups.

Parameters	Groups	Mean	Std. Deviation	T	Sig. (2-tailed)
Vertical Jump Difference	Plyometrics	6.42	0.80	14.90	0.0000
	Multigym	4.09	0.53		

Interpretation of results shows that vertical jump after training was 6.42 in the plyometrics training group and 4.09 in the multigym training group. It shows a significant difference between the groups with a t value -14.90 and a p value of 0.0000. This shows that plyometric training group had a greater improvement in vertical jump than multigym training group Plyometrics

Graphical representation showing the mean values across plyometrics and multigym training groups.



5. Discussion

The study results showed that plyometric training was more effective than multigym resistance training in improving vertical jump performance among recreational volleyball players, while resistance training produced greater improvements in lower limb strength, particularly in the one-repetition maximum (1RM) leg press test [29–54]. Demographic factors such as age, height, weight, and BMI were considered to ensure fairness, as they influence performance outcomes [29]. Both groups performed similar warm-up and cool-down routines to enhance preparedness, blood flow, and flexibility, thereby reducing injury risk [29–31]. The resistance training group achieved superior gains in muscle strength through hypertrophy and neuromuscular adaptations, while plyometric training improved muscle activation and explosive power [32–37]. Vertical jump performance improved significantly with plyometric exercises, which activate key lower limb muscles, although combining both training types has been shown to yield the greatest overall performance benefits [38–41]. These findings highlight that integrating plyometric and resistance exercises offers the most comprehensive benefits for volleyball players, enhancing both strength and explosive power while minimizing injury risks.

6. Limitations of the Study

1) The sample size for this study was small in both the plyometrics group and multigym resistance group which was not enough for the study to generalize the result in the whole recreational players.
2) There was no long-term follow-up to measure the actual effect so the long-term effect of strength and vertical jump performance not explored or explained in this study.
3) This study was done on subjects with age groups 18-25 years age old. It can be planned for other age groups also.
4) Male recreational players only taken in this study.

7. Future Recommendations

1) Large sample size will be recommended for future studies.
2) Long-term follow-up to measure the actual effect so the long-term effect of strength and vertical jump performance will be recommended for future studies.

3) Future studies can be planned for other age groups also.
4) Female players were also being taken in future studies.

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