

COMPARATIVE EFFECTS OF FOUNDATION AND TOTAL RESISTANCE EXERCISE (TRX) SUSPENSION TRAINING ON ENDURANCE, STRENGTH AND POWER IN FAST BOWLERS

Naweera Ghaffar^{*1}, Zahid Iqbal², Nasik Kaleem³, Humna Altaf⁴,
Muhammad Touqeer⁵

^{*1}DPT, MS-SPT Sports Therapist

^{2,5}PhD Scholar Department of Health & Physical Education And sports sciences, Health Services Academy,
Islamabad, Pakistan

³DPT Physiotherapist

⁴DPT, MS-NMPT

⁵PhD Scholar Department of Health & Physical Education And sports sciences, Health Services Academy,

¹naweeraghaffar@gmail.com, ²zahidiqbal44510@gmail.com, ³nasikch30@gmail.com,

⁴humnaaltaf898@gmail.com, ⁵touqeerawan93@gmail.com,

DOI: <https://doi.org/10.5281/zenodo.23336473>

Keywords

TRX Suspension Training, Foundation Training, fast bowlers, endurance, strength, explosive power, injury prevention.

Article History

Received: 25 June 2026

Accepted: 16 September 2026

Published: 13 October 2026

Copyright @Author

Corresponding Author: *

Naweera Ghaffar

naweeraghaffar@gmail.com

Abstract

Background: Fast bowling in cricket demands a combination of strength, endurance, and explosive power. To enhance performance and prevent injuries, effective training programs are essential. Foundation training and Total Resistance Exercise (TRX) Suspension Training have been widely used to improve physical fitness, but their comparative effects on fast bowlers remain underexplored.

Objective: To determine the effects of Foundation Training and TRX Suspension Training on endurance, strength, and power in fast bowlers.

Methodology: A randomized clinical trial was conducted with 44 fast bowlers who were randomly assigned to two groups: Group A (Foundation Training) and Group B (TRX Suspension Training). Both groups participated in an 8-week training program. Pre- and post-training assessments were conducted to measure endurance, strength, and explosive power using the 1RM biceps curl, medicine ball throw, and push-ups. Data analysis was performed using the Mann-Whitney U test and Wilcoxon signed-rank test.

Results: Both groups showed significant improvements in endurance, strength, and power ($p < 0.05$). However, Group B (TRX Suspension Training) demonstrated significantly greater improvements in explosive power, particularly in the medicine ball throw ($p = 0.000$). No significant difference was observed between the two groups in push-ups or the 1RM biceps curl ($p > 0.05$).

Conclusion: TRX Suspension Training was more effective than Foundation Training in enhancing explosive power, making it a valuable training tool for fast bowlers. Both methods were effective in improving endurance and strength, contributing to better performance and injury

INTRODUCTION

Among the various skills required in cricket, fast bowling is probably the most extreme one. To get to the speed of more than 140 km/h (87 mph) it takes a lot of physical strength, quickness, stamina and also a great deal of skill (1). Performance of a fast bowler is influenced by a number of key factors like physical fitness, bowling style, mental strength, and match awareness (2). Furthermore, they need the agility to make adjustments based on pitch conditions and different styles of play (3).

Fast bowlers as well as other athletes need a full training program consisting of the attributes of the bowler's Strength, Power, Endurance, Flexibility, and Coordination (the attributes) in order to improve their performance and at the same time to reduce injury risks (4). In the last few years, specific training techniques like Total Resistance Exercise (TRX) Suspension Training have gained a lot of fans among fast bowlers. These training practices focus on the muscle strengthening and core stability development at the same time (5).

Foundation exercises help one develop the basic strength and conditioning required for sports performance. For fast bowlers, these activities serve as the cornerstone of their fitness regimen, designed to enhance overall muscular endurance and core strength as well as improve flexibility all vital fast bowling attributes (6) (7).

While the basis of the strength exercises is regular weight lifting, TRX Suspension Training is a fresher and more adaptable way of developing the strength, power, and stability necessary for fast bowling (8). One of the outstanding features of TRX Suspension Training is its impact on core stability. For fast bowlers, this is exceedingly important since they have to control every single part of their bowling action (9). TRX Suspension Training incorporates a large variety of exercises that cover all the main muscle groups involved in fast bowling, which are legs, core, shoulders and arms (10).

Training with TRX also helps increase mobility and coordination which is also important for fast bowlers since they need to be able to move around the field and off it quickly and fluidly (11). The ability of a fast bowler to perform at an optimal level is influenced by endurance and how well the bowler can sustain high-intensity activities over longer durations, especially throughout longer spells (12). TRX Suspension Training is mainly concerned with training the core muscles (13).

When a fast bowler delivers the ball, the bowler's core needs to be tight to assist with keeping proper posture and alignment (14). Another significant advantage of TRX Suspension Training is improving muscular endurance (15). Squats, lunges, push-ups, and rows are some of the TRX training exercises that target large muscle groups and at the same time, muscular endurance is increased (16). The backbone of fast bowling that is effective is strength and power. A fast bowler needs to create a huge force in a very quick time, which will allow him to throw the ball at high speeds and yet control it and aim accurately (17).

The lower body is the base of the fast bowler's delivery. The legs, hips, and glutes, which are the main parts of the lower body, particularly give the necessary power to drive the bowler's body forward and thus, speed up the whole bowling action (18). The upper and lower body are linked via the core muscles during the delivery stride, which is crucial for fast bowlers. The ability to pass energy from the legs to the upper body relies on a powerful and solid core (19). (20). The upper body, mainly the shoulders, arms, and chest, is very significant in the bowling action. The power generated through the arms and shoulders gets frequently to the bowl's speed and accuracy (21). The primary muscles responsible for directing and controlling the ball's speed are the strong shoulder muscles (22).

The principle that lies at the very heart of foundation exercises is that the compound

movements should be used—these are exercises that work more than one muscle group at the same time (23). For quick bowlers, compound workouts are the main and basic methods to increase the power required to make their bowling action explode. Moreover, these workouts simulate the fast bowling functional movements, thereby increasing the strength transfer to sport directly (24).

The research titled "Comparative Effects of Foundation and Total Resistance Exercise Suspension Training on Endurance, Strength, and Power in Fast Bowlers," mainly focused on changing the performance and injury prevention of fast bowlers through specific training methods. Total Resistance Exercise (TRX) suspension training, which consists of bodyweight exercises on an unstable surface, is to boost dynamic strength and stamina by engaging several muscle groups at the same time.

Methodology

This randomized clinical trial was conducted at Azhar Ali Academy, Lahore, over a period of 10 months following approval of the research synopsis. The sample size was calculated using G*Power software, with muscular strength as the outcome measure, resulting in an initial sample size of 40 participants. After accounting for a 10% attrition rate, the required sample size was adjusted to 44 participants, with 22 participants allocated to each group. A non-probability convenience sampling technique was used to recruit eligible participants. Both male and female cricket fast bowlers aged 18–30 years were included if they engaged in physical activity two to three times per week, had at least six months of cricket-playing experience, demonstrated

adequate range of motion (ROM) at the shoulder, hip, and knee joints, and had a body mass index (BMI) between 18.5 and 25.5 kg/m². Participants with musculoskeletal injuries, including sprains, strains, or ligamentous injuries, those participating in other physical training programs, and those taking medications that could affect physical performance were excluded. Following recruitment, participants were randomly allocated to two groups using a computer-generated randomization method. Group A received foundational exercise training designed to improve muscular endurance, strength, and power, whereas Group B received total resistance exercise (TRX) suspension training with similar training objectives. The study employed a single-blinded design in which the outcome assessor was blinded to group allocation. Outcome measures included the one-repetition maximum (1RM) biceps curl test to assess upper-body muscular strength, the medicine ball throw test to evaluate upper-body power and explosiveness, and the push-up test to assess upper-body muscular endurance. Outcome assessments were conducted at the relevant measurement intervals according to the study protocol. Data were entered and analyzed using IBM SPSS Statistics for Windows, version 25. Descriptive statistics were used to summarize the participants' characteristics and outcome measures. The normality of the data was assessed using the Shapiro-Wilk test. As the data were analyzed using non-parametric methods, the Mann-Whitney U test was employed to compare outcomes between the two independent groups at the respective assessment intervals. Statistical significance was set at $p < 0.05$.

Results

Table 4. 1 Descriptive statistics of age and BMI

Variables	Group A	Group B
	Mean (SD)	Mean (SD)
Age (years)	24.40±3.36	25.40±3.66
BMI (kg/m ²)	23.04±.77	23.21±.51

In table 4.1 the data shows the comparison of age and BMI between two groups, A and B. Group A has a mean age of 24.40 years with a standard deviation of 3.36, while Group B has a mean age

of 25.40 years with a standard deviation of 3.66. In terms of BMI, Group A has a mean of 23.04 kg/m² (SD = 0.77), while Group B has a mean BMI of 23.21 kg/m² (SD = 0.51).

Table 4. 2 Gender distribution of group A and B

Variable		Group A	Group B
Gender	Male	17	14
	Female	5	8
	Total	22(100%)	22(100%)

In table 4.2 data shows the gender distribution between two groups, A and B. In Group A, there are 17 males and 5 females, making up a total of 22 participants (100%). In Group B, there are 14 males and 8 females, also totaling 22 participants (100%).

Table 4. 3 Study groups

The study consists of two groups: Group A, which received Foundation Exercise Training, and Group B, which received Total Resistance Exercise Suspension Training. Both groups have an equal number of participants, with 22 individuals (50%) in each group. In total, the study includes 44 participants, representing 100% of the sample.

Table 4. 4 Test of normality

The results of the Shapiro-Wilk test for normality show that all three variables 1RM Biceps Curl, Medicine Ball Throw, and Push-ups—are not normally distributed. For the 1RM Biceps Curl, the Shapiro-Wilk statistic is 0.946 with a p-value of 0.038, indicating non-normality. Similarly, the Medicine Ball Throw had a statistic of 0.950 with a p-value of 0.004, and the Push-ups data showed a statistic of 0.927 with a p-value of 0.008, both also suggesting non-normality. Since all the p-values are less than 0.05, the data for each of these variables does not follow a normal distribution.

Table 4. 5 Mann-Whitney u test between groups analysis of pre 1RM, medicine ball throw and push-ups

Variables	Groups	No	Mean Rank	z-value	P value
Pre-1 RM biceps curl	Group A	22	21.61	-.463	.644
	Group B	22	23.39		
Pre Medicine ball throw	Group A	22	22.43	-.036	.971
	Group B	22	22.57		
Pre-Push ups	Group A	22	23.00	-.262	.793
	Group B	22	22.00		

The results of the Mann-Whitney U test for the variables are as follows: Pre-1RM Biceps Curl: Group A has a mean rank of 21.61, while Group B has a mean rank of 23.39. The z-value is -0.463 and the p-value is 0.644, indicating that there is no statistically significant difference between the two groups for this variable. Pre-Medicine Ball Throw: Group A has a mean rank of 22.43, and

Group B has a mean rank of 22.57. The z-value is -0.036 and the p-value is 0.971, showing no statistically significant difference between the groups. Pre-Push-ups: Group A has a mean rank of 23.00, while Group B has a mean rank of 22.00. The z-value is -0.262 and the p-value is 0.793, which again shows no statistically significant difference between the two groups.

Table 4. 6 Mann-Whitney u test between groups analysis of post 1RM, medicine ball throw and push-ups

Variables	Groups	No	Mean Rank	z-value	P value
Post-1 RM biceps curl	Group A	22	23.61	-.580	.562
	Group B	22	21.39		
Post Medicine ball throw	Group A	22	14.59	-4.098	.000
	Group B	22	30.41		
Post-Push ups	Group A	22	26.05	-1.861	.063
	Group B	22	18.95		

The results of the Mann-Whitney U test for the post-intervention variables are as follows: Post-1RM Biceps Curl: Group A has a mean rank of 23.61, while Group B has a mean rank of 21.39. The z-value is -.580 and the p-value is 0.562, indicating no statistically significant difference between the two groups, as the p-value is greater than 0.05. Post-Medicine Ball Throw: Group A has a mean rank of 14.59, and Group B has a mean rank of 30.41. The z-value is -4.098 and the

p-value is 0.000, showing a statistically significant difference between the two groups, as the p-value is less than 0.05. Group B performed better in this test. Post-Push-ups: Group A has a mean rank of 26.05, while Group B has a mean rank of 18.95. The z-value is -1.861 and the p-value is 0.063, indicating no statistically significant difference between the two groups, as the p-value is greater than 0.05.

Table 4. 7 Wilcoxon sign rank test within group A analysis

Variables	Foundation exercise training			
	Mean	St. Dev	Z value	P value
Pre: 1 RM biceps curl	43.00	2.20	-4.211	.000
Post: 1 RM biceps curl	51.27	2.60		
Pre: Medicine ball throw	4.29	.15	-4.192	.000
Post: Medicine ball throw	4.77	.23		
Pre: Push ups	12.72	1.54	-4.268	.000
Post: Push ups	18.63	1.70		

Table 4.7 presents the results of the Wilcoxon signed-rank test analyzing the effects of foundation exercise training within Group A. Statistically significant improvements were observed across all measured variables following the intervention. The 1RM biceps curl increased from a mean of 43.00 kg to 51.27 kg ($Z = -4.211$, $p = .000$), indicating enhanced muscular strength. Similarly, performance in the medicine ball

throw improved from 4.29 m to 4.77 m ($Z = -4.192$, $p = .000$), suggesting gains in upper body power. Push-up repetitions rose from a mean of 12.72 to 18.63 ($Z = -4.268$, $p = .000$), reflecting increased muscular endurance. These results demonstrate that foundation exercise training had a significant positive impact on strength, power, and endurance in Group A.

Table 4. 8 Wilcoxon sign rank test within group B analysis

Variables	TRX Suspension Training			
	Mean	St. Dev	Z value	P value

Pre: 1 RM biceps curl	43.27	2.11	-4.215	.000
Post: 1 RM biceps curl	50.86	2.33		
Pre: Medicine ball throw	4.29	.17	-4.137	.000
Post: Medicine ball throw	5.25	.35		
Pre: Push ups	12.59	1.62	-4.218	.000
Post: Push ups	17.63	1.49		

Table 4.8 summarizes the Wilcoxon signed-rank test results for Group B, which underwent TRX Suspension Training. The data show statistically significant improvements across all performance variables after the intervention. The mean 1RM biceps curl increased from 43.27 kg to 50.86 kg ($Z = -4.215$, $p = .000$), reflecting gains in muscular strength. Upper body power, as measured by the medicine ball throw, improved from 4.29 m to 5.25 m ($Z = -4.137$, $p = .000$). Additionally, push-up performance rose from 12.59 to 17.63 repetitions ($Z = -4.218$, $p = .000$), indicating enhanced muscular endurance. These results confirm that TRX Suspension Training had a significant positive effect on strength, power, and endurance in Group B.

Discussion

The study was intended to compare the outcomes of Foundation Training and Total Resistance Exercise (TRX) Suspension Training on endurance, strength, and power among fast bowlers. In the baseline findings, there were no significant differences between the two groups in the 1RM biceps curl, medicine ball throw, and push-ups ($p > 0.05$) and thus we concluded that the two groups were similar in terms of strength, power, and endurance during the baseline (25). Olivier et al. (2022) studied the effect of core stability and strength endurance on adolescent cricket fast bowlers, specifically using Foundation training (26). According to the investigation, TRX training enhanced the parameters in consideration with improvements spanning

between 8 to 15 % concerning endurance, power and strength (25).

Pancar et al. (2021) focused on the effects of TRX suspension training on young, sedentary individuals and found significant improvements in physical capacity, including endurance and strength. The research reported a rise in endurance and total fitness of 10-12%. The enhancements met a p-value of below 0.05 (27). Joseph et al. (2021) studied core stabilization training for cricketers and its impact on endurance and balance. The findings indicated that there were very noticeable enhancements in core stability, toughness, and reaching of balance, especially in the case of the bowlers.

Conclusion

In conclusion, both TRX Suspension Training and Foundation Training significantly improve endurance, strength, and power in fast bowlers. However, TRX training was particularly effective in enhancing explosive power, especially in exercises like the medicine ball throw. While Foundation Training excelled in improving core stability and endurance, TRX offered a more comprehensive benefit, impacting overall strength and explosive performance.

REFERENCES:

1. Kiely N, Pickering Rodriguez L, Watsford M, Reddin T, Hardy S, Duffield R. The influence of technique and physical capacity on ball release speed in cricket fast-bowling. *Journal of Sports Sciences*. 2021;39(20):2361-9.

2. Maker R, Taliep M. The effects of a four weeks combined resistance training programme on cricket bowling velocity. *South African Journal of Sports Medicine*. 2021;33(1):1-6.
3. Andrews MH, Gorman AD, Crowther RH. Functional movement variability to maintain delivery speed in cricket fast bowling. *European Journal of Sport Science*. 2024;24(4):415-21.
4. Ramachandran AK, Singh U, Lathlean TJ. Strength and conditioning practices for the optimisation of speed and accuracy in cricket fast bowlers: A systematic review and meta-analysis. *International Journal of Sports Science & Coaching*. 2022;17(5):1211-24.
5. Felton P, McCaig S, King M. Cricket fast bowling: The relationship between range of motion and key performance and injury technique characteristics. *Journal of sports sciences*. 2023;41(2):112-20.
6. Hislen S. Exploring adolescent fast bowling: a mixed methods approach: Doctoral dissertation; 2023.
7. Callaghan SJ, Lockie RG, Tallent J, Chipchase RF, Andrews WA, Nimphius S. The effects of strength training upon front foot contact ground reaction forces and ball release speed among high-level cricket pace bowlers. *Sports Biomechanics*. 2024;23(9):1193-209.
8. Lim J, Wong S, McErlain-Naylor SA, Scanlan A, Goggins L, Ahmun R, et al. Strength and conditioning for cricket fielding: A narrative review. *Strength & Conditioning Journal*. 2023;45(5):509-24.
9. Weldon A, Duncan MJ, Turner A, Christie CJ, Pang CM. Contemporary practices of strength and conditioning coaches in professional cricket. *International Journal of Sports Science & Coaching*. 2021;16(3):585-600.
10. Pote L, Christie CJ. Strength and conditioning practices of university and high school level cricket coaches: a South African context. *The Journal of Strength & Conditioning Research*. 2016;30(12):3464-70.
11. Thomas B, Khan FM. Effect of core stability training on selected fitness components among cricket players. *Int J Physiol Nutr Phys Educ*. 2020;5(1):139-42.
12. Alfredatama I, Fauzi F, Tomoliyus T, Budiarti R, Prabowo T. The Impact of Functional Training on Physical Abilities in Combat Sport: A Mini Review. *Journal of Advances in Sports and Physical Education*. 2024;7(05):105-10.
13. LEE D-g, SHO M-y, MOON H-w. The Effect of Complex Training of Middle School Soccer Players on Body Composition, Basic Physical Strength and Movement Function. *The Korean Journal of Food & Health Convergence*. 2021;7(4):31-41.
14. Logeswaran A, Raj S, Giridharaprasath R, Nirendan J. Impact of endurance training on aerobic fitness and speed endurance of inter collegiate cricket players. *Journal of Sports Science and Nutrition*. 2022;3(1):85-7.
15. Herridge R, Turner A, Bishop C. Monitoring changes in power, speed, agility, and endurance in elite cricketers during the off-season period. *The Journal of Strength & Conditioning Research*. 2020;34(8):2285-93.
16. Anand PC, Khanna GL, Chorsiya V, Geomon T. Relationship of core stability with bowling speed in male cricket medium and medium fast bowlers. *Al Ameen J Med Sci*. 2017;10(3):8-11.
17. Boyat AK, Rathod PV. Designing and testing basic protocol for medium fast bowler to increase the speed and accuracy. *International Journal of Health Sciences*. 2022(II):11165-70.

18. Letter RT, Dwyer DB, Drinkwater EJ, Feros SA. The Perceptions of Australian Physical Preparation Coaches About How to Enhance Ball Release Speed in Elite Male and Female Cricket Pace Bowlers. *The Journal of Strength & Conditioning Research*. 2025;39(8):e991-e1002.
19. Kaur H, Chaudhary S, Chhabra C. Core strength as a paramount contributor for potential upper limb isometric strength-A correlational study. *Central European Journal of Sport Sciences and Medicine*. 2023;42(02).
20. Saeterbakken AH, Sandvikmoen TE, Iversen E, Bjørnsen T, Stien N, Andersen V, et al. The effect of heavy-resistance core strength training on upper-body strength and power performance in national-level junior athletes-a pilot study. *Frontiers in Physiology*. 2025;16:1617104.
21. Belli G, Marini S, Mauro M, Maietta Latessa P, Toselli S. Effects of eight-week circuit training with core exercises on performance in adult male soccer players. *European Journal of Investigation in Health, Psychology and Education*. 2022;12(9):1244-56.
22. Majewska J, Kołodziej-Lackorzyńska G, Cyran-Grzebyk B, Szymczyk D, Kołodziej K, Wądołkowski P. Effects of core stability training on functional movement patterns in tennis players. *International journal of environmental research and public health*. 2022;19(23):16033.
23. Karacay BC, Sahbaz T, Gurtekin B, Yildiz S, Ozcan E. Effectiveness of whole-body vibration exercise and core stabilization exercise in chronic non-specific low back pain: A randomized-controlled study. *Turkish journal of physical medicine and rehabilitation*. 2022;68(2):184.
24. Zemková E, Zapletalová L. The role of neuromuscular control of postural and core stability in functional movement and athlete performance. *Frontiers in physiology*. 2022;13:796097.
25. Omar FH. Effect of TRX Suspension Training on Technical Performance for Artistic Swimming Figures. *International Journal of Sports Science and Arts*. 2024;26(1):7-19.
26. Marta C, Alves AR, Esteves PT, Casanova N, Marinho D, Neiva HP, et al. Effects of suspension versus traditional resistance training on explosive strength in elementary school-aged boys. *Pediatric Exercise Science*. 2019;31(4):473-9.
27. El-Swaify ST, Refaat MA, AbdelWahab AA, Seddik MEE, Mostafa Abdelrazek AE, Doas Y, et al. Is platelet-rich plasma a new solution for shoulder adhesive capsulitis? A systematic scoping review of the literature. *Shoulder & Elbow*. 2023:17585732231174184.