Effect of Plyometric Training on Long Jump Performance and Physical Fitness in Female Collegiate Athletes

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https://doi.org/10.62345/jads.2026.15.3.7

Abstract

The long jump is a complex athletic event influenced by technical skills, physical fitness, and anthropometric factors. Plyometric training (PT) has been shown to enhance neuromuscular performance, yet its effectiveness in female collegiate athletes remains underexplored. This study evaluated the effects of an 8-week plyometric training program on anthropometric characteristics, physical fitness, and long jump performance in female college students. Thirty female participants (mean age = 17.4 ± 2.6 years) were randomly allocated to an experimental group (EG; n=15) who performed plyometric training, and a control group (CG; n=15) who maintained standard physical education activities. Pre- and post-intervention assessments included anthropometry (height, weight, girths, lengths, breadths), physical fitness (vertical jump, standing broad jump, 30-m sprint, 600-m endurance run, sit-and-reach, agility T-test, hexagon test), and effective long jump distance. Data were analyzed using independent t-tests (p < 0.05). Compared with the CG, the EG demonstrated significant improvements in vertical jump (+30.2%, p<0.001), standing broad jump (+26.3%, p=0.01), flexibility (+18.8%, p<0.001), agility (T-test −26.2%, p=0.01; hexagon test −26.4%, p=0.01), and endurance (−35.9% completion time, p=0.02). Long jump performance improved markedly in the EG (pre: 2.24 ± 0.56 m vs. post: 4.12 ± 0.52 m; p<0.001). Anthropometric changes were minimal, with only body weight decreasing significantly in the EG (−8.3%, p=0.03). Kinematic analysis revealed minor technique modifications, with significant improvements observed only in right elbow angles at take-off and touchdown (p=0.01). Eight weeks of plyometric training significantly enhanced physical fitness and long jump performance in female collegiate athletes, with limited anthropometric changes. Plyometric training is an effective and time-efficient intervention to improve explosive power, agility, flexibility, and endurance in young female athletes.

Keywords: Plyometric Training; Female Athlete; Physical Fitness; Long Jump; Anthropometry Performance.

Introduction

The long jump is one of the oldest track and field disciplines, demanding a combination of speed, explosive power, coordination, and refined technical execution. Performance outcomes depend not only on sprinting velocity and take-off mechanics but also on underlying physiological and anthropometric characteristics such as limb length, body mass, and muscular power (Shahidi et al., 2023; Zhuravleva et al., 2023; Chaitidou & Panoutsakopoulos, 2023). Among these determinants, neuromuscular fitness plays a decisive role in translating physical

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potential into performance, making targeted training essential for athletes seeking competitive improvements.

Plyometric training (PT), characterized by rapid stretch-shortening cycle activities such as jumps, hops, and bounds, has been recognized as an effective modality for developing muscular strength, agility, and explosive power (Taher et al., 2021; Diosalan et al., 2024). Evidence suggests that PT enhances jump height, sprint ability, and change-of-direction speed, particularly in sports requiring maximal lower-limb actions (Arazi & Asadi, 2011). Importantly, PT can be adapted to different age groups, training levels, and environments, making it a versatile and practical intervention for both elite and recreational athletes.

While several studies have examined the benefits of PT in youth and male athletes, there is limited evidence on its effects among female collegiate populations, particularly in the context of long jump performance. Female athletes often display different neuromuscular characteristics compared to males, such as reduced explosive strength and altered biomechanics, which may influence both performance and injury risk (Slimani et al., 2022). Addressing these gaps is essential for developing evidence-based training interventions tailored to female athletes. Furthermore, although anthropometric factors such as limb length and girths are considered structural determinants of performance, they are less modifiable in the short term, suggesting that motor abilities and neuromuscular conditioning may play a more critical role in immediate performance enhancement (Azuma & Matsui, 2021).

Therefore, this study aimed to evaluate the effects of an 8-week plyometric training program on anthropometric variables, physical fitness, and long jump performance among female collegiate athletes. We hypothesized that PT would significantly improve physical fitness outcomes and long jump performance, while producing minimal changes in anthropometric characteristics.

Methodology

Study Design and Participants

A randomized controlled experimental design was employed. Thirty female college students from Government Degree College, Bahawalpur (mean age = 17.4 ± 2.6 years; mean height = 164.0 ± 3.9 cm; mean weight = 49.5 ± 5.8 kg) were recruited. Participants were randomly assigned to either the experimental group (EG; n=15) or the control group (CG; n=15).

Inclusion criteria: Female students aged 16–20 years, free from musculoskeletal injuries, and not engaged in structured sports training.

Exclusion criteria: Participation in extracurricular sports, recent injury, use of performance-enhancing substances, or medical conditions affecting physical performance.

Ethical approval was obtained from the institutional ethics committee (Project No. 834/PESS, February 2023). Informed consent was provided by all participants.

Intervention

The EG completed an 8-week plyometric training program (five sessions per week, 60 min per session), while the CG continued with general physical education activities. Training sessions included warm-up (5–10 min jogging, dynamic stretching), main plyometric exercises (cone hops, bounding, depth jumps, box jumps, medicine ball throws, zigzag drills), and cool-down (static stretching).

Training intensity was progressively increased over the 8 weeks (see supplementary material 1 for full training protocol). Rest intervals ranged from 60 s to 4 min depending on week and exercise intensity.

Outcome Measures

Anthropometric Assessments

Standardized ISAK protocols were followed to measure stature, weight, girths (arm, thigh, calf, chest, waist, hip), limb lengths (upper and lower), and breadths (shoulder, hip, knee, ankle) (Norton, 2019). Measurements were taken pre- and post-intervention.

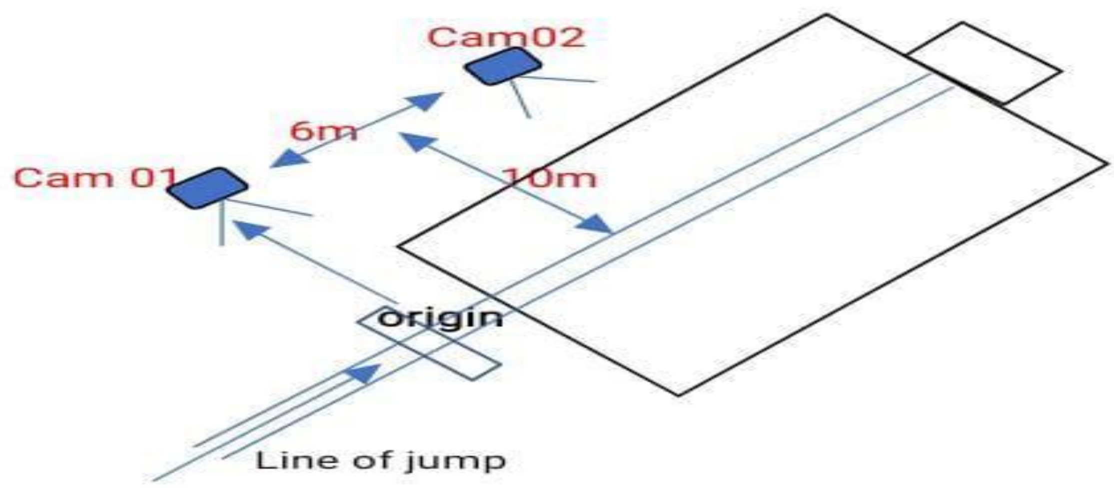
Physical Fitness Assessments

Vertical Jump Test: lower-limb power.
Standing Broad Jump: explosive leg strength.
Sit-and-Reach Test: flexibility.
30-m Sprint Test: speed.
600-m Run Test: aerobic endurance.
Hexagon Test & T-test: agility.
Each test was performed three times, with the best performance recorded as previously applied (Taher et al., 2021; Tai et al., 2022; Sharma et al., 2013; Mola, 2025; Abd Rahim et al., 2020; Hernández-Davó et al., 2021; Türkarslan & Deliceoglu, 2024).

Long Jump Performance

Effective jump distance was recorded as the horizontal distance from the take-off board to the nearest landing mark. Each participant performed six trials, and the best attempt was analysed.

Figure 1: Distance for effective jump



Kinematic Analysis

Two high-speed cameras (150 Hz) recorded participants' last stride, touchdown, and take-off phases. Angles of hip, knee, ankle, and elbow joints were analyzed using Kinovea software (Version 0.9.5) (Wondirad et al., 2016).

Results

After eight weeks of training, the experimental group (EG) demonstrated significant improvements across several fitness parameters compared with the control group (CG). Vertical jump height increased by over 30% in the EG ($p<0.001$), while standing broad jump performance also improved significantly ($p=0.01$). Flexibility gains were evident, with sit-and-reach scores increasing by nearly 19% in the EG compared to minimal change in the CG

($p<0.001$). Endurance capacity, assessed via the 600-m run, improved markedly in the EG, with completion time decreasing by 35.9% ($p=0.02$). Agility tests showed substantial benefits: both the T-test and hexagon test times decreased significantly in the EG ($p=0.01$), indicating faster change-of-direction ability. Effective long jump distance improved by nearly 2 m in the EG (from 2.24 ± 0.56 m to 4.12 ± 0.52 m; $p<0.001$), whereas the CG showed smaller, non-significant gains. In contrast, 30-m sprint performance did not differ significantly between groups ($p=0.42$). Anthropometric changes were minimal, with body weight being the only variable to decrease significantly in the EG ($p=0.03$), while height, limb lengths, and girths remained unchanged. Kinematic analysis revealed limited modifications, with significant differences observed only in right elbow angles at touchdown and take-off ($p=0.01$ and $p=0.05$, respectively).

Figure 2: Key physical fitness and performance outcomes

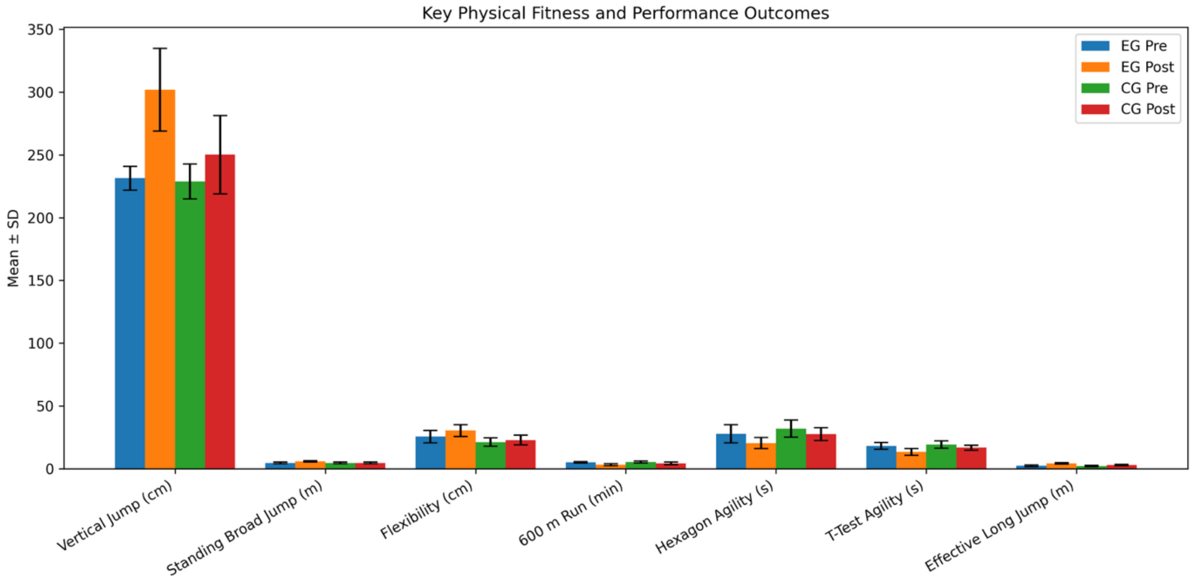


Table 1: Key Physical Fitness and Performance Outcomes (n=30)

Variable	EG Pre	EG Post	CG Pre	CG Post	p-value
Vertical Jump (cm)	231.4 ± 9.5	301.9 ± 33.0	228.8 ± 13.8	250.1 ± 31.1	<0.001
Standing Broad Jump (m)	4.63 ± 0.74	5.85 ± 0.65	4.53 ± 0.65	4.61 ± 0.73	0.01
Flexibility (cm)	25.6 ± 5.0	30.4 ± 4.7	21.2 ± 3.3	22.8 ± 3.8	<0.001
600 m Run (min)	5.03 ± 0.50	3.22 ± 0.81	5.24 ± 0.82	4.23 ± 1.04	0.02
Hexagon Agility (s)	27.8 ± 7.2	20.4 ± 4.5	31.9 ± 6.8	27.6 ± 5.1	0.01
T-Test Agility (s)	18.1 ± 2.6	13.4 ± 2.7	19.2 ± 3.0	16.8 ± 2.0	0.01
Effective Long Jump (m)	2.24 ± 0.56	4.12 ± 0.52	2.13 ± 0.61	2.92 ± 0.52	<0.001

Discussion

This study demonstrated that eight weeks of plyometric training significantly improved vertical and standing broad jump performance, flexibility, agility, endurance, and effective long jump distance in female collegiate athletes, while producing minimal anthropometric adaptations aside from reduced body weight. These findings are consistent with recent systematic reviews showing that PT is a potent stimulus for enhancing neuromuscular function and jump-related performance in youth and female athletes (Slimani et al., 2022; Sinthania et al., 2023). The marked improvements in explosive power and agility underscore PT's effectiveness in developing stretch-shortening cycle efficiency, which directly benefits long jump performance, while the lack of significant sprint gains suggests that sprint-specific training may be required to optimize running speed (Ramírez-Campillo et al., 2021). The absence of substantial anthropometric changes supports the view that structural traits are less responsive to short-term interventions, and that motor ability development contributes more immediately to performance outcomes (Ameti et al., 2022). Minor kinematic adjustments, such as improved elbow coordination, indicate possible refinements in technique, though longer interventions or three-dimensional analyses may be necessary to detect larger biomechanical adaptations. Collectively, these results emphasize PT's value as a safe, time-efficient, and effective training method for female athletes, with practical applications for coaches aiming to enhance explosive power, agility, and long jump performance.

Conclusion

An 8-week plyometric training program significantly improved physical fitness and long jump performance in female collegiate athletes, with limited effects on anthropometric characteristics. Plyometric training should be considered an effective component of athletic development programs for female long jumpers, particularly to enhance explosive power, agility, and endurance.

Recommendations

Future studies should extend intervention duration beyond 8 weeks to assess long-term anthropometric and biomechanical adaptations.Combining PT with sprint-specific and resistance training may yield more comprehensive performance improvements.Coaches should individualize PT intensity and progression to maximize benefits while minimizing injury risk.

References

- Abd Rahim, M. A., Lee, E. L. Y., Abd Malek, N. F., Suwankhong, D., & Nadzalan, A. M. (2020). Relationship between physical fitness and long jump performance. *Age (years old), 21*, 271.
- Ameti, V., Iseni, A., & Memishi, S. (2022). The effect of plyometric programs in long jump and triple jump among students. *International Journal of Sport Sciences and Health, 9*(17–18), 222–228.
- Arazi, H., & Asadi, A. (2011). The effect of aquatic and land plyometric training on strength, sprint, and balance in young basketball players. *Journal of Human Sport and Exercise, 6*(1), 101–111.
- Azuma, A., & Matsui, K. (2021). Relationship between jump distance for running long jump and physical characteristics of male students in PE class. *Advances in Physical Education, 11*(2), 232. https://doi.org/10.4236/ape.2021.112018
- Chaitidou, V., & Panoutsakopoulos, V. (2023). Long jump performance is not related to inter-limb asymmetry in force application in isometric and vertical jump tests. *Biomechanics, 3*(3), 389–400.
- Diosalan Jr, E. I., Diosalan, S. A., & Martinez, C. M. (2024). Plyometrics in long jump performance: A basis for a training program. *Pantao: International Journal of the Humanities and Social Sciences*.
- Hernández-Davó, J. L., Loturco, I., Pereira, L. A., & et al. (2021). Relationship between sprint, change of direction, jump, and hexagon test performance in young athletes. *Sports, 9*(3), 197–203.

- Mola, D. W. (2025). Effect of a 12-week training program on the fitness and performance of long jumpers. *International Journal of Kinesiology & Sports Science*.
- Norton, K. I. (2019). Standards for anthropometry assessment. In *Kinanthropometry and exercise physiology* (pp. 68–137). Routledge.
- Qi, F., Zhang, Y., Liu, X., & et al. (2019). Effects of combined training on physical fitness and anthropometric measures among boys aged 8–12 years. *Sustainability, 11*(5), 1219.
- Ramírez-Campillo, R., García-Pinillos, F., García-Ramos, A., & et al. (2021). Effects of plyometric training on physical fitness in youth and young female athletes: A systematic review and meta-analysis. *Sports Medicine, 51*(9), 1893–1910.
- Shahidi, S. H., Yalçın, M., & Holway, F. E. (2023). Anthropometric and somatotype characteristics of top elite Turkish national jumpers. *International Journal of Kinanthropometry, 3*(2), 45–55.
- Sharma, S. K., Saiyad, S., & Nandwani, R. (2013). Effect of plyometric training on long jump performance in athletes. *Indian Journal of Physiotherapy and Occupational Therapy, 7*(2), 176.
- Sinthania, D., Nazri, S. B. M., & Kardi, I. S. (2023). Biomechanical measurement with motion analysis system via software (Kinovea): A case study on motion and joint angles in hurdles athletes. *Journal of Physical Education and Sport, 23*(12), 3189–3195.
- Slimani, M., Chaabene, H., Miarka, B., & et al. (2022). The effects of plyometric jump training on physical fitness in youth and female athletes: A systematic review and meta-analysis. *Frontiers in Physiology, 13*, 814212.
- Taher, A. V., Pavlović, R., Ahanjan, S., Skrypchenko, I., & Joksimović, M. (2021). Effects of vertical and horizontal plyometric exercises on explosive capacity and kinetic variables in professional long jump athletes. *Pedagogy of Physical Culture and Sports, 25*(2), 108–113.
- Tai, W. H., Yu, H. B., Tang, R. H., Huang, C. F., Wei, Y., & Peng, H. T. (2022). Handheld-load-specific jump training over 8 weeks improves standing broad jump performance in adolescent athletes. *Healthcare, 10*(11), 2301.
- Türkarslan, B., & Deliceoglu, G. (2024). The effect of plyometric training program on agility, jumping, and speed performance in young soccer players. *Pedagogy of Physical Culture and Sports, 28*(2), 116–123.
- Wondirad, S., Eba, A., & Khan, A. (2016). The effect of different joints' angles on the performance of Oromia regional state clubs long jumpers: A kinematical study. *Journal DOI*, 44975451.
- Zhuravleva, T., Aiken, C. A., Becker, K. A., Lin, P. C., & Sampson, J. J. (2023). The use of a holistic focus of attention to improve standing long jump performance among NCAA track and field athletes. *International Journal of Sports Science & Coaching, 18*(4), 1074–1081.

Supplementary Materials

Table 2: Full anthropometric measurements pre/post intervention

	Pre-Data				Post-Data					
Variables	Experimental		Control		Experimental		Control			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	F	sig
Height(cm)	165.07	3.86	162.73	4.57	165.40	4.01	163.00	4.69	2.29	0.14
Weight(kg)	49.53	5.53	49.53	6.32	45.40	4.76	46.27	5.57	0.05	0.03*
Arm Girth Relaxed(cm)	23.40	2.26	23.53	3.02	21.39	2.05	22.70	3.02	0.60	0.44
Arm Girth Flexed(cm)	25.53	2.29	26.27	2.81	22.91	2.31	25.28	2.55	3.06	0.09
Forearm Girth mx(cm)	22.60	1.80	22.93	1.75	21.09	1.91	22.51	1.91	1.78	0.19

Wrist Girth(cm)	15.07	1.10	15.47	0.92	13.93	1.17	15.16	1.02	5.53	0.33
Chest Girth(cm)	81.67	5.84	83.60	6.99	79.44	8.23	82.49	8.74	0.91	0.35
Waist Girth(cm)	69.68	5.61	70.17	6.65	67.85	5.49	69.38	6.69	0.20	0.65
Hip Girth(cm)	90.41	5.42	90.13	5.80	87.38	4.44	88.51	5.77	0.05	0.83
Thigh Girth(cm)	42.49	1.70	42.36	2.64	38.37	3.22	40.75	3.48	1.44	0.24
Calf Girth(cm)	32.53	2.80	33.40	3.25	30.78	3.43	32.39	3.06	1.23	0.28
Upper Arm Length(cm)	34.73	1.98	35.33	1.45	34.54	1.82	35.63	1.35	2.00	0.17
Forearm Length(cm)	26.93	1.67	27.20	0.86	26.80	1.82	27.20	0.86	0.44	0.51
Hand Length(cm)	18.53	1.77	18.52	1.11	18.52	1.77	18.52	1.11	0.02	1.00
Total Arm Length(cm)	80.33	4.88	81.07	3.03	80.73	4.81	81.50	3.01	0.26	0.61
Upper Leg Length(cm)	50.87	3.11	50.07	2.63	50.87	3.11	50.07	2.63	0.58	0.45
Lower Leg Length(cm)	40.07	2.99	40.87	2.53	40.61	2.98	41.43	2.44	0.65	0.43
Foot length(cm)	23.93	1.33	24.07	1.28	24.53	1.44	24.55	1.50	0.02	0.88
Total Leg Length(cm)	93.09	3.74	92.32	3.53	93.71	3.35	92.78	3.40	0.44	0.51
Bi acromial shoulder breadth(cm)	40.13	2.75	40.07	1.79	39.37	3.14	39.57	1.95	0.01	0.94
Bi Ili Cristal hip breadth(cm)	38.47	4.19	38.20	3.03	37.30	4.20	38.01	3.14	0.03	0.86
Transverse Chest breadth(cm)	30.60	2.90	31.40	2.13	28.06	3.13	30.65	2.17	3.32	0.08
Humerus elbow breadth(cm)	6.89	0.88	6.91	1.01	6.64	0.90	6.71	1.01	0.01	0.91
Femur knee breadth(cm)	8.93	0.70	8.75	0.61	8.67	0.61	8.44	0.60	0.83	0.37
Ankle breadth	5.50	0.58	5.68	0.35	5.28	0.55	5.29	0.36	0.30	0.59
Arm span(cm)	173.07	7.04	171.20	6.13	173.20	6.99	171.20	6.13	0.65	0.43
Sitting height(cm)	77.27	2.69	76.87	2.56	77.20	2.65	76.87	2.56	0.15	0.70

Table 3: Detailed plyometric training protocol

Warm-up exercises before training (running like jogging, dynamic stretching) and cool down after training (static stretching) continue 5 minutes.

Workout Day's	(1^{st}-2^{nd}) weeks of training	Rapt × sets	(3^{rd}-4^{th}) weeks of training	Rapt × set	(5^{th}-6^{th}) Weeks of training	Rapt × sets	(7^{th}-8^{th}) Weeks of training	Rapt × sets
Monday	Cone hops, medicine ball chest passing, depth jumps from 20 cm box to another 20 cm box	5×2	Cone hops with change of direction sprint, standing broad jump	10×2	Jumping lunges, Two-foot ankle hops	12×3	Step-up, depth jumps from 20 cm box to another 20 cm box	15×3
Tuesday	Light sprint, Zigzag drill, single leg rope skipping	5×2	20 m sprint, Double leg rope skipping, jumping spider	2×3	30 m sprint, box jump,	2×3	60 m sprint, zigzag drill,	4×1
Wednesday	Vertical jump, rotational ball throw	5×2	Tuck jumps, Medicine ball chest pass	10×2	Vertical jump, hurdle hops rotational ball throw,	12×3	Single leg rope skipping, Standing broad jump,	15×3

Thursday	Forearm planks(15s), push-ups, step-ups,	5×2	half squat jump, planks	10×2	Planks, push-ups, step-ups,	12×3	Box jump, walking lunges	15×3
Friday	Overhead medicine ball throw, side to side ball throw,	5×2	Wall toss ball jump, walking lunges	10×2	Back ward throw, Standing broad jump,	12×3	High knees, overhead medicine ball throw	15×3
Saturday	Frog jump, standing broad jump	5×2	Frog jump,	10×2	Standing broad jump,	12×3	Side to side ankle hops, standing broad jump	15×3
Sunday	OFF (Recovery)							

*(w-1st to 2nd) rest b/w set 60 seconds; rest b/w exercises:15 seconds
(W-3rd to 4th) rest b/w set 60-90 seconds; rest b/w exercises:15-30 seconds
(w-5th-6th) rest b/w set 2-3 minutes; rest b/w exercises:60 seconds
(w-7th-8th) rest b/w set 3-4 minutes; rest b/w exercises:60-90 seconds

Table 4: Kinematic data

	Pre-Data				Post- Data					
Variables	Experimental		Control		Experimental		Control			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	F	sig
Last stride length	0.83	0.11	0.77	0.09	0.77	0.10	0.78	0.11	0.43	0.52
Right knee angle last stride	146.40	14.23	146.39	13.22	147.27	12.55	145.91	14.95	0.02	0.88
Left knee angle last stride	146.49	18.23	138.78	20.61	135.95	23.10	140.35	19.52	0.06	0.81
Right elbow angle Last stride	68.02	22.17	67.22	25.35	66.07	24.44	76.81	32.44	0.29	0.59
Left elbow angle Last stride	94.39	32.46	93.56	29.65	86.63	27.85	92.81	13.69	0.09	0.76
Right ankle angle last stride	99.82	31.32	92.97	21.58	83.79	20.04	94.71	11.79	0.11	0.74
Left ankle angle last stride	92.39	15.14	93.79	11.95	78.02	9.75	80.85	14.40	0.35	0.56
Right knee angle touch down	91.12	35.20	93.41	33.57	93.15	27.63	89.45	35.25	0.03	0.94
Left knee angle touch down	68.16	48.78	96.99	39.75	87.03	39.85	99.23	26.43	2.69	0.11
Right elbow angle touch down	84.82	20.68	98.21	23.09	84.80	16.13	93.48	11.40	3.42	0.05*
Left elbow angle touch down	101.80	33.98	90.85	48.50	100.01	24.15	87.70	29.52	0.96	0.34

Right ankle angle touch down	78.17	12.73	80.68	11.58	75.13	13.03	72.03	14.28	0.01	0.94
Left ankle angle touch down	88.50	14.71	91.90	14.93	84.98	15.75	93.48	12.25	1.77	0.19
Right knee angle Take off	140.70	30.03	137.23	37.88	134.37	23.15	120.13	37.91	0.65	0.43
Left knee angle Take off	92.70	41.64	109.96	43.51	89.84	36.00	103.33	39.53	1.14	0.29
Right elbow angle Take off	96.79	24.90	71.37	24.42	93.72	29.81	70.93	19.57	7.74	0.01*
Left elbow angle Take off	65.79	32.62	85.07	52.24	83.15	38.45	84.59	37.19	0.61	0.44
Right ankle angle Take off	99.35	24.36	96.94	23.91	99.49	14.65	102.63	27.26	0.00	0.96
Left ankle angle Take off	98.58	24.33	98.25	25.82	94.55	12.42	93.20	17.68	0.02	0.90