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Sprint Stronger, Sprint Faster: The Impact of Resisted Sprint Training on Sprinter Performance – A Randomized Controlled Trial

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Abstract:

- ***Introduction-***

Athletics like running has grown substantially over the past decades because it is of low cost and easy implementation by a variety of population. Sprinting relies on anaerobic metabolism (ATP-PC) and glycolytic energy systems) for short bursts of high-intensity activity, with better balance can generate higher force output during ground contact, leading to improved sprint times. strong aerobic capacity ensures athletes recover quickly between efforts, maintaining peak performance across multiple sprints. Hence,

- ***Aim-***

Of the study was to find the effect of resisted sprint training programme (RSTP) on selected fitness variables in sprinters.

- ***Methodology-***

After preparation of study protocol, Ethical clearance was obtained from IEC(No.: Dr.APJAKCOPT/MPT/PG/24) . 60 amature sprinters were screened and 46 were selected as per eligibility criteria. After obtaining their consent, they were randomized into Group A(n=23) and Group B(n=23) by computer generated randomization method. Further allocation was done by SNOSE method, Group A received RSTP 3 sessions per week for 6 weeks. Group B continued their regular exercise program.

- ***Result and Data Analysis-***

The Shapiro-Wilk test indicated that the data were normally distributed($p>0.05$). Therefore, a one way ANOVA was conducted to analyze both within group and between group differences, Experimental group showed significant improvement on Anaerobic power($p<0.001$), fatigue index($p<0.05$), Dynamic balance($P<0.05$), Aerobic Capacity($P<0.001$) Conclude, RSTP when implemented for 6 weeks has shown improvement in anaerobic power, fatigue index, dynamic balance, aerobic capacity. Therefore, it is recommended to introduce RSTP in regular exercise protocols.

Keywords: *RSTP, Sprinters, Aerobic and Anaerobic, Dynamic Balance, Runners, Resisted Sprint, SNOSE, Sprint Training, Skill.*

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I. INTRODUCTION

1.1 Running, and particularly sprinting, is a fundamental human activity that plays a central role in numerous sports disciplines. Due to its minimal cost, ease of implementation, and effectiveness in developing athleticism, sprinting has become increasingly popular among athletes and recreational participants alike[1]. Sprinting performance is influenced by several physiological and biomechanical factors, including anaerobic and aerobic power, muscular strength, neuromuscular coordination, dynamic balance, and the ability to resist fatigue[2]. Among the modern training approaches,

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Resisted Sprint Training (RST) has gained traction for its ability to provide task-specific mechanical overload, which aligns with the principle of specificity[3].

RST involves sprinting under additional resistance, such as using sleds, parachutes, or weighted vests. These resistive modalities create external loading that enhances force production and stimulates greater neuromuscular adaptations compared to unresisted sprinting[4]. Research indicates that RST improves sprint-specific parameters such as ground reaction forces, acceleration, and stride length[5]. Moreover, RST has shown to stimulate both the central and peripheral nervous systems, leading to enhanced explosive strength and proprioceptive control[6]. However, the translation of these improvements into enhanced aerobic capacity and reduced fatigue is still being actively studied.

Sprint performance is a multifactorial construct influenced by anaerobic capacity, maximal aerobic uptake (VO_2 max), and dynamic balance, all of which are critical determinants of athletic efficiency and injury prevention[1]. Epidemiological data suggest that sprint athletes sustain approximately 5.6 to 5.8 injuries per 1,000 hours of training, with over 40% of these attributed to impaired neuromuscular control and deficits in dynamic stability[2].Studies have shown that over 60% of amateur sprinters report early fatigue and suboptimal balance during high-intensity phases.[31]

With the introduction of equipment like weighted sleds and parachutes, athletes could now train under conditions that closely mimic actual performance situations[9]. Hence we hypothesized that use of resisted techniques during the training sessions of sprinters may enhance their performance. This study aims to assess the impact of resisted sprint training program on performance in amateur sprinters.

II. MATERIALS AND METHODOLOGY

The study, approved by the Institutional Ethics Committee (IEC No.: Dr.APJAKCOPT/MPT/PG/2024/22) and adhere to the ethical standards for human research participants as set forth in the Declaration of Helsinki. The study is registered under CTRI (CTRI/2024/03/064533), was a randomized controlled trial conducted among amateur sprinters aged 18–25 with a 6 weeks of resisted sprint training, study was conducted on PMT Sports ground, Loni. Total 46 Participants were selected according to inclusion and exclusion criteria (Table No. 1) and randomly assigned using simple randomization with SNOSE allocation concealment, with participant blinding. Equipment used included a Power Chute™, weight cuffs, a photocell stopwatch, assessment sheets, consent forms, and PAR-Q. Outcome measures included VO_2 max (Queens College step test) , anaerobic power (RAST), fatigue index (RAST), and dynamic balance (Crossover Hop Test), assessed under consistent environmental conditions at baseline and post-intervention. Group A, i.e., (RSTP) (n=23), received Resisted Sprint Training Programme along with regular exercises, and Group B, i.e., (control)(n=23) continued their regular exercise program. Data analysed using SPSS v23 revealed significant improvements in VO_2 max, anaerobic power, fatigue index and dynamic balance in the experimental group ($p < 0.001$).

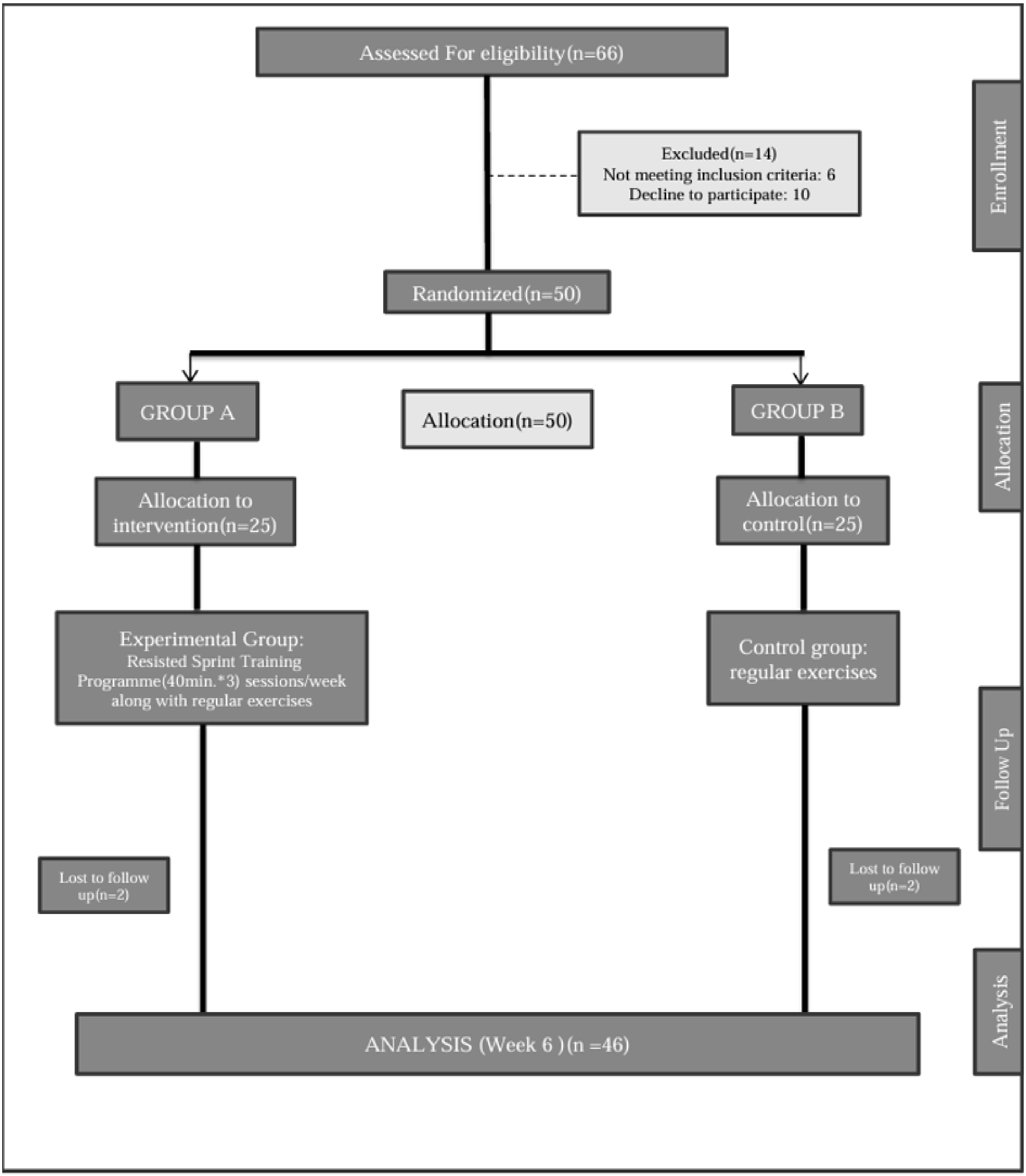

Fig 1 CONSORT Diagram Flow of Participants through Trial

Table 1 Selection Criteria F Eligibility (n=66)

Inclusive Criteria	Exclusion Criteria
Amateur sprinters. Both Genders. Age group 18 to 25years. Participants who are willing to participate. Participants fulfilling PAR Q	Any type of acute and severe systemic illness. Any recent surgical and medical history which will affect performance. Psychologically unstable participants.

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Table 2 Demographic Details of Experimental and Control Group

Parameter	**Experimental Group (M=14, F=09)**		**Control Group (M=14, F=09)**	
	Mean	Std Dev	Mean	Std Dev
Age (Year)	21.22	1.65	21.61	1.78
Height (cm)	162.74	5.76	162.04	5.4
Weight (kg)	59.43	7.66	62.57	6.57
BMI (kg/m2)	22.37	1.73	23.68	1.92

Table 3 Experimental Group Exercises

Category	**Exercises**	**Level- I Week 1-2**	**Level-II Week 2-4**	**Level-III Week 4-6**	**Freq**
Warm-up (7 min)	Warm up lap, Dynamic Stretching, sprint drills (A-skips, High knee butt kicks, Karaokas) (1- 6 weeks)				
Resisted Sprint	Running with Parachute	Athlete will run 60 m straight with medium sized parachute (56’’) tied at the waist. **Repetitions**: 2 laps	Athlete will run 60m straight with large sized parachute (72’’) tied at the waist. **Repetitions**: 3 laps	Athlete will run 60m straight with large sized parachute (72’’) tied at the waist. **Repetitions**: 5 laps	3 sessions/week
	Running with ankle weight	Athlete will run 60m straight with 0.5 kg weight tied just below knee **Repetitions**: 2 laps	Athlete will run 60m straight with 0.5 kg weight tied at the mid calf . **Repetitions**: 2 laps	Athlete will run 60m straight with 0.5 kg weight tied at the ankle. **Repetitions**: 2 laps	
	Running with weighted vest	Athlete will run 60m straight with 5 kg weighted vest **Repetitions**: 2 laps	Athlete will run 60m straight with 5 kg weighted vest **Repetitions**: 3 laps	Athlete will run 60m straight with 5 kg weighted vest **Repetitions**: 5 laps	
Cool down (5 min)	Slow jogging, Stretching of major group of muscle for 5 min. (1- 6 weeks)				

Table 4 Control Group Exercises

Exercise Category	**Exercise**	**Volume**		**Frequency *(Sessions/week)***
Warm Up	ROM, Spot marching, small distance jogging (1- 6 weeks)			
		Reps	Sets	3
Strength Training	Back Squat	8	2	
	Front Squat	8	2	
	Curl Ups	15	2	
	Calf raises	18	3	
	100m sprint	4	1	
Cool Down	Stretching of a major group of muscles, gentle walk for 3 minutes. (1-6 weeks)			

III. RESULT AND DATA ANALYSIS

Data was tabulated and analyzed with IBM SPSS V 23 software. The Shapiro-Wilk test was used to normalize the data, and analysis of Variance (ANOVA) was used to compare mean values.

Demographic characteristics, including age, gender, weight, height, and BMI, showed no significant difference ($p>0.05$) between the two groups.

➤ *Data Analysis-*

Data was normally distributed by the Shapiro-Wilk test. Paired and unpaired t-test was used for further within and between-group pre-post analysis. Results showed a statistically significant difference for VO2max, Anaerobic power in both groups. when done between-group experimental group analysis showed an extremely significant difference ($p<0.001$) and a significant difference for fatigue index and dynamic balance($p<0.05$). Overall, the analysis indicates that males generally outperform females in most physical performance parameters, but both genders show considerable improvement over time.

Table 5 P-values of Variables

Parameter	**Group**	**Week0**		**Week6**		**P Value**	**Inference**
		Mean	**St. Dev.**	**Mean**	**St. Dev.**		
VO2max (ml/kg/min)	Experimental	34.13	3.03	45.35	4.61	0.0001	Highly Significant
	Control	36.87	2.97	37.74	3.08		
Anerobic Power (w)	Experimental	391.78	37.24	474	23.81	0.0001	Highly Significant
	Control	388.57	30.4	391.13	31.68		

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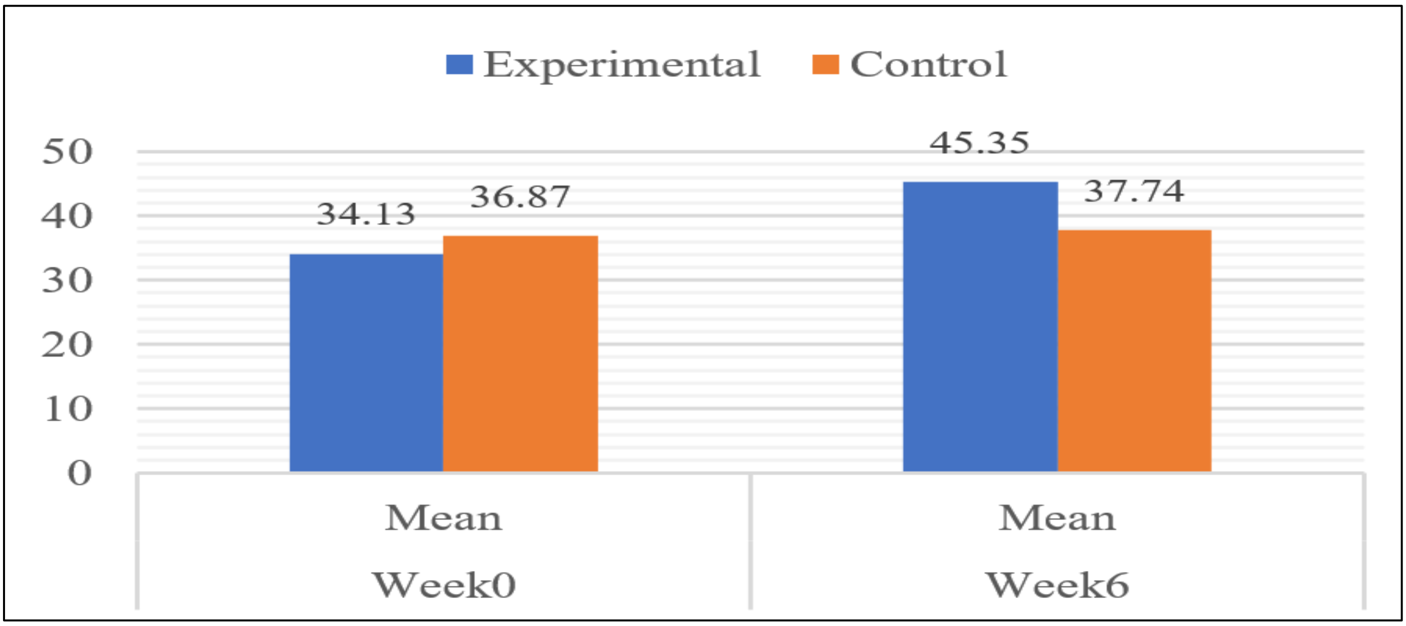
Fatigue Index	Experimental	17.04	1.31	14.3	0.98	0.025	Significant
	Control	17.03	1.31	14.99	1.01		
Dynamic Balance Dominant Leg (cm)	Experimental	425.78	29.65	425.43	55.81	0.042	Significant
	Control	455.96	40.11	455.85	41.6		
Dynamic Balance Non-Dominant Leg (cm)	Experimental	413.48	44.69	436.57	33.16	0.039	Significant
	Control	434.65	34.2	411.57	45.72		

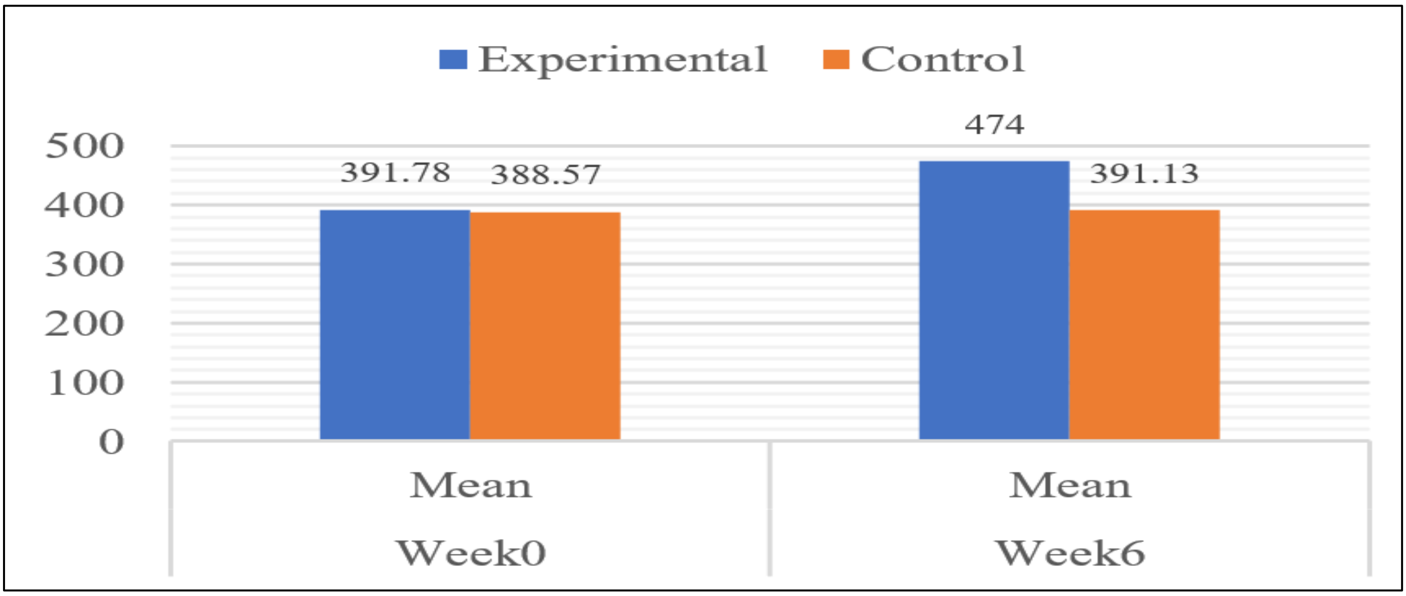
Table 6 Mean Difference between groups

Parameter	Mean Difference	
	Experimental Group	**control Group**
VO_2max (ml/kg/min)	11.22	0.87
Anaerobic Power (W)	82.22	2.56
Fatigue Index	2.74	2.04
Dynamic Balance – Dominant Leg (cm)	0.35	0.11
Dynamic Balance – Non-Dominant Leg (cm)	23.09	23.08

➢ *Graphical Representation of Pre- and Post-mean Values of all Variables*



Graph 1 VO2max(ml/kg/min)



Graph 2 Anerobic Power(W)

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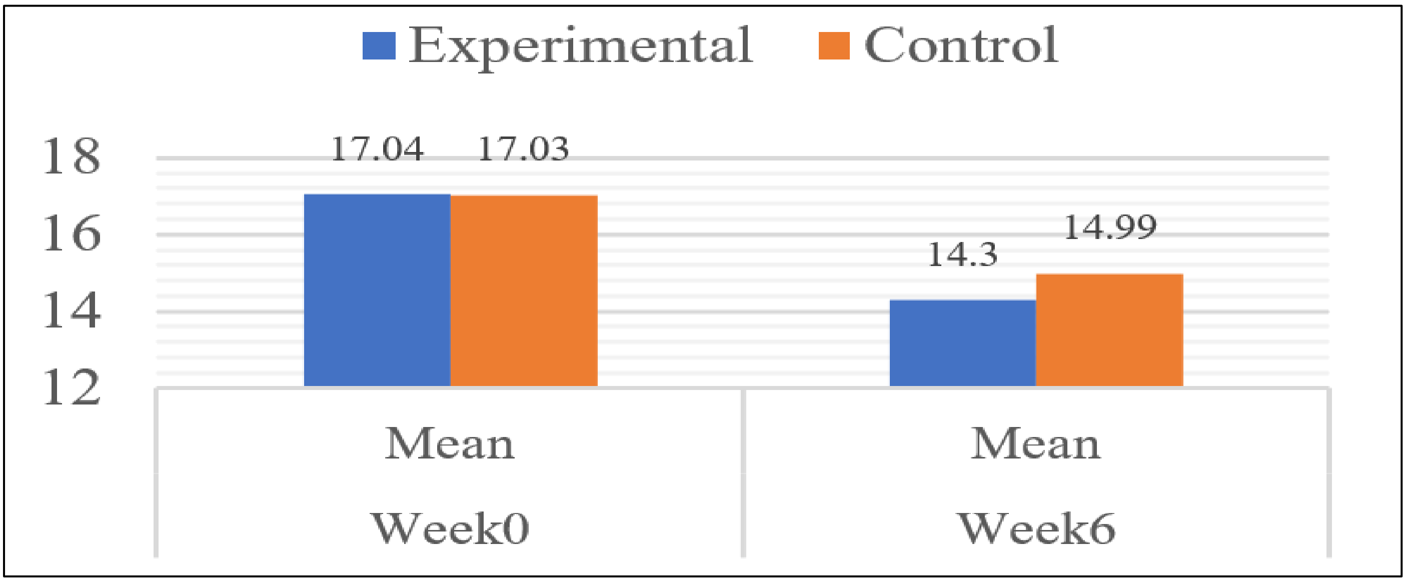
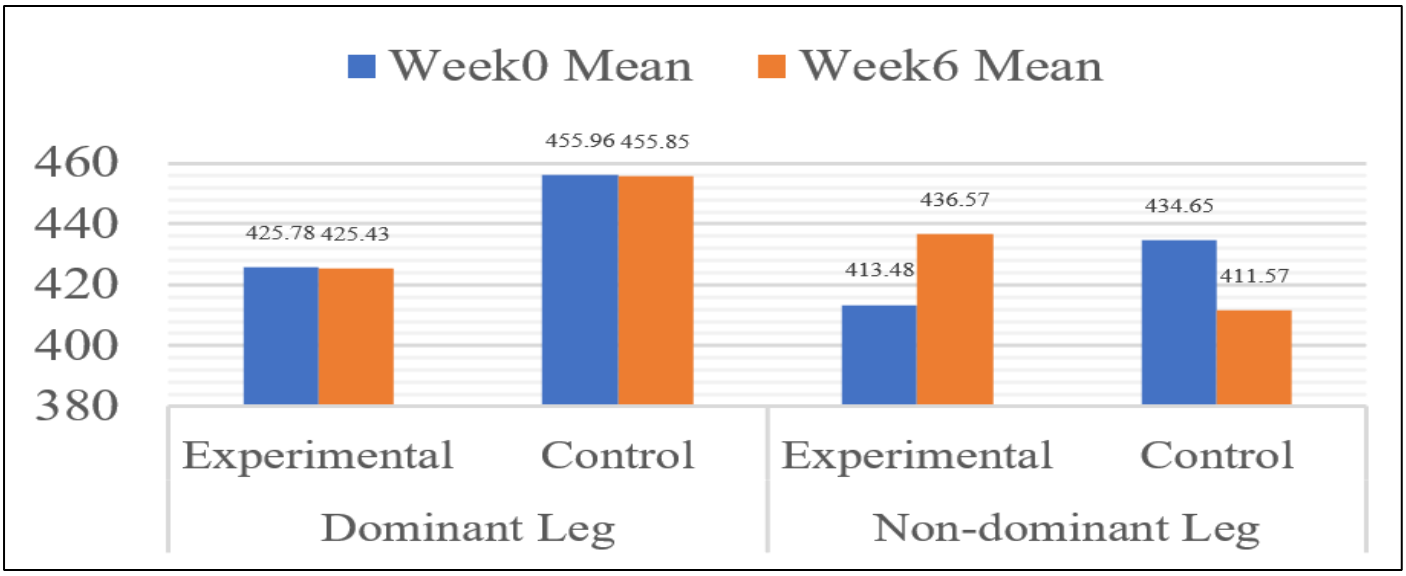


Graph 3 Fatigue Index



Graph 4 Dynamic Balance (Cm)

IV. DISCUSSION

Sprint performance is a multifactorial phenomenon requiring optimization of both physiological and biomechanical components[15]. The present study demonstrates significant improvements across four key parameters in amateur sprinters undergoing a 6-week RST program.

Improvement in **VO2 max** may be attributed to the cardiovascular adaptations induced by repeated high-intensity bouts. RST increases the recruitment of large muscle groups, thereby imposing higher demands on the cardiovascular system, which may stimulate increases in stroke volume and mitochondrial efficiency[16]. Though sprinting is primarily anaerobic, aerobic capacity supports recovery between sprints and contributes to overall performance[17].

Enhancement in **anaerobic power** is consistent with literature suggesting that resistance training increases the efficiency of fast-twitch muscle fiber recruitment, phosphocreatine resynthesis, and ATP turnover[18]. By training under resistance, athletes develop greater ground reaction force and stride propulsion, contributing to better sprint times[19]. Additionally, RST improves rate of force development, which is critical in short-burst events[20].

Fatigue index reflects the athlete's ability to maintain output across repeated sprints. RST may delay fatigue by increasing lactate threshold and buffering capacity, which enhances muscle endurance and metabolic efficiency[21]. Neuromuscular efficiency and reduced central fatigue could also play a role in minimizing performance decrement[22].

Improved **dynamic balance** in the experimental group can be attributed to enhanced proprioceptive feedback and neuromuscular control. RST promotes reactive postural adjustments, engaging the core and lower limb stabilizers more effectively[23]. Such adaptations are crucial for maintaining sprint mechanics and avoiding injuries[24].

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The multifaceted benefits of RST observed in this study align with other research emphasizing its application in both elite and amateur populations[25]. While most literature focuses on sprint time improvements, our study expands the understanding by incorporating metabolic and neuromuscular parameters.

However, individual responses to RST can vary based on gender, muscle fibre composition, baseline fitness level, and adaptation potential[26]. The role of genetics and neuromechanical efficiency should be explored further to personalize training interventions[27]. Additionally, considerations like optimal resistance load and frequency of sessions are key for maximizing gains without inducing overtraining[28].

V. CONCLUSION

A 6-week of RST protocol resulted in significant improvements in VO2 max, anaerobic power, fatigue index, and dynamic balance. These findings advocate the inclusion of RST in training regimes for amateur sprinters.

➢ *Clinical Implications:*

The findings of this study highlight the effectiveness of incorporating resisted sprint training (RST) into conventional training programs for amateur sprinters. Sports physiotherapists and strength and conditioning professionals can confidently integrate RST protocols using accessible tools like power chutes and weight cuffs to maximize training outcomes in young athletes.

➢ *Novelty:*

The study integrates a multidimensional assessment approach by evaluating both metabolic (VO_2 max, anaerobic power, fatigue index) and neuromotor (dynamic balance via Crossover Hop Test) outcomes.

VI. LIMITATIONS OF THE STUDY

- Short intervention duration
- Absence of long-term follow-up
- Homogeneity of the sample (amateur level only)

- **Future Scope:** Larger trials with diverse populations and longer duration are recommended to confirm findings and determine optimal resistance protocols.
- **Funding:** Self-funded
- **Conflict of Interest:** There is no conflict of interest between the authors.

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