



RESEARCH ARTICLE

Effect of autoregulatory progressive resistance exercise on hip extensor and knee flexor muscles on power, balance, and Ollie performance among skateboarders

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Abstract

Skateboarding requires significant power, balance, and Ollie maneuvers, particularly in hip extensors and knee flexors, which are critical, resulting in explosive power necessary for such movements. Autoregulatory Progressive Resistance Exercise has shown an enhancement in muscular power by adjusting the intensity of workouts based on the individual's performance and recovery rate, thus providing a tailored approach to strength training. The aim of the study is to evaluate the effectiveness of Autoregulatory Progressive Resistance Exercise on hip extensor and knee flexor muscles on power, balance, and Ollie performance among skateboarders. 50 skateboarders recruited using a convenient sampling technique. Lower body power, balance, and ollie performance were measured using the vertical jump test, the star excursion balance test, and the Ollie maneuvers evaluation, respectively. Skateboarders took a post assessment for APRE for 6 weeks, 3 days per week, and SPSS data analyzed. The subject showed significant improvement in every variable after 6 weeks. The measures are independent as there is no association between vertical jump test values and ollie maneuver evaluation. The effectiveness of the Autoregulatory Progressive Resistance Exercise on hip extensors and knee flexor muscles among skateboarders proved effective in improving power, balance, and ollie performance.

Keywords: Autoregulatory progressive resistance exercise, Hip extensor muscles, knee flexor muscles, muscle power, Balance, Ollie performance, skateboarders.

Introduction

The research aims to examine the autoregulatory progressive resistance exercise (APRE) impacts on power, balance, and ollie performance of skateboarders, with a focus on hip extensor and knee flexor muscles. Skateboarding is becoming more popular, although the age groups that sustain injuries from it the most are children and teenagers (Seasons and Morrongiello, 2023). Skateboarding started in the 1960s, California and has since expanded in popularity. Skateboards were more useful in the 1970s because of

advancements like polyurethane wheels and better board designs, which developed the skating community. The sport has grown in popularity around the world and was included in the 2020 olympic games (Rodríguez-Rivadulla *et al.*, 2020). Candotti *et al* (2012) stated that despite skateboarding's popularity, limited scientific research on the performance aspects of the sport, especially regarding power, balance, and ollie maneuvers.

The Ollie, an essential skateboarding trick, is fundamental for most other tricks, yet there is a lack of comprehensive studies on improving ollie maneuvers. Performing an ollie depends on intrinsic factors (e.g., muscle power, balance) and extrinsic factors (e.g., foot positioning, skateboard design). The specific impact of each factor on Ollie's performance is not fully understood (Rodríguez-Rivadulla *et al.*, 2020). For optimal athletic performance and injury prevention, balance is essential. Coordination of joint motions with vestibular, somatosensory, and visual inputs is necessary for effective movement. Research shows a strong correlation between good balance and sports performance, and balance training can enhance skills specific to different sports (Hrysomallis, 2011). The gluteus maximus plays a vital

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role in skateboarding, helping maintain balance during movement transitions and assisting in forward propulsion.

Resistance exercises such as the deep squat, hip bridging, front squat, knee curls, lunges, and deadlift with a bar can be incorporated into an APRE program to enhance lower body strength and power. Exercises that increase lower limb strength and power that are particularly popular include squats (Martinez *et al.*, 2022). Some studies have looked at how strength and jump performance are affected by shallow and deep squat training (Weiss *et al.*, 2000). Enhancing GM muscle activation with bridging exercises at 30° of hip abduction may be an effective approach (Distefano *et al.*, 2009). Skateboarders can gain the muscle essential to do tricks and maneuvers more efficiently by gradually raising the resistance load based on their performance (Šarabon and Kozinc, 2020).

APRE provides adjustments based on an individual's performance, making it ideal for the dynamic demands of skateboarding. APRE can improve strength, power, balance, and stability by targeting specific muscle groups and incorporating exercises resembling skateboarding movements. Enhancing these muscles through APRE can reduce injury risk and boost overall skateboarding performance (Mann *et al.*, 2010). The research on APRE benefits for skateboarders is noticeably lacking, especially when it comes to strengthening knee flexors and hip extensors. This study aims to fill this gap, providing valuable insights to improve training and performance in skateboarding. The article highlights the necessity of exploring scientifically-based training methods like APRE to enhance skateboarders' performance and reduce injury risks, ultimately supporting their development in the sport.

Materials and Methods

Study design and participants

The Institutional Ethical Committee (EC-MPT/23/PHY/008) granted the study ethical clearance. The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975 that was revised in 2013. In the current study, recreational skateboarders in Bengaluru participated in an experimental design consisting of a single-group pre-and post-test. Using a convenient sampling method, 50 sample sizes were recruited. The skateboarders gave their informed consent prior to the research starting, and each subject separately provided written consent to participate. The subjects were then chosen using selection criteria. A group of 50 skateboarders was used in this study after they were screened using the Vertical Jump Test, Star Excursion Balance Test, and Ollie maneuver evaluation for power, balance and ollie performance. A total of 18 sessions of 45 minutes each, spread over 6 weeks of thrice weekly scheduling,

were used for APRE. Inclusion criteria: Age: 18 to 21 years, Recreational skateboarders with a minimum of 2 years of experience.

Exclusion criteria: Skateboarders with an open wound, venous disorders, cardiovascular diseases, impaired vestibular function, and lower limb fractures.

Junior skateboarders were excluded. Skateboarders with any disease or impairment that would interfere with participation in the strength training, or any injured skateboarders, were excluded from this study.

Study procedure

The study was allocated to a single experimental group of 50 skateboarders and informed consent was obtained from the participants. APRE was a goal-oriented oriented that was conducted for 45 minutes per session. APRE aims to improve lower limb power, balance and ollie performance among skateboarders. By using vertical jump test, star excursion balance test and Ollie maneuver evaluation, the pre-training scores was evaluated, and the results were documented. The training starts with an explanation of the APRE program. The subjects were given a 5-minute warm-up and Autoregulatory Progressive Resistance Exercises such as deep squats, hip bridging, front squats for gluteus maximus and knee curls, lunges, and deadlift for hamstring muscles with bar 3 sets of 5 reps. Considering the subject's exhaustion level, 5-10 mins rest was allowed between each exercise set. The frequency of training sessions adhered to the FITT principle, with 3 sessions/week with an intensity of 85% of 1 RM and 15 repetitions per set for six weeks. The sessions lasted approximately 45 minutes, including appropriate rest intervals of 2 to 3 minutes between sets. Post-training power, balance, and ollie performance assessments were done using the vertical jump test, SEBT, and Ollie Maneuver Evaluation after six weeks of the training program; measurements were recorded. In SPSS (version 23.0), statistical tests were used to analyze the data. Mean and SD were calculated using descriptive statistics to provide an overview of the data. A 2-tailed significant threshold ($p < 0.05$) was used.

Outcome Measures

It measures leg power and has been linked to skating skills and the capacity to execute a variety of basic and advanced tasks, such as sprinting and direction changes. A common tool to evaluate this capacity is the vertical jump test. A vertical leap is frequently utilized as one of the most reliable tests of strength (Aragón, 2000).

One of the most popular techniques for evaluating the lower limb's dynamic balance in the literature is SEBT. Four lines that crossed at the same center position formed the SEBT original form. A person must stand in the middle of the star and maintain a single-leg squat position while reaching as far as they can with the opposing leg in

any one of the eight reach directions to pass the test. The distance travelled in centimeters is used to quantify dynamic balance, and it is often normalized to the participant's height or leg length; however, this is not always the case (Gribble *et al.*, 2013).

The Ollie starts with the skater putting his back foot on the tail (the back portion of the skateboard) and his front foot in the middle of the form, which is a wooden board covered in sandpaper that supports the skater's feet. The person squats as they get closer to the object they want to leap over, then quickly propels themselves upward, extending their arms, chest, and knees. The skateboard spins on its back axle as the user lifts the nose (front of the shape) by pulling down the tail with the back foot. The skate must lift off the ground and begin the flying phase when its tail strikes the floor because it causes a force reaction in the opposite direction. Simultaneously, the skater's body, already in the lift phase, rises in time with the skateboard, whose front foot controls its trajectory. In order to cushion the fall and guarantee a safe and controlled landing, the skater flexes their knees and trunk during the last phase.

Results

Descriptive statistics

Table 1 presents the descriptive statistics, the group of 50 participants' mean and SD of weight is 58.38 ± 4.69 , age 19.94 ± 1.20 , height 162.58 ± 3.93 , experience in years 2.50 ± 0.83 , play time in a day 2.14 ± 0.98 , and play time in a week 8.84 ± 4.52 .

Highly Significant

The above table infers that there are highly significant changes in the outcomes of power, balance, and ollie performance within the group. In Table 2 (Paired T-test), the group of 50 participants was assessed and given an intervention for 6 weeks. All the outcomes were evaluated at the initial stage and values were obtained after 6 weeks of intervention. Again, values were obtained to check the difference within the group of participants.

Table 2 showed that the single group pre-post intervention of hip extensor and knee flexor muscles on power pre-test was mean (50.79) and post-test was mean

(57.51 ($p = 0.000$)). Balance on hip extensor and knee flexor muscles pre-test was mean (89.88) and post-test was Mean (94.7, $p = 0.000$) Ollie performance pre-test was mean (54.56) and post-test was mean (64.54, $p = 0.000$). The paired-t test showed statistically significant improvement in autoregulatory progressive resistance on power, balance, and ollie performance.

The Pearson correlation computed between the Vertical Jump Test post-test and Ollie Maneuver Evaluation was not significant and positive ($r = 0.24$). There is no association between the Vertical Jump and the Ollie Maneuver Evaluation post-test (Table 3).

Discussion

This study aimed to investigate the hip extensor and knee flexor muscle power, balance, and ollie performance of skateboarders from Bengaluru. The aim of the research was to determine how skateboarders in Bengaluru performed ollies, with respect to their hip extensor and knee flexor muscles, power, and balance, using the Autoregulatory Progressive Resistance Exercise. Our result demonstrated that there was a significant improvement in power, balance and ollie performance among skateboarders by using Autoregulatory Progressive Resistance Exercise on hip extensors and knee flexor muscles.

Skateboarding gained popularity in the mid-20th century, particularly among surfers who used it as an alternative to surfing when the waves were not suitable (Seasons and Morrongiello, 2023). According to 2012 research by Candotti *et al.*, lower limb power accounts for 76.3% of the performance in the Ollie maneuver. According to this study, skateboarding's resilient physical demands may be the reason for the high prevalence of lower limb pain. It shows even more the importance of training in improving physical abilities and preventing injuries among skateboarders. Additionally, the study found that the independent variable APRE (Auto-regulated Progressive Resistance Exercise) had a positive impact on hip extensor and knee flexor muscles, leading to improved power, balance, and Ollie performance among skateboarders. The research indicates a strong association between power, balance, and Ollie performance in skateboarders, which can be used to predict and enhance

Table 1: Distribution of study participants

	<i>N</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Mean</i>	<i>SD</i>
Weight in kg	50	49.00	68.00	58.38	4.69
Age in years	50	18.00	21.00	19.94	1.20
Height in cm	50	155.00	173.00	162.58	3.93
Experience in years	50	1.00	5.00	2.50	0.83
Play time in a day	50	1.00	5.00	2.14	0.98
Play time in a week	50	3.00	18.00	8.84	4.52

Table 2: Statistical difference of paired t-test for parameters vertical jump test, the star excursion balance test, and Ollie Maneuver evaluation

		Paired differences			Sig. (2-tailed)
		Mean	SD	Std error	p-value
Vertical jump test	Pre-test	-6.728	3.964	0.560	<.0001
	Post-test				
Star excursion balance test	Pre-test	-4.82	1.586	0.224	<.0001
	Post-test				
Ollie maneuver evaluation	Pre-test	-9.904	2.742	0.387	<.0001
	Post-test				

Table 3: Correlation between the vertical jump test post-test and Ollie Maneuver evaluation post-test

Variable	N	Correlation	Sig. (2-tailed)
Vertical Jump Test post-test and Ollie Maneuver Evaluation post-test	50	0.245	0.086 ($p > 0.05$)

performance in the Ollie maneuver through tailored training programs. The mechanisms behind APRE's efficacy are unclear. However, it is possible that the larger strength increases associated with APRE were due to a continual modification of repetitions. In this study, preliminary analysis of the data revealed significant improvements in vertical jump power following the completion of the APRE training program. Despite the focus on strength rather than explicit power training modalities, the observed enhancements underscored the importance of foundational strength in generating explosive force during dynamic movements like the vertical jump (Mann *et al.*, 2010).

Efficient exercise programs are crucial to prepare and condition the muscles for the intense activity involved in skateboarding. Another study by Sarabon in 2020 indicated significant improvements in balance ability following resistance exercise (RE) (Šarabon and Kozinc, 2020).

Developing lower limb extensor muscles is essential for the successful performance of figure skating jumps. Similarly, specific training of these muscles is crucial for achieving high jumps with multiple rotations.

APRE was selected due to its approach, which adjusts the intensity of workouts based on individual performance. This specificity was deemed beneficial for addressing the varying needs of skateboarders, who require significant power and balance for ollie maneuvers. A study by Xing Zhang 2021 shown that autoregulation outperforms fixed loading approaches in terms of increasing maximum strength during maximum strength training. The study uses the vertical jump test to evaluate hip extensor and knee flexor muscles' effect on power, the SEBT (Star Excursion Balance Test) for balance, and the ollie maneuver evaluation for assessing

ollie performance among skateboarders (Gribble *et al.*, 2013; Candotti *et al.*, 2012). The selection of APRE is based on its ability to adjust workout intensity according to individual performance, making it beneficial for addressing the diverse needs of skateboarders, who require significant power and balance for Ollie maneuvers.

Previous studies have also shown that APRE effectively improves lower limb power, while autoregulation methods in strength training are more effective in improving maximum strength. It has been demonstrated in several studies that resistance training is beneficial for enhancing power, balance, and performance in a range of sports, including skateboarding. Nevertheless, the usage of APRE by skateboarders has been the subject of very little specialized study.

According to Coratella's 2021 study, front squats activate the gluteus maximus far more during the descending phase than any other exercise, whereas there is no discernible difference in activation during the rising phase.

In summary, this study demonstrates the importance of APRE in improving the power of lower limbs, balance and Ollie performance in a skateboarder. The limitation of the study was that Elite skateboarders were excluded from consideration, no sample size was allocated for control group, short duration of the study limited to one year may not capture the long-term effects hence the need to include control group in subsequent studies in order to understand better what really happens with intervention. This points toward more research with greater numbers for substantiation of these factors as well as to help scientists grasp how hip extensor and knee flexor muscles are influenced by lower limb power, balance and Ollie performance in skateboarders. Further studies can be conducted among 25 years and above more physiotherapy interventions on skateboarders can be done.

Conclusion

It has been hypothesized that Autoregulatory Progressive Resistance Exercise is an effective training program for enhancing power, balance and Ollie performance on hip extensors and knee flexor muscles. Skateboarders have greatly increased their power, balance and Ollie performance lately. However, there are no definite correlations between vertical jump test values and ollie maneuver evaluation scores, indicating that they are independent measures.

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