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The Effects of Weight Training Using the Normal Pyramid, Inverted Pyramid, and Double Pyramid Methods on the Lower-Body Power of Soccer Players

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Abstract

Modern soccer demands peak physical condition, particularly lower-body power to generate explosive jumps. Although crucial, the use of pyramid-style weight training is still rare among soccer athletes. Therefore, this study aims to examine the significant effects of each method (normal, reverse, and double pyramid) on improving leg power in soccer athletes, while also identifying differences in the effects among the three methods. This quantitative study adopted a true experimental approach using a Matched-Groups Pretest-Posttest Design. Using total sampling, 30 athletes from the Asa Bina Sejahtera 19 (ABS 19) youth soccer academy were enrolled and assigned to three treatment groups using a serpentine (S-shaped) randomization pattern. Lower-body power was measured via a vertical jump test before (pretest) and after (posttest) a 4-week intervention (2 sessions/week). Data analysis employed the Paired Sample T-Test and One-Way ANOVA. The results revealed that all three pyramid methods successfully produced a statistically significant effect on leg power improvement (Sig. < 0.05). However, the One-Way ANOVA indicated no significant difference in effect among the three methods (Sig. 0.14 > 0.05). In conclusion, all three pyramid methods had an equivalent effect on increasing lower-body power. Nevertheless, descriptively, the double pyramid method recorded the highest increase.

Keywords: Football; leg power; pyramid method; vertical jump; weight training.

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Introduction

Sports, in general, are physical activities that people engage in to maintain their health and physical condition; in modern life, sports play an important role that is inseparable from people's daily lives (Imran et al., 2022). Over time, modern sports have become increasingly competitive and demand peak performance from every athlete. Achieving peak performance no longer depends solely on mastery of technique and tactics but is largely determined by a foundation of excellent physical conditioning. Each sport has specific physiological requirements, including soccer (Bortnik et al., 2024). Modern soccer is a high-intensity sport that demands a perfect combination of technical, tactical, mental, and physical abilities (Bangsbo, 2015; Mulyadi et al., 2021).

Well-trained physical and muscular conditioning not only serves to maximize performance but is also crucial in helping athletes' bodies reduce fatigue toward the end of a match (Novian et al., 2025). One of the fundamental physical components supporting the performance of soccer players is strength and speed, which, when combined, produce power (Santoso et al., 2017). Power is the ability of muscles to generate maximum force in a short period of time, enabling athletes to perform explosive movements such as running and jumping effectively (Suchomel et al., 2016). In the context of soccer, lower-body power plays a crucial role in various explosive movements such as kicking, sprinting, and especially jumping (Fauzi et al., 2025).

The optimal execution of jumping techniques is heavily influenced by the physical element of lower-body power (Mukrimin et al., 2023). Furthermore, these technical abilities essentially form the foundation of a player's movement. Motor skills are a vital foundation because they support players in performing various movement skills and serve as the primary foundation for mastering more complex sports techniques, such as the vertical jump, to the fullest extent (Febrianty, 2020). Specifically, lower-body power is crucial for achieving vertical jump height, which is required by players in every position from goalkeepers, who rely on lower-body power for jumps during aerial saves, to defenders, who need vertical jump height for clearances and aerial duels, while midfielders and forwards use this power for attacking headers inside the penalty box (Bortnik et al., 2024; Putra et al., 2024).

Based on preliminary observations of soccer players from SSB Asa Bina Sejahtera 19 (ABS 19), a pressing issue was identified: many players exhibited weaknesses in lower-body power, particularly when performing vertical jumps. The players appeared to lack explosiveness when jumping to meet a lofted ball or during aerial duels. This issue aligns with the findings of previous research reporting that low lower-body power directly impacts a player's lack of explosive jumping power (Aziz & Febriyana, 2023). The implications of this low lower-body power significantly hinder players' tactical effectiveness, even though the manifestation of lower-body power through jumping technique is a crucial tool for winning aerial duels, meeting crosses, and clearing the ball in the defensive zone (Alhadi & Mardhika, 2025).

Based on the situation described above, there is a gap between the ideal conditions and the reality on the field. The current training program still relies too heavily on technique and tactics, resulting in the neglect of specific physical exercises designed to increase lower-body power. To address this issue of low lower-body power, a structured training intervention is needed. One proven effective alternative is weight training, which systematically aims to increase muscle strength and mass (Afif & Nasrullah, 2016; Blocquiaux et al., 2020). Selecting the appropriate weight training method during this phase is crucial, as increases in maximum muscle strength have been shown to provide the foundation for athletes to execute movement techniques far more effectively and efficiently (Novian et al., 2024).

To convert this strength into power, weight training must be applied using methods that demand maximum adaptation with a focus on fast and explosive movements, particularly with light loads to maximize speed so that it transforms into power such as the pyramid method with specific lower-body exercises (barbell squats, leg presses, leg extensions, and leg curls) (Farhiah et al., 2019; Rasekh & Shabani, 2021). The choice of this method is not without reason, given that each variation of the pyramid method triggers specific neuromuscular performance adaptation responses (Costa et al., 2021). Neurologically, this neural adaptation occurs as a result of an increase in the activation rate (firing pattern) of motor units (Cattan, 2021).

In a normal pyramid, progressively increasing the load in each set provides a high mechanical stimulus (Santos et al., 2020). This increase in intensity triggers the central nervous system to progressively recruit fast-twitch muscle fibers (Cattan, 2021). A different approach is taken in the inverted pyramid, where applying maximum load in the initial set instantly places pressure on the nervous system to recruit muscle fibers to their maximum capacity while the body is still fresh (Cattan, 2021; Costa et al., 2021). On the other hand, the application of the double pyramid requires a much greater training volume and mechanical load, which induces the highest metabolic stress among the three methods (Angleri et al., 2020; Cattan, 2021).

The differences in mechanical tension and metabolic stress across these methods also stimulate endocrine hormonal responses, particularly increased secretion of growth hormone (GH), testosterone, and insulin the primary drivers of muscle anabolism (Angleri et al., 2020; Cattan, 2021). It is these conditions that optimize muscle hypertrophy (Angleri et al., 2020). While simultaneously stimlating superior muscle endurance adaptations compared to the single pyramid and reverse pyramid methods (Cattan, 2021; Omidbakhsh et al., 2020). Although pyramid training effectively stimulates hypertrophy and optimal increases in lower-body power, this also depends on the athlete's discipline in following recovery protocols to minimize post-workout fatigue.

The success of this physiological adaptation is supported by fundamental external factors, such as maintaining proper nutritional status and daily protein intake within the range of 1.6-2.2 g/kg of body weight to maximize muscle synthesis (Stokes et al., 2018). In addition, maintaining adequate sleep duration and quality, supported by optimal hydration status, has been shown to be crucial for the comprehensive recovery of neural function (Walsh et al., 2021). Furthermore, the absence of a history of lower extremity injuries is also a prerequisite to ensure that the athlete's ability to withstand mechanical loads remains unimpeded (Kalkhoven et al., 2022).

In this intervention, it is assumed that all these external factors are balanced, so that the margin of increase in lower-body power achieved purely represents the effectiveness of each pyramid variation. A review of the literature indicates that there is a strong empirical foundation regarding the effectiveness of pyramid-method weight training for developing lower-body power, a topic that has been extensively studied. As concrete evidence, a previous study by (Farhiah et al., 2019) found that pyramid-method weight training has a positive effect on increasing lower-body muscle power. Furthermore, (Rasekh & Shabani, 2021; Sahri et al. 2014) also demonstrated that both the standard and double pyramid methods effectively increase power in weightlifters and powerlifters.

However, observations from previous studies indicate that the application of the pyramid method remains heavily concentrated in weightlifting and martial arts. Studies specifically applying this method to improve lower-body power in soccer athletes remain very limited. Furthermore, no comprehensive study has yet been conducted to simultaneously test and compare the differences in the effects of the three types of pyramid methods (normal, reverse, and double) on the jumping ability of soccer athletes. This finding is consistent with a recent literature review indicating that most studies on the pyramid method focus on only one method or compare only two methods separately, and that the research subjects are predominantly from the general population or other sports (Cattan, 2021).

Therefore, the lack of empirical data comparing all three variations of the pyramid method simultaneously in soccer athletes represents a research gap in the sports literature. Therefore, the novelty of this study lies in filling that gap by not only applying the pyramid method to the functional context of soccer but also by directly comparing the three pyramid methods (head-to-head) to determine whether there are differences in the effects of these three types of load variation methods. This study aims to provide empirical evidence regarding which method is most optimal for improving soccer athletes' jumping ability through lower-body power training, thereby generating practical recommendations to prevent overtraining and maximize athletic performance.

Specifically, this study was designed to answer the following research questions (1) Is there a significant effect of weight training using the normal pyramid method on the improvement of lower-body power in soccer players? (2) Is there a significant effect of weight training using the reverse pyramid method on the improvement of lower-body power in soccer players? (3) Is there a significant effect of weight training using the double pyramid method on the improvement of lower-body power in soccer athletes? (4) Are there significant differences in the effects of these three methods on the improvement of lower-body power?

Method

The research methodology employed a quantitative approach using a true experimental design. Specifically, the design used was a Matched-Group Pretest-Posttest Design (Fraenkel et al., 2019; Thomas et al., 2015). This design was chosen because it is highly effective in determining cause-and-effect relationships by simultaneously comparing the differences in the effects of the three treatment groups (normal, inverted, and double pyramid methods) through pretest and posttest instruments without involving a pure control group. This is a valid practice applied in modern sports science experiments, as implemented in the study by

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Vol. 9, No. 2, pp 1476-1493 June 2026
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(Claußen et al., 2025), which also compared the effects of three different training methods simultaneously.

The population in this study consisted of all 30 active soccer players at SSB Asa Bina Sejahtera 19 (ABS 19). Total sampling was used. Inclusion criteria: male, registered as an official athlete at SSB Asa Bina Sejahtera 19, in the U-16 age group (15-16 years old), actively participating in the SSB's regular soccer training schedule, and willing to participate in the weight training program for the full 4 weeks. Exclusion criteria included athletes currently experiencing an injury, having a history of a congenital condition that precludes strenuous physical activity, frequently being absent during the weight training intervention program, and currently participating in additional physical training programs outside the SSB schedule.

Although a G* Power analysis (effect size = 0.25; $\alpha = 0.05$; power = 0.80; correlation = 0.5) projected a sample size of 42 athletes, the actual sample size of n = 30 was deemed statistically adequate for the specific target population (U-16) to observe physiological adaptations (Faul et al., 2007). To ensure equality in initial ability (homogeneity), the 30 athletes first took a vertical jump pretest. Based on the results of these scores, the athletes were ranked and distributed into three treatment groups (normal pyramid, inverted pyramid, and double pyramid), with each group consisting of 10 athletes, using a Matched Group Design with the Equating Groups method, which applies a ranking mechanism. The sample distribution procedure followed the Serpentine System ("S" or zig-zag pattern) as recommended by studies (Hadi, 2015; Prakosa et al., 2021; Thomas et al., 2015). The flowchart of the experimental research is summarized in figure 1.

Figure 1. Research process

The research instrument used to measure lower-body strength was the vertical jump test using a vertical jump board, with a reliability coefficient of 0.93 and a validity coefficient of 0.78 (Pratama & Erawan, 2019). The test procedure is conducted strictly (Palinata et al., (2023): the activity begins by setting up a scaled board or measuring tape hung on the wall at the athlete's reach height. Before performing the jump, chalk powder is sprinkled on the hands. The participant stands sideways in front of the scaled board. The hand used to touch the scaled board or measuring tape is raised as high as possible and pressed against the board until it leaves a mark that can be read as the reach height. Steps for performing the vertical jump: lower the body by bending both knees. Jump as high as possible, and at the peak of the jump, tap or press the hand against the measuring board. Participants are given three attempts, and the difference between the best jump height and the reach height is the final result.

Vol. 9, No. 2, pp 1476-1493 June 2026
Doi: 10.29408/porkes.v9i2.36057

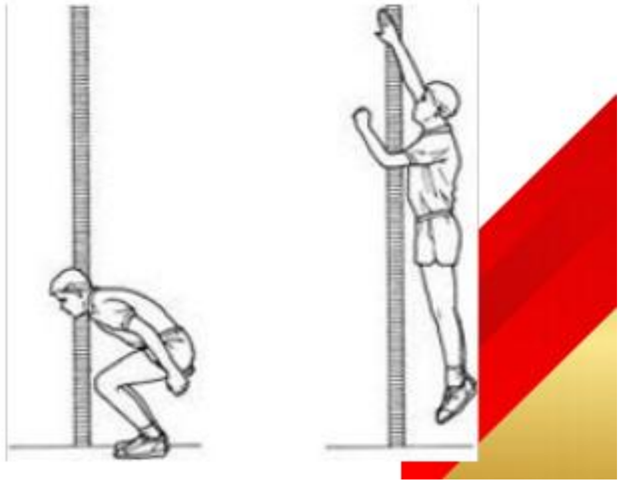

Figure 2. Vertical jump test source: (Sidik et al., 2025)

The weight training intervention, utilizing the pyramid method, was conducted at a fitness center over a four-week period with a frequency of two sessions per week. This method is empirically proven to be highly valid and effective for eliciting neuromuscular adaptations; furthermore, the four-week duration is considered sufficient to induce improvements in vertical jump height and explosive power (Da Silva et al., 2010; Mike et al., 2017; Ribeiro et al., 2015). The exercises prescribed included the Barbell Squat, Leg Press, Leg Extension, and Leg Curl. Movement techniques were strictly standardized Barbell Squats were performed as half-squats (lowering the body only to the halfway point or until the thighs were parallel to the floor), Leg Presses were executed with the feet positioned in the center of the footplate, and Leg Extensions and Leg Curls were performed through the full range of motion (full ROM).

Training loads were determined based on a percentage of each athlete's 1-Repetition Maximum (1RM). To prevent injury, the 1RM was estimated using the Relative Strength Ratio method (body weight x 1). For sets involving more than one repetition, the maximum load was calculated using the Brzycki/Epley formula (Grgic et al., 2020). group 1 followed the Normal Pyramid method (increasing load intensity, decreasing repetitions), group 2 employed the Reverse Pyramid method (starting with maximum load intensity and decreasing it, while increasing repetitions), group 3 utilized the Double Pyramid method (combining ascending and descending phases within a single session), Rest intervals between sets were set at 3-5 minutes (Sidik & L.Pesurnay, 2019) while rest between exercises was 2-3 minutes. Throughout the program, athletes were strictly monitored to ensure they did not engage in additional strength training. Details of the training program are provided in table 1.

Table 1. Training program

Week	Session	Pyramid method	Repetition	Set	Intensity	Rest
		Normal	11-10-9-8	4	45-50-55-60 % (1 RM)	3 minute
	1	Inverted	8-9-10-11	4	60-55-50-45 % (1 RM)	3 minute
1		Double	10-9-8-9	4	50-55-60-55 % (1 RM)	3 minute
		Normal	11-10-9-8	4	45-50-55-60 % (1 RM)	3 minute

Week	Session	Pyramid method	Repetition	Set	Intensity	Rest
	2	Normal	8-9-10-11	4	60-55-50-45 % (1 RM)	3 minute
		Inverted	10-9-8-9	4	50-55-60-55 % (1 RM)	3 minute
		Double	10-9-8-7	4	50-55-60-65 % (1 RM)	4 minute
	3	Normal	7-8-9-10	4	65-60-55-50 % (1 RM)	4 minute
2		Normal	9-8-7-8	4	55-60-65-60 % (1 RM)	4 minute
		Inverted	9-8-7-6	4	55-60-65-70 % (1 RM)	4 minute
	4	Double	6-7-8-9	4	70-65-60-55 % (1 RM)	4 minute
		Normal	8-7-6-7	4	60-65-70-65 % (1 RM)	4 minute
		Normal	8-7-6-5	4	60-65-70-75 % (1 RM)	5 minute
	5	Inverted	5-6-7-8	4	75-70-65-60 % (1 RM)	5 minute
3		Double	7-6-5-6	4	65-70-75-70 % (1 RM)	5 minute
		Normal	7-6-5-4	4	65-70-75-80 % (1 RM)	5 minute
	6	Normal	4-5-6-7	4	80-75-70-65 % (1 RM)	5 minute
		Inverted	6-5-4-5	4	70-75-80-75 % (1 RM)	5 minute
		Double	9-8-7-6	4	55-60-65-70 % (1 RM)	4 minute
	7	Normal	6-7-8-9	4	70-65-60-55 % (1 RM)	4 minute
4		Normal	8-7-6-7	4	60-65-70-65 % (1 RM)	4 minute
		Inverted	9-8-7-6	4	55-60-65-70 % (1 RM)	4 minute
	8	Double	6-7-8-9	4	70-65-60-55 % (1 RM)	4 minute
		Normal	8-7-6-7	4	60-65-70-65 % (1 RM)	4 minute

Inferential data analysis was performed using SPSS, including tests for normality (Shapiro-Wilk) and homogeneity (Levene's Test), followed by hypothesis testing using the Paired Sample T-Test and One-Way ANOVA at a significance level of $\alpha = 0{,}05$.

Results

Before hypothesis testing was conducted, prerequisite analyses including a normality test (Shapiro-Wilk) and a homogeneity test (Levene's test) were performed. The results of the normality test are presented in table 2 below.

Table 2. Vertical jump normality test (shapiro-wilk)

Group	Variable	Statistic	df	Sig.	Description
Normal pyramid	Pre-test	0,95	10	0,62	Normally Distributed
	Post-test	0,95	10	0,67	Normally Distributed
	Gain score	0,97	10	0,84	Normally Distributed
Inverted pyramid	Pre-test	0,93	10	0,44	Normally Distributed
	Post-test	0,91	10	0,27	Normally Distributed
	Gain score	0,91	10	0,26	Normally Distributed
Double pyramid	Pre-test	0,90	10	0,24	Normally Distributed
	Post-test	0,94	10	0,50	Normally Distributed
	Gain score	0,97	10	0,85	Normally Distributed

Based on table 2, The Sig. values for the pretest, posttest, and gain score (0,62; 0,67; 0,84) are > 0,05. The inverted pyramid shows Sig. values for the pretest, posttest, and gain score (0,44; 0,27; 0,26) > 0.05. For the double pyramid, the significance values for the pretest, posttest, and gain score (0,24; 0,50; 0,85) are all greater than 0,05. Therefore, H0 is accepted. It can thus be concluded that all research data from the three pyramid method groups are normally distributed. Furthermore, the results of the homogeneity test are presented in table 3 below.

Vol. 9, No. 2, pp 1476-1493 June 2026
Doi: 10.29408/porkes.v9i2.36057

Table 3. Test of homogeneity of variances (Levene's test)

	Levene Statistic	df1	df2	Sig.	Description
Pre-test	0,11	2	27	0,90	Homogeneous

Based on table 3, The Sig. value (0,90) is greater than 0,05, so H0 is accepted. Therefore, it can be concluded that the data from all three methods are homogeneous. Overall, the results of the prerequisite analyses indicate that all significance values (Sig.) for the normality test (Shapiro-Wilk) and the homogeneity of variance test (Levene's Test) exceed 0.05. This confirms that the fundamental assumptions of parametric testing specifically, that the data are normally distributed and exhibit homogeneous variances across groups are fully met. Meeting these assumptions demonstrates that the use of parametric statistical tests, namely the Paired Sample T-Test and One-Way ANOVA, is valid and appropriate to proceed with (Fraenkel et al., 2019).

Table 4. Summary of vertical jump improvement, pyramid group hypothesis test, distribution, and effect size (Cohen's d)

Group	Average pretest (cm) (Mean ± SD)	Average Posttest (cm) (Mean ± SD)	Gain Score (cm) (Mean ± SD)	Range (Min - Max)	Median increase	Increase (%)	Cohen's *d* (Effect Size)	Sig. (2-tailed)
Normal pyramid	43,60 ±7,92	48,70 ± 6,96	5,10 ± 2,47	1,00 - 9,00	5,50	12,6%	2,06	0,00*
Inverted pyramid	43,60 ±7,99	47,70 ± 6,70	4,10 ± 3,76	-1,00 - 9,00	4,50	10,6%	1,09	0,01
Double pyramid	43,40 ±7,25	50,20 ± 6,44	6,80 ± 2,53	2,00 - 11,00	7,00	16,5%	2,69	0,00*

Based on table 4, It can be seen that all three groups experienced an increase in their average vertical jump following a 4-week intervention. The Normal Pyramid group showed an increase of 5,10 cm (12,6%), the Inverted Pyramid group increased by 4,10 cm (10,6%), and the Double Pyramid group showed the highest increase of 6,80 cm (16,5%). Effect size calculations using Cohen's d indicate that all three methods yield large to very large effects on improving athletes' vertical jump performance. Furthermore, based on the results of the Paired Sample T-Test, a significance value of (0,00) < 0,05 was obtained for the Normal Pyramid and Double Pyramid methods, and a significance value of (0,01) < 0,05 for the Inverted Pyramid method. Since all significance values were < 0,05, H0 was rejected. Thus, it can be concluded that weight training using the normal pyramid, inverted pyramid, and double pyramid methods has a significant effect on the lower-body power of soccer players.

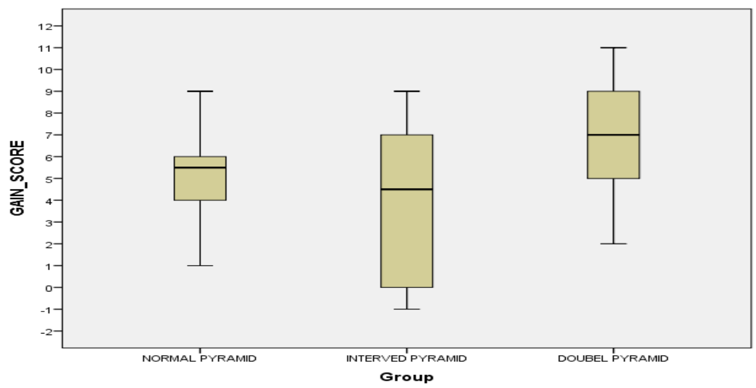

Figure 3. Boxplot of the distribution of vertical jump improvement (gain scores) for the three pyramid method groups

Table 5. Uji One-Way ANOVA

Gain Score	Sum of Squares	df	Mean Square	f	Sig.
Between Groups	37,27	2	18,63	2,10	0,14
Within Groups	239,40	27	8,87		
Total	276,67	29			

Based on table 5, The Sig. value (0,14) is greater than 0,05; therefore, H0 is accepted. It can thus be concluded that there is no significant difference in the effects of the normal pyramid, inverted pyramid, and double pyramid weight training methods on the improvement of lower-body power in soccer players. Therefore, no further interpretation of the Tukey HSD post hoc test is necessary. Although the One-Way ANOVA results indicated no significant difference in the effects of the three methods (Sig. 0.14 > 0.05), the calculation of practical effect size using partial eta squared yielded a value of 0.13. Based on statistical interpretation guidelines, this result indicates that the variations in the pyramid method (normal, inverted, and double) still contribute a medium-to-large practical effect (13% of the total variance) regarding the adaptation of differences in athletes' leg power (Cohen, 1998). As an additional analysis to control for potential differences in athletes' initial abilities prior to the intervention, an Analysis of Covariance (ANCOVA) was conducted using pretest scores as the covariate. The test results are presented in Table 6. below:

Table 6. Uji analysis of covariance (ANCOVA)

Sumber Varians	Sum of Squares	df	Mean Squares	f	Sig.
Corrected model	1068,99	3	356,33	52,50	0,00
Intercept	160,57	1	160,57	23,66	0,00
Pretest	1037,32	1	1037,32	152,83	0,00
Group	36,11	2	18,06	2,66	0,09
Error	176,48	26	6,79		
Total	72884,00	30			
Corrected Total	1245,47	29			

Based on Table 6, The ANCOVA results show a significance value for the Group variable of 0.09 (> 0.05); this further reinforces the finding that there is no statistically significant difference in the effects of the three methods, even after controlling for the athletes' initial abilities.

Discussion

The findings of this study confirm that the use of varying load patterns in weight training across the three pyramid method variations makes a significant contribution to increasing lower-body power. The success in increasing lower-body power in the standard pyramid group is supported by the structural and systematic nature of the loading pattern; biomechanically, this initial phase is highly advantageous as it allows athletes to prepare the muscles that will be used in each subsequent set (Nurtamami & Sulistyarto, 2022). This sequence of loading patterns aligns with the mechanism of progressive overload a progressive loading pattern in which the load, increased from the previous set, facilitates rapid muscle adaptation and forces the muscles to work harder and stronger than in the previous set (Santoso et al., 2017). This progressive overload is a manifestation of the Law of Overload, which states that the body must be gradually subjected to heavier-than-usual stimuli to prevent muscle fibers from plateauing (Giechaskiel, 2020; Sidik & L.Pesurnay, 2019).

The transition to progressively increasing load intensity provides physiological benefits; the light load at the beginning allows the joints time to adapt, while the increase in load in subsequent sets as the maximum load is reached forces the central nervous system to massively recruit fast-twitch type II muscle fibers in the lower extremity stabilizers, namely the quadriceps, hamstrings, and gluteus maximus (Bompa & Buzzichelli, 2019; Camara et al., 2016). The anatomical readiness of these supporting muscles, combined with instructions for rapid movement patterns, successfully converted basic strength into significant jumping power (Farhiah et al., 2019). Specifically, the normal pyramid method is highly effective for facilitating neural adaptation and refining technique. Furthermore, when this weight training routine is integrated with on-field soccer practice, it creates a synergistic effect; this combination allows the foundational strength developed to be directly coverted into explosive power during the execution of specific soccer skills a mechanism that theoretically aligns with the concept of strength conversion in sports (Bompa & Buzzichelli, 2019).

In addition to the progressive approach used in the standard pyramid method which stimulates the muscles by gradually increasing the load from light to maximum power can also be enhanced through the opposite approach, namely by applying a load shock at the beginning of the training session (Nia et al., 2024). The factors contributing to the success of the inverted pyramid method can be analyzed empirically. This method is characterized by the reversal of the normal pyramid structure: it places the heaviest load on the first set when the muscles are still at their freshest, followed by a reduction in load and an increase in repetitions in subsequent sets, Physiologically, performing maximum load early in the workout triggers a pre-compensation mechanism (Bompa & Buzzichelli, 2019; Nia et al., 2024). This pre-compensation state also known as muscle pre-activation stimulates an increase in strength by engaging more motor units and recruiting fast-twitch muscle fibers as soon as the first training session begins (Bompa & Buzzichelli, 2019). Then, when the load intensity is reduced in the next set, and the number of repetitions is increased, the already-stimulated nervous system is able to move the limbs with greater rhythm and speed, thereby significantly generating maximum power (Hartoto, 2018).

In other words, this method provides a strong initial stimulus, resulting in maximal motor unit activity right from the start of the first set (Cattan, 2021). However, the application of this method must take the athlete's psychological readiness into account. A perception of maximal load right from the beginning can influence the athlete's motivation levels and success. If an athlete struggles to manage the psychological demands of the initial set, it may lead to mental fatigue that impacts the achievement of goals in subsequent sets (Febrianty et al., 2021).

Furthermore, to reap the adaptive benefits of both previous methods simultaneously, an advanced variation was designed to combine the two previous variations in order to provide a significantly longer duration of mechanical stress on the muscles (Rasekh & Shabani, 202; Sahri et al., 2014). The most impressive gains achieved by the double-pyramid group stem entirely from its hybrid loading pattern design, which deliberately manipulates the loading and unloading phases within a single, complete session (Rasekh & Shabani, 2021). Because the execution of these ascending and descending cycles is performed simultaneously, this method forces the muscles to remain under tension for a much longer duration, making it highly effective at increasing muscle hypertrophy and lower-body strength (Mangine et al., 2015; Rasekh & Shabani, 2021). This increase in muscle mass (hypertrophy) resulting from the balance between the anterior and posterior muscle groups is the primary source of the upward propulsive force generated by the legs when resisting gravity (Camara et al., 2016). Therefore, the increased structural strength through hypertrophy of both the anterior and posterior muscles achieved through explosive movement demands explains why the double pyramid method is the most effective means of improving lower-body power and vertical jump performance (Aziz & Febriyana, 2023; Rasekh & Shabani, 2021).

The primary mechanism driving the superiority of the double pyramid method is the greater total workload, which triggers increased metabolic stress and thereby maximizes muscle hypertrophy (Cattan, 2021). This advantage aligns with findings from previous quantitative research. A study by (Farhiah et al., 2019) involving martial arts athletes demonstrated an 11.5% increase in leg power using a conventional (single) method. That figure is slightly lower than the results achieved by the pyramid method in the current study (12.6%) and falls significantly short of the impressive gains yielded by the double pyramid method (16.5%). These results indicate that the combination of prolonged mechanical tension and the accumulation of metabolic stress inherent to the combined cycles of this method effectively stimulates optimal muscle hypertrophy; this serves as the primary physiological explanation for why the double pyramid method in this study achieved the most significant improvements in leg power (Cattan, 2021; Rasekh & Shabani, 2021).

The results of the one-way ANOVA test show that there is no statistically significant difference in influence among the three pyramid methods (Sig. 0,14). The variations in gain scores among the three pyramid methods were considered to be within the range of normal variation. One possible reason for this could be the duration of the intervention. According to (Ribeiro et al. 2015; Da Silva et al. 2010), pyramid-method resistance training with a 4-week intervention is indeed highly valid and effective in eliciting early neuromuscular adaptation and increasing lower-body muscle strength. This is further supported by the research of (Mike et al., 2017), which indicates that a 4-week duration is sufficient to trigger improvements in vertical jump height and power.

However, the finding that there was no statistically significant difference in effects among the three methods (Sig. 0.14 > 0.05) warrants further analysis. Although a four-week duration proved sufficient to generally enhance power across all three pyramid methods, physiologically, this timeframe falls within the phase of early neural adaptation. During this initial phase, the body's central nervous system tends to respond to any new form of load stimulus with a relatively similar rate of adaptation (Bompa & Buzzichelli, 2019). Consequently, four weeks was insufficient to generate drastic differences in effects between the groups. This lack of significance was further confirmed by the Analysis of Covariance (ANCOVA) test; even after controlling for the athletes' baseline abilities (pre-test), the results remained non-significant (Sig. 0.09 > 0.05). This underscores that, during the first four weeks, the three methods yielded statistically comparable improvements, even though significant gains were observed within each individual group. Furthermore, the absence of a significant difference was heavily influenced by the relatively small sample size (n=10 per group), which limited the statistical power to detect subtle variations in effects among the three methods.

Another crucial factor is the high variability in individual responses, as evidenced by the magnitude of the standard deviation. Field data reveal that some subjects responded exceptionally well to the training showing improvements exceeding 15% (up to 11 cm) while others demonstrated only modest gains of less than 5% (approximately 1 cm). This response variability is simultaneously influenced by factors such as each athlete's prior resistance training experience, genetically determined muscle fiber type composition, and their daily recovery or fatigue status (Walsh et al., 2021). Therefore, statistical analysis considers these three improvements to be normal. Although the statistical calculations are considered equivalent, empirical descriptive observations in the field have successfully demonstrated that exposure to dual stress in the double pyramid method is the most effective treatment for enhancing lower-body power. However, achieving this maximum physical performance is, of course, closely tied to the athlete’s own psychological readiness. Psychological factors greatly assist athletes in setting goals and visualizing the steps needed to achieve them (Febrianty et al., 2024). Furthermore, this physically demanding strength training program also requires a high level of motivation and mental resilience so that athletes can persevere and not give up easily during the course of the training program (Febrianty et al., 2021). To maintain this level of motivation, the role of a coach is crucial, as the right leadership style and instructional approach will significantly determine an athlete’s success in achieving peak performance on the field (Novian et al., 2020).

This study should be interpreted with due consideration of several methodological limitations. These limitations include the relatively short intervention duration lasting only four weeks and the small sample size of 10 participants per group. Furthermore, the researchers lacked strict control over the athletes' dietary intake and daily sleep quality outside of their scheduled soccer academy training sessions. Variable measurement relied on a single instrument: the vertical jump. Regarding participant demographics, the sample consisted entirely of males; consequently, the observed adaptation patterns cannot be directly generalized to the broader population. Finally, the study did not include follow-up measurements in the weeks following the conclusion of the intervention, leaving it unclear whether the strength gains were permanent or susceptible to regression (detraining).

Based on the overall findings, this study outlines specific practical recommendations for strength and conditioning coaches when designing weekly programs. For beginner or intermediate athletes, starting with the normal pyramid method is highly recommended to establish a foundation of safe movement. If the goal is to maximize lower-body power gains within a short timeframe, the double pyramid method utilizing intensities of 50-80% of 1RM is the most effective option. Meanwhile, for advanced athletes, coaches are advised to implement rotating periodization cycles to prevent stagnation. The recommended weekly periodization scheme involves a normal pyramid for two weeks, followed by a double pyramid for two weeks, and concluding with a reverse pyramid for two weeks.

Conclusion

Based on the previously discussed findings, this study demonstrates that a four-week resistance training intervention utilizing normal, reverse, and double pyramid methods significantly improves lower-limb power in soccer players (Sig. < 0.05). Although the statistical comparative analysis revealed no significant difference in the effects among the three methods (Sig. < 0.14), empirical descriptive analysis in the field showed different results. The greatest improvement was achieved by the double pyramid intervention group (6.80 cm; 16.5%), followed by the normal pyramid method (5.10 cm; 12.6%) and the reverse pyramid method (4.10 cm; 10.6%).

Theoretically, these findings reinforce the principle of conjugate periodization (Bompa & Buzzichelli, 2019), which asserts that variations in training methods can provide equivalent adaptive stimuli, provided the principle of progressive overload is consistently met. Furthermore, this study offers the first empirical contribution directly comparing three variations of the pyramid method among soccer players, thereby addressing a research gap that had previously been limited to weightlifting and martial arts.

From the perspective of practical implications for football strength and conditioning coaches, these three methods are well-suited for alternating use to avoid athlete boredom and prevent training stagnation. If a coach is targeting a short-term program (4 weeks), the double pyramid method is highly recommended, as it has been conclusively proven to yield the greatest surge in power output. However, for long-term programming, coaches are advised to implement a periodization plan that rotates these three methods using each for a cycle of two to three weeks to optimize sustained neuromuscular adaptation.

Although this study makes a positive contribution, it still has several limitations. Therefore, future research is advised to: (a) extend the intervention duration to 8-12 weeks to observe more chronic adaptation effects; (b) incorporate a control group design for direct comparison; (c) include measurements of other biomotor parameters, such as running speed, isometric strength, and changes in muscle mass structure; (d) involve a sample of elite athletes competing at higher levels; and (e) empirically test and verify the long-term effects of rotating these three periodization methods in a practical setting.

Weight training utilizing normal, reverse, and double pyramid methods has been shown to significantly improve leg power in soccer players. One-Way ANOVA analysis revealed no significant difference in effectiveness among the three methods, indicating that they are comparable in their ability to enhance leg power. However, empirical field observations suggest that the accumulated mechanical stress associated with the double pyramid method makes it the most optimal training approach, as evidenced by the greatest gains in leg power performance. The study recommends that strength and conditioning coaches rotate these three methods to optimize athletes' leg power while preventing training stagnation and boredom; nevertheless, the double pyramid method stands out as the best option for maximizing leg power within a short timeframe.

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