



The effect of resistance band and complex training on strength, power, speed and agility of soccer players

El efecto de las bandas de resistencia y el entrenamiento complejo en la fuerza, la potencia, la velocidad y la agilidad de los futbolistas

Authors

Ramadhany Hananto Puriana ¹
Mugiyo Hartono ¹
Hadi ¹
Heny Setyawati ¹
Cahyo Yuwono ¹
Yogi Sayuty ²
Dewangga Yudhistira ²

¹ Universitas Negeri Semarang

² Universitas Negeri Surabaya

Corresponding author:
ramadhany@students.unnes.ac.id

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Abstract

Background and study aim: Choosing the right training method is key to developing the physical abilities of soccer players. This study aims to test the effects of resistance band (RB) and complex training (CT) methods on the strength, power, speed, and agility of male soccer players aged 17-19 years.

Material and methods: This study is an experiment with a two-group pretest-posttest design. The research sample consisted of 30 players divided into two groups given RB (n=15) and CT (n=15) training. The research instruments were a leg dynamometer, standing broad jump, medicine ball throw, 30-meter sprint, and Illinois agility run. Data analysis used the paired samples t-test and independent samples t-test with a significance level of $p < 0.05$, and calculated the effect size using Cohen's with the help of SPSS version 23.

Results: The paired samples t-test showed that both the RB and CT groups experienced significant improvements in all physical aspects ($p < 0.001$) with a high effect size ($d > 0.80$). The independent samples t-test showed that the CT group was significantly superior to the RB group in increasing leg muscle strength ($p < 0.001$; $d = 2.32$) and leg muscle power ($p < 0.000$; $d = 1.27$), while no significant differences were found in arm power, speed, and agility ($p > 0.05$). **Conclusions:** Both groups were effective in improving physical performance, but CT was the recommended training method for optimizing strength and power through the post-activation potentiation mechanism. In addition, RB was a flexible method for improving strength and power that could be applied according to the movement characteristics of soccer.

Keywords

Resistance band, complex training, soccer, physical performance.

Resumen

Antecedentes y objetivo del estudio: Elegir el método de entrenamiento adecuado es fundamental para desarrollar las capacidades físicas de los futbolistas. El objetivo de este estudio es evaluar los efectos de los métodos de entrenamiento con bandas elásticas (RB) y entrenamiento complejo (CT) sobre la fuerza, la potencia, la velocidad y la agilidad de futbolistas varones de entre 17 y 19 años.

Material y métodos: Este estudio es un experimento con un diseño pretest-posttest de dos grupos. La muestra de la investigación estuvo compuesta por 30 jugadores divididos en dos grupos a los que se les impartió entrenamiento con RB (n = 15) y CT (n = 15). Los instrumentos de investigación fueron un dinamómetro de piernas, salto de longitud sin impulso, lanzamiento de balón medicinal, sprint de 30 metros y carrera de agilidad de Illinois. El análisis de datos utilizó la prueba t para muestras emparejadas y la prueba t para muestras independientes con un nivel de significación de $p < 0,05$, y se calculó el tamaño del efecto utilizando Cohen con la ayuda de SPSS versión 23.

Resultados: La prueba t para muestras emparejadas mostró que tanto el grupo RB como el CT experimentaron mejoras significativas en todos los aspectos físicos ($p < 0,001$) con un tamaño del efecto alto ($d > 0,80$). La prueba t para muestras independientes mostró que el grupo CT fue significativamente superior al grupo RB en el aumento de la fuerza muscular de las piernas ($p < 0,001$; $d = 2,32$) y la potencia muscular de las piernas ($p < 0,000$; $d = 1,27$), mientras que no se encontraron diferencias significativas en la potencia de los brazos, la velocidad y la agilidad ($p > 0,05$).

Conclusiones: Ambos grupos fueron eficaces para mejorar el rendimiento físico, pero el CT fue el método de entrenamiento recomendado para optimizar la fuerza y la potencia a través del mecanismo de potenciación postactivación. Además, el RB fue un método flexible para mejorar la fuerza y la potencia que podía aplicarse de acuerdo con las características de movimiento del fútbol.

Palabras clave

Banda de resistencia, entrenamiento complejo, fútbol, rendimiento físico,

Introductio

In recent decades, the intensity of soccer games has increased, marked by an increase in the number of sprints and high-intensity actions in each game (Sulistiyono et al., 2024). Improvements in physical performance rely on measurable physical components. Physical components such as strength, power, and agility cannot be considered complementary components, but rather the foundation for determining victory in each game (Sulistiyono, Akhiruyanto, et al., 2021). The ability to generate force quickly in the shortest possible time is the definition of power (Hadi & Yudhistira, 2023). The ability to change direction in a relatively short time with action and reaction without losing concentration and balance is the definition of agility (Yudhistira & Tomolius, 2020). The ability to change direction in a relatively short time with action and reaction without losing concentration and balance is the definition of agility (Paryadi et al., 2023; Sulistiyono, Sugiyanto, et al., 2021). Therefore, appropriate training methods are needed to optimize the components of strength, speed, power, and agility. Furthermore, it is important to understand Resistance Band (RB) and Complex Training (CT) in soccer.

Training methods that are often used are Resistance Band (RB) and complex training. A study by Katushabe et al directly compared power resistance band training and conventional training in college athletes, with the results showing a 34.6% increase in squat strength compared to the conventional group's 31.6% increase (Katushabe & Kramer, 2020). A study by Loturco et al. found evidence that elastic band training can accelerate strength gains in the first two weeks of the preseason (Loturco et al., 2022), while a systematic review by Sousa et al. stated that elastic band training consistently has a positive effect on lower limb muscle strength variables in various sports (Sousa et al., 2025). Recently, it was found that elastic band training significantly improves the coordination ability of 13-year-old soccer players (Grine, 2025). This indicates that the resistant elastic nature requires movement control and proprioception (Grine, 2025).

Although it excels at increasing strength and power, there is still debate regarding its effectiveness in improving agility and speed, with varying research results. A study by Loturco found that elastic band and conventional training failed to increase speed (Loturco et al., 2022), while Katushabe et al. stated that there was no difference in the increase in 40-meter sprint speed between the elastic band group and the control group (Katushabe & Kramer, 2020). While Grine et al. reported a significant increase in 30-meter sprint speed (Grine, 2025). Sousa et al. summarized this inconsistency, noting that while many studies reported improvements in sprinting, several others found no significant effects (Sousa et al., 2025).

Results on agility also found inconsistencies. Loturco et al. found that only the traditional training group experienced an increase in agility (Loturco et al., 2022), direction and repeated change of direction. These differences are highly dependent on the type of exercise used, e.g., specific change of direction exercises with elastic bands vs. general strength exercises with elastic bands (Sousa et al., 2025).

On the other hand, complex training (CT) is widely recognized for improving strength, power, speed, and agility in soccer players. This method is characterized by weight training (WT) followed by plyometrics (PLY) exercises simultaneously (Hadi et al., 2024). This method is based on the physiological phenomenon of post-activation potentiation (PAP), whereby muscle performance in explosive movements can be improved after being preceded by muscle contractions at near-maximal intensity. A study by Miranda et al. states that CT and traditional strength training are equally effective in increasing maximum strength in bench press and back squat in 19-year-old soccer players (Miranda et al., 2022).

The main advantage of CT lies in its ability to transform strength into power. Thapa et al. stated that CR produced moderate to high improvements in jumping ability compared to the control group (Thapa et al., 2021), Miranda et al. also reinforced this by stating that CT improved jumping performance, while the traditional strength training group did not improve (Miranda et al., 2022). Meanwhile, Barra et al. found that CT performed three times a week improved countermovement jump (CMJ) performance (Barra-moura et al., 2024).

Thapa et al. stated that CT overall improved sprinting (Thapa et al., 2021), while Barra et al. stated that there was no improvement in sprint performance for both 5 meters and 15 meters after 6 weeks of CT training. Furthermore, Miranda et al. stated that there was no significant improvement in the Illinois



agility test and 505 agility test after the CT program (Miranda et al., 2022), similar to Barra et al. who stated that CT did not have a significant effect on the agility of soccer players (Barra-moura et al., 2024). Sousa et al. also stated that this was likely due to the training method, intensity, and sample characteristics (Sousa et al., 2025).

Based on the above description, there are two promising training methods but with different areas of debate. Training using resistance bands shows advantages in increasing strength, but the effectiveness in speed and agility is still inconsistent. On the other hand, CT is recognized as a superior method for increasing power. However, improvements in speed and agility show mixed results. The most fundamental knowledge gap is that there is still confusion regarding the effectiveness of these two methods, no definitive results have been obtained, and there is a lack of comparative studies between RB and CT. The purpose of this study is to investigate the effects of resistance band (RB) training vs. complex training (CT) on improving strength, power, speed, and agility in youth soccer players, with the following research questions:

1. Does resistance band training have an effect on strength, speed, power, and agility?
2. Does complex training have an effect on strength, speed, power, and agility?
3. How do resistance band training and complex training affect strength, speed, power, and agility?

Method

Study Participants

This study is a two-group pretest-posttest experiment conducted in several systematic phases (Hadi & Yudhistira, 2023). The first phase: focused on sample recruitment and qualification; sampling was conducted using a purposive method, in which 35 samples were selected from the initial population, followed by the selection of 30 male soccer players aged 17–19 years based on the following criteria: (1) had previously undergone maximum strength training as a foundation for power training, (2) were members of a club, (3) were willing to participate in a 6-week training program, three times a week, with a minimum attendance rate of 80%, (6) were male, (7) were aged 17–19 years. Exclusion criteria were no injuries, no additional training, and no dropouts during the 6-week period. Consequently, the sample size was 30 participants with characteristics of a height of 160–175 cm and a weight of 60–72 kg. Phase Two: Collection of initial test data (*Pretest*) using a leg dynamometer, two-handed medicine ball throw, standing long jump, 30-meter sprint, and the Illinois running test (Akhiruyanto et al., 2022; Hartono et al., 2024; Purnawan et al., 2022). The test results were then entered into the

formula $Z = \frac{X - \mu}{\sigma}$, X = The subject's original score, μ = the group average, σ = the standard deviation.

These results were then converted into Z-scores; each individual's Z-score was ranked from highest to lowest, and then applied to the Match Subject Ordinal Pairing (MSOP) using an A-B-B-A pattern to maintain balance between the RB and CT groups. The results yielded 15 RB groups and 15 CT groups.

Study Organization

Next, the third phase: involved implementing a 6-week RB and CT training program with a frequency of 3 sessions a week. After the treatment was completed, a post-test was conducted to see the improvement. The training procedure was (1) all players were guided to perform stretching for 3 minutes, followed by dynamic movements for 3 minutes, then performing the core RB and CT group exercises. The training program was guided by the coach and team. Compliance was measured by manual attendance at each session, and the average attendance rate was 87%, exceeding the minimum threshold of 80%. All athletes were included in the final analysis according to the minimum attendance criteria. The RB and CT training program is presented as follows:

Table 1. Resistance band training program and Complex training program

		Resistance band training program	
Meeting	Week	Material	Dosage
1-18	1-6	Resistance band chest press Resistance band tricep Resistance band squat jump	Method : Block system Model : resistance band



		Resistance band broad jump Resistance band sprint 30 meter Resistance band sprint multidirectional	Intensity: Adjusts to the elastic stretch of the band Rep/working time : 10-15 times/ 10-20 seconds etc Set : 2-3-4-5 dst Recovery : 1-3 minutes (adjust)
		Program latihan complex training	Metode : complex training Model : plyometrics dan weight training Intensitas weight training : 40-60 (1RM) Volume plyometrics : 80-150 foot contact/sesi Rep plyometrics – weight training ; 6-8 Recovery : 1-3 minutes (adjust) Set : 2-3-4-5 dst
1-18	1-6	Bench press – push up front clap Tricep extention – drop push up Barbel squat – tuck jump Leg extention – broad jump Leg curl – depth jump to sprint 30 meter Barbel calf raises -hurdle jump to sprint	

Statistical Analysis

Finally, in the fourth phase, we analyzed the data using descriptive statistics (mean and standard deviation), normality prerequisite tests (Shapiro-Wilk), homogeneity (Levene), paired samples t-test and independent samples t-test hypothesis tests, then measured the effect size between the two groups' posttests with Cohen, all assisted by SPSS version 23 (Saifu et al., 2021; Yudanto, Suherman, et al., 2022; Yudanto, Yudhistira, et al., 2022).

Results

Table 2. The results of this descriptive analysis provide an overview of the sample's condition before (pretest) and after (posttest) the intervention was administered to both groups. The standard deviations for the five instruments indicate a significant improvement in physical performance in both the Resistance Band and Complex Training (CT) groups.

Table 2. Results of pretest-posttest descriptive analysis of RB and CT groups

Components	Groups	Pretest (Mean ± SD)	Posttest (Mean ± SD)
Arm power	RB	6.43 ± 0.38	7.00 ± 0.37
	CT	6.42 ± 0.35	7.04 ± 0.38
Leg strength	RB	139.84 ± 8.47	147.22 ± 8.16
	CT	140.37 ± 7.66	166.17 ± 8.20
Agility	RB	17.46 ± 0.40	16.84 ± 0.41
	CT	17.47 ± 0.43	16.81 ± 0.41
Leg power	RB	219.63 ± 8.39	227.82 ± 7.73
	CT	221.68 ± 12.53	241.69 ± 13.36
Speed	RB	4.57 ± 0.19	4.41 ± 0.20
	CT	4.58 ± 0.16	4.42 ± 0.14

Table 2. Shows that, leg muscle strength; CT exercises exert a better influence than RB with a posttest average of 7.04 ± 0.38 , and the RB group of posttest average of 7.00 ± 0.37 . Strength of the limb muscles; The CT group provided a better improvement of 241.69 ± 13.36 than the RB group of 227.82 ± 7.73 . arm muscle power; both CT and RB groups were equally effective with almost identical averages. Agility ; The CT and RB groups increased agility in a balanced manner, but the time of the illinois run decreased to around 16.8 with no significant difference between the two groups. Speed ; There was an increase in running compared to the pretest of the two groups, but no significant difference was found between the two groups.

Table 3. Normality results with shapiro wilk test

Components	Groups	Sig		Justification
		Pretest	Posttest	
Arm power	RB	0.812	0.840	Normal
	CT	2.000	0.991	Normal
Leg strength	RB	0.510	0.519	Normal



	CT	0.973	0.884	Normal
Agility	RB	0.564	0.457	Normal
	CT	0.611	0.417	Normal
Leg power	RB	0.115	0.208	Normal
	CT	0.088	0.075	Normal
Sprint	RB	0.553	0.258	Normal
	CT	0.658	0.638	Normal

Table 4. Shows that all pretest-posttest variables have $p > 0.05$, so the data can be said to be normally distributed.

Table 4. Homogeneity results with the levene test

Components	Levene statistic	Sig	Justification
Arm power	53	0.819	Homogeneous
Leg strength	12	0.915	Homogeneous
Agility	25	0.875	Homogeneous
Leg power	271	0.607	Homogeneous
Speed	144	0.707	Homogeneous

Table 5. Shows that all variables have a significance value of $p > 0.05$. This indicates that there is no significant difference in variance, so it can be said to be homogeneous. Table 5. Hypothesis test results with paired samples t-test.

Table 5.

Components	Groups	Mean defference	Sig	Cohen's size effect
Arm power	RB	0.57	0.001	5.63
	CT	0.62	0.001	7.46
Leg strength	RB	7.38	0.001	5.84
	CT	25.80	0.001	08.08
Agility	RB	-0.62	0.001	6.95
	CT	-0.66	0.001	6.32
Leg power	RB	8.19	0.001	3.77
	CT	20.01	0.001	6.53
Speed	RB	-0.16	0.001	03.03
	CT	-0.16	0.001	04.04

Table 6. Shows that both methods statistically provided a significant improvement ($p < 0.05$) in all physical aspects and had an effect size above the threshold of 0.8, indicating that the impact of the training was not merely a statistical figure but had a strong influence. .

Table 6. Hypothesis test results with independent samples t-test

Components	Mean RB	Mean CT	Sig	Cohen's size effect	Justification
Arm power	7.00	07.04	0.771	0.11	Insignifcant
Leg strength	14.22	166.17	0.001	2.32	Signifikan
Agility	16.84	16.81	0.841	-0.07	Insignifcant
Leg power	227.82	241.69	0.000	1.27	Signifikan
speed	4.41	4.42	0.843	0.07	Insignifcant

Table 6 shows that the CT group was significantly superior to the RB group in terms of leg strength improvement ($p < 0.001$; $d = 2.32$) and leg power ($p < 0.000$; $d = 1.27$), and the effect size was in the high category, indicating that CT was better at improving the lower extremities. Conversely, arm power, speed, and agility showed no significant difference ($p > 0.05$) between the two groups, indicating that CT and RB have equivalent effectiveness in increasing arm power, speed, and agility in soccer players.

Discussion

This study aims to examine the effects of resistance band (RB) and complex training (CT) methods on the physical aspects of arm muscle power, leg muscle power, leg muscle strength, speed, and agility in



adolescent soccer players. The main results show that both training methods provide positive training adaptations and have mechanical differences, especially in the lower extremities. The paired samples t-test results show that the RB and CT groups showed a significant increase in performance in all physical parameters ($p < 0.05$), which is confirmed by the Cohen effect size value of 8.08, which is classified as high effect. These improvements demonstrate efficient neuromuscular adaptation, where a 6-week training program with a frequency of three times per week provided sufficient mechanical training load to trigger locomotor movement synchronization and connective tissue strengthening in athletes aged 17–19 years. This is similar to the findings of Lopes et al., who stated that elastic bands can produce strength gains similar to conventional equipment in adolescents when administered with measured and appropriate training doses. (Lopes, Silva, Santos et al., 2019)

The most contrasting results were the superiority of the CT group over the RB group in terms of leg strength ($p < 0.001$; $d = 2.32$) and leg power ($p < 0.001$; $d = 1.27$). Post-test data showed that the mean leg muscle strength of the CT group was 166.17 kilograms, far exceeding the RB group's average of only 147.22 kilograms. This advantage is theoretically attributed to the post-activation potentiation (PAP) phenomenon. During high-intensity muscle contractions at 40–60% (1 RM), myosin levels in the body increase. This process enhances the sensitivity of the myosin-regulating cross-bridge to calcium, thereby creating space within the nervous system to optimize motor units more efficiently. Research by Qiao et al. states that CT significantly increases the stretch shortening cycle (SSC) and increases leg power through better motor recruitment compared to single-method training (Qiao et al., 2022), Cormier et al. also confirmed that CT is more efficient in increasing maximal capacity to power (Cormier et al., 2020), The dominance of CT in increasing leg power is 241.69 centimeters compared to RB's 227.82 centimeters. In this case, it directly answers the problem formulation regarding the CT method being more effective in improving the lower extremities.

Furthermore, unlike the results for arm strength, speed and agility showed no significant differences between the CT and RB methods. This indicates that the increase in pretest and posttest values for both groups can be considered equivalent. This phenomenon is explained from several biomechanical perspectives; agility and speed are more influenced by the efficiency of intermuscular coordination and proprioception than by increases in absolute strength. Grine et al. state that resistance training provides dynamic resistance variables, where load increases are determined by the tension of the band, thereby forcing the muscles to remain stable in maintaining body posture and balance (Laugh, 2025), Second, for arm muscle power, the use of elastic bands provided equivalent results from the RB and CT groups. Ghigiarelli et al. state that adding elastic band training to the upper extremities increases power equally to pure weight training methods (Ghigiarelli et al., 2009). Similarly, research from Yudhistira states that elastic band training methods specifically designed with maximum movements advance the development of leg and arm muscle power (Yudhistira, 2023). This explains why the post-test arm power of the RB (7.00) and CT (7.04) groups was almost the same. Similarly, research by Katushabe & Kramer states that the addition of elastic band training is equivalent to an increase in 40-meter sprint speed (Katushabe & Kramer, 2020). Based on this, the improvement in arm power, speed, and agility is equally good from both methods. The insignificant results are not because both methods are ineffective in improving these physical components.

Physiologically, leg muscle strength and leg muscle power are significantly superior due to the higher intensity of weight training ranging from 40-60% of 1RM, whereas elastic bands only rely on the elasticity of the band. Furthermore, the RB and CT training programs included multidirectional sprinting and 30-meter sprinting with resistance, while the CT group also included plyometric depth jumps to sprint, while the CT group also incorporates plyometric depth jumps into sprints, thereby promoting optimal and efficient running movements to optimize the movements that represent soccer technique. Although Complex training (CT) provides consistent evidence of improved explosive power in soccer, its implementation certainly requires strict supervision by a coach or team of experts, and athletes must have a strong foundation to minimize the risk of injury. Studies by Hadi et al and Maliki et al support the finding that plyometric training combined with external resistance promotes power and agility (Hadi et al., 2024; Maliki et al., 2025)

The novelty of this study lies in the direct comparison between RB and CR in a population of soccer players. Most previous studies have shown inconsistent results regarding the use of elastic resistance on agility. This study clarifies that the use of elastic band training can improve agility and speed if the



training program is specifically designed to prioritize sprint movements using elastic bands as resistance. Furthermore, CT training does provide consistent evidence regarding improvements in strength, speed, agility, and power. However, the implementation of a CT training program requires strict supervision, and athletes must at least already have maximum strength training experience

Research limitations: the duration of training was limited to 6 weeks; tests and measurements in this study were still field-based; laboratory tests such as electromyography (EMG) were needed to observe muscle electricity or biomechanical analysis to monitor angles and joints when jumping; the research sample was limited to regional athletes and focused on males. Future research directions: extend the training duration to observe the chronic effects of training; vary the training dose to find the optimal threshold for triggering post-activation potentiation; use laboratory-based measurement tests to obtain comprehensive data; expand the sample size and include both genders.

Conclusions

Resistance band (RB) and complex training (CT) methods improve all physical components. In comparison, CT is significantly superior in terms of leg muscle strength and leg muscle power. On the other hand, both methods show no significant differences in agility, speed, and arm muscle power; that is, they are equivalent. These results imply that under limited weight training facility conditions, resistance bands can serve as an alternative exercise method, while complex training remains a highly recommended training method for improving strength, power, speed, and agility in soccer players.

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Authors and translators' details:

Ramadhany Hananto Puriana	ramadhany@students.unnes.ac.id	Author
Mugiy Hartono	mugiyohartono@mail.unnes.ac.id	Author
Hadi	hadi_pabbsi@mail.unnes.ac.id	Author
Heny Setyawati	henysetyawati@mail.unnes.ac.id	Author
Cahyo Yuwono	cahyoyuwono@mail.unnes.ac.id	Author
Yogi Sayuty	yogisayuty@unesa.ac.id	Translator
Dewangga Yudhistira	dewanggayudhistira@unesa.ac.id	Author