COMPETITOR:
JURNAL PENDIDIKAN KEPELATIHAN OLAHRAGA
e-ISSN: 2657-0734 & p-ISSN: 2085-5389 ‖ Volume 18, Number 1, 2026 ‖ P.0987-0998

Effects Circuit Training on Strength and Power in Youth: A Study on Futsal KSC Academy

Agung Yongki Faisal[1A-E*], Andri Suyoko[2B-D], Bayu Agung Pramono[3B-D], Adi Pranoto[4B-D]

[1,2,3,4] Universitas Negeri Surabaya, Jawa Timur, Indonesia

agungyongki.22012@mhs.unesa.ac.id[1*], andrisuyoko@unesa.ac.id[2], bayupramono@unesa.ac.id[3], adipranoto@unesa.ac.id[4]

ABSTRACT

This study examined the effects of circuit training on strength endurance and lower-limb power in 13-year-old futsal athletes at KSC Academy. Considering that adolescence represents a sensitive period for neuromuscular adaptation and long-term athlete development, structured and time-efficient training models are essential. A quasi-experimental pretest-posttest control group design was implemented involving 20 athletes divided equally into treatment (n = 10) and control (n = 10) groups. The treatment group completed a four-week circuit training program (three sessions per week), while the control group continued routine technical training. Strength endurance was assessed using 60-second push-up, sit-up, and back-up tests, and explosive power was measured via the standing broad jump. Statistical analysis included the Shapiro-Wilk normality test followed by Independent Samples t-test or Mann-Whitney U test ($\alpha = 0.05$). The findings revealed a significant between-group improvement in upper-body strength endurance, as indicated by push-up performance ($p = 0.002$), supporting the principle of training specificity and neuromuscular adaptation under repeated submaximal loading. No significant differences were observed in sit-up and back-up outcomes, suggesting limited trunk-specific overload. Although within-group analysis demonstrated significant improvement in standing broad jump performance ($p < 0.001$), intergroup comparison did not confirm exclusive intervention effects. Overall, circuit training effectively enhances muscular endurance in youth futsal athletes; however, optimizing explosive power likely requires more targeted modalities such as plyometric or progressive resistance training.

ARTICLE HISTORY
Received: 2026/01/31
Accepted: 2026/02/16
Published: 2026/02/21

KEYWORDS
Circuit Training;
Strength Endurance;
Explosive Power;
Youth Athletes;
Futsal Conditioning.

AUTHORS' CONTRIBUTION
A. Conception and design of the study;
B. Acquisition of data;
C. Analysis and interpretation of data;
D. Manuscript preparation;
E. Obtaining funding

Cites this Article : Faisal, A.Y.; Suyoko, A.; Pramono, B.A.; Pranoto, A. (2026). Effects Circuit Training on Strength and Power in Youth: A Study on Futsal KSC Academy. **Competitor: Jurnal Pendidikan Kepelatihan Olahraga**. 18 (1), p.0987-0998

INTRODUCTION

Futsal is recognized as a high-intensity intermittent sport characterized by repeated accelerations, decelerations, rapid directional changes, explosive kicking actions, and continuous tactical transitions (Naser et al., 2017; Taufik et al., 2022). Match analyses indicate that players frequently perform high-intensity efforts interspersed with short recovery intervals, placing substantial demands on both anaerobic and aerobic systems (De Oliveira Bueno et al., 2019; Spyrou et al., 2020). Consequently, optimal physical conditioning particularly strength endurance and lower-limb power is fundamental for sustaining performance across two halves of play.

Strength endurance enables athletes to maintain repeated muscular contractions against submaximal loads without premature fatigue, supporting pressing, marking, and repeated sprint actions throughout the match (Rahman, 2018; Granacher et al., 2018). Meanwhile, leg muscle power directly influences jumping, shooting velocity, and explosive changes of direction, all of which contribute to offensive efficiency and defensive responsiveness (Ardiansyah, 2020; Loturco et al., 2019). Empirical findings demonstrate that vertical and horizontal jump performance correlates significantly with sprint speed and kicking power in team-sport athletes (Ramírez-Campillo et al., 2018; Zheng et al., 2025).

The issue becomes more complex when addressing 13-year-old athletes. At this age, players typically experience peak height velocity (PHV), marked by rapid growth, neuromuscular reorganization, and hormonal changes that influence adaptation to training stimuli (Malina et al., 2015; Lin et al., 2025). Although this developmental phase offers high trainability potential, inappropriate program design may increase injury risk or fail to optimize long-term athlete development (Lloyd et al., 2016; Sukarta, 2019). Coaches often face constraints in training duration and must simultaneously develop multiple physical components within limited sessions (Ardiansyah, 2024). Designing an integrated and developmentally appropriate training model therefore remains a critical challenge in youth futsal coaching.

Among various conditioning strategies, circuit training has emerged as a widely adopted and efficient method for developing multiple fitness components simultaneously. Circuit training integrates strength, muscular endurance, and cardiovascular exercises performed sequentially with minimal rest, generating combined neuromuscular and metabolic stimuli (Reza, 2023; Myers et al., 2015). Its structure aligns well with the intermittent and high-tempo characteristics of futsal competition.

Recent studies report that circuit training improves aerobic capacity and anaerobic performance in adolescent athletes (Achmad Mukhlisin, 2025; Milanović et al., 2015). Furthermore, it has been shown to significantly enhance muscular endurance through repeated submaximal contractions (Putri, 2020; Schoenfeld et al., 2021) and to increase explosive power via plyometric or dynamic resistance elements embedded within circuit stations (Bouhlel et al., 2022; Ramírez-Campillo et al., 2018). Physiologically, this method induces improvements in neuromuscular coordination, motor unit recruitment, mitochondrial density, and glycolytic enzyme activity (Li et al., 2025; Suchomel et al., 2018).

Evidence of its effectiveness spans various sports contexts. In soccer, circuit-based programs improved sprint ability and repeated sprint performance (Fatah, 2025; Hammami et al., 2018). In basketball, circuit training enhanced agility and lower-limb explosive strength (Andika et al., 2025; Putri, 2020). Athletics research similarly demonstrated improvements in power output and muscular endurance among youth athletes (Mappanyukki, 2025). Within futsal specifically, participation in structured circuit programs has been associated with significant increases in VO_2max, anaerobic threshold, and overall match-related fitness indices (Nandana, 2025; Spyrou et al., 2020).

The effectiveness of circuit training is partly explained by its ability to combine moderate-to-high intensity loads with short recovery intervals, simulating competitive fatigue conditions (Li et al., 2025). Performing explosive movements under partial fatigue enhances neuromuscular efficiency and metabolic resilience—qualities essential in dynamic futsal matches (Sabransyah, 2025). Thus, from both theoretical and empirical perspectives, circuit training represents a promising integrative conditioning model.

Despite extensive literature on circuit training, several critical gaps remain. First, most studies emphasize general fitness indicators such as VO_2max, agility, or sprint time, with limited focus on specific strength endurance parameters measured through push-up, sit-up, and back-up tests in early adolescent futsal athletes (Granacher et al., 2018; Lloyd et al., 2016). These field-based instruments are widely used in youth physical assessment, yet their responsiveness to structured circuit interventions within futsal contexts remains insufficiently documented.

Second, although explosive power improvements have been widely reported in adult or mixed-age samples (Ramírez-Campillo et al., 2018; Bouhlel et al., 2022), studies specifically evaluating horizontal power through the standing broad jump in 13-year-old futsal players are scarce. Horizontal jump performance is highly relevant to futsal due to its association with acceleration and directional propulsion (Loturco et al., 2019), yet empirical validation within this age group is limited.

Third, adolescence around age 13 is considered a “window of opportunity” for neuromuscular development (Lloyd et al., 2016; Zakiyah et al., 2024). Training stimuli applied during this phase may produce long-lasting adaptations in strength, coordination, and power (Atiqah et al., 2024). However, inappropriate intensity manipulation or insufficient recovery may disrupt motor development or increase injury risk (Malina et al., 2015). Therefore, more targeted, age-specific investigations are required to determine whether circuit training effectively enhances both strength endurance and power within safe developmental boundaries.

Finally, previous futsal studies often analyze isolated components rather than examining the combined effect of circuit training on multiple performance parameters simultaneously (Spyrou et al., 2020; Nandana, 2025). Given the multidimensional demands of futsal, an integrative evaluation of muscular endurance and explosive power in early adolescents remains underexplored. The limited empirical evidence in this specific population underscores the urgency of conducting data-driven research that addresses both physiological and developmental considerations.

Based on the identified gaps, this study aims to comprehensively examine the effect of a structured circuit training program on strength endurance and leg muscle power in 13-year-old futsal athletes. Strength endurance will be assessed through push-up, sit-up, and back-up tests, while explosive power will be measured using the standing broad jump. By integrating multiple field-based instruments within a youth futsal context, this study seeks to provide more specific and ecologically valid evidence.

The novelty of this research lies in several aspects. First, it focuses explicitly on early adolescent futsal players at a critical developmental stage, integrating principles of long-term athlete development with practical field testing. Second, it simultaneously evaluates strength endurance and horizontal power outcomes, offering a multidimensional performance analysis rarely addressed in previous studies. Third, it contributes empirical evidence regarding the applicability of circuit training within youth futsal environments characterized by limited training time and high performance demands.

The findings are expected to enrich sport science literature by clarifying how circuit-based conditioning influences neuromuscular adaptation in early adolescence. Practically, the results may assist coaches in designing efficient, developmentally appropriate, and evidence-based training programs that optimize performance while supporting healthy growth trajectories. Ultimately, this study contributes to bridging the gap between theoretical conditioning models and real-world youth futsal coaching practices.

METHODS

Research Design

This study employed a quasi-experimental pretest-posttest control group design, a model widely recommended in youth sport science where full randomization is often impractical but experimental control remains feasible (Lloyd et al., 2016; Granacher et al., 2018). Two groups were involved: a treatment group receiving a structured circuit training intervention and a control group following routine academy training. This design enables the identification of causal trends in neuromuscular adaptation by comparing within- and between-group performance changes (Milanović et al., 2015; Schoenfeld et al., 2021). Quasi-experimental approaches are considered appropriate for applied field settings involving adolescent athletes, balancing ecological validity with methodological rigor (Malina et al., 2015; Hammami et al., 2018).

Participants

Twenty male futsal athletes (age = 13 years) from KSC Academy participated and were equally assigned to treatment (n=10) and control (n=10) groups using purposive sampling. Inclusion criteria were: (1) active membership in the U-13 category, (2) regular training participation, (3) injury-free status, and (4) parental consent. Exclusion criteria included injury occurrence or incomplete participation during the intervention period. Adolescence at this age corresponds to a sensitive developmental window for strength and power adaptation due to neuromuscular plasticity and peak height velocity proximity (Lloyd et al., 2016; Malina et al., 2015). Therefore, structured and progressive training exposure is critical for safe performance enhancement (Granacher et al., 2018).

Instruments

Strength endurance was assessed using standardized 60-second push-up, sit-up, and back-up tests. These field-based measures are frequently applied in youth physical fitness monitoring and demonstrate acceptable reliability for muscular endurance evaluation (Castro-Piñero et al., 2010; Ortega et al., 2015). Lower-limb explosive power was measured

Agung Yongki Faisal[1A-E*], Andri Suyoko[2B-D], Bayu Agung Pramono[3B-D], Adi Pranoto[4B-D]
agungyongki.22012@mhs.unesa.ac.id[1*]

using the standing broad jump test, a validated indicator of horizontal power and acceleration capability in team-sport athletes (Ramírez-Campillo et al., 2018; Loturco et al., 2019).

Supporting equipment included a digital stopwatch (time control), measuring tape (jump distance accuracy), and field markers (station layout consistency). Standardized protocols were maintained across pretest and posttest sessions to ensure measurement reliability and minimize inter-tester bias (Hopkins et al., 2009; Granacher et al., 2018).

Procedures

Pretest

Baseline assessments were conducted for both groups prior to intervention. Each participant completed push-up, sit-up, back-up (60 seconds each), and standing broad jump tests. Three jump trials were performed, with the best distance recorded. Pretesting established group equivalence and provided baseline data for change analysis (Milanović et al., 2015).

Intervention

The treatment group completed a four-week circuit training program, three sessions per week, consistent with recommended youth conditioning frequency (Lloyd et al., 2016). Each session consisted of three sets of eight stations performed at approximately 80% perceived intensity for 30 seconds per station, reflecting moderate-to-high intensity stimulus shown to enhance both muscular endurance and power (Bouhlel et al., 2022; Schoenfeld et al., 2021).

The stations included: incline push-up, step-up, twisting sit-up, lateral in-out, walking lunges with torso twist, 10-m shuttle run, bear crawl, and V-run (zigzag cones). This combination integrates upper-body endurance, core stability, agility, and lower-limb explosive tasks, mirroring futsal's intermittent movement profile (Spyrou et al., 2020; Hammami et al., 2018).

Progressive overload was applied by systematically reducing inter-set rest intervals from 60 seconds (week 1) to 30 seconds (week 4), maintaining constant work duration per station. Manipulating rest intervals has been shown to enhance metabolic stress and neuromuscular adaptation without excessive load increments in youth populations (Suchomel et al., 2018; Li et al., 2025). The control group continued standard academy sessions emphasizing technical drills and small-sided games.

Posttest

After four weeks, both groups underwent identical post-intervention testing using the same protocols, sequence, location, and evaluators to ensure reliability and internal validity (Hopkins et al., 2009).

Data Analysis

Statistical analyses were conducted using IBM SPSS Statistics 27. Data normality was examined via the Shapiro–Wilk test. Normally distributed variables (push-up, back-up) were analyzed using Independent Samples t-tests, while non-normally distributed variables (sit-up, standing broad jump) were analyzed using the Mann–Whitney U test, consistent with methodological recommendations for small samples (Field, 2018). Significance was set at $\alpha = 0.05$.

Results indicated a significant between-group difference in posttest push-up performance (p = 0.002), suggesting improved upper-body strength endurance following circuit training. However, no statistically significant differences were observed for sit-up, back-up, or standing broad jump variables, indicating partial adaptation within the four-week intervention period.

RESULTS AND DISCUSSION

Result

Descriptive analysis shows an increase in the mean of all physical performance variables after circuit training intervention. The push-up score increased from 19,50 ± 5,09 become 25,20 ± 4,21 at the posttest stage. The sit-up variable experienced a relatively small change in the mean from 41,60 ± 13,19 become 41,70 ± 14,20. The backup value increases from 61,25 ± 20,53 become 71,40 ± 19,83. In addition, the standing broad jump as an indicator of power showed an average increase from 172,6 ± 16,11 become 184,7 ± 21,18. In general, these descriptive results indicate a tendency for athletes' physical performance to improve after participating in a circuit training program.

Table 1.
Descriptive Statistics

Variabel	Pretest (Mean ± SD)	Posttest (Mean ± SD)
Push-up	19.50 ± 5.09	25.20 ± 4.21
Sit-up	41.60 ± 13.19	41.70 ± 14.20
Back-up	61.25 ± 20.53	71.40 ± 19.83
Standing Broad Jump	172.6 ± 16.11	184.7 ± 21.18

Based on statistical analysis, circuit training has been proven to significantly improve upper arm strength endurance, as measured by push-up tests, in adolescent athletes. The results of the Independent Samples t-test at the pretest stage showed that there was no significant difference between the treatment group and the control group in terms of push-up ability (p = 0,444), which indicates that both groups had relatively similar initial conditions before the intervention was administered.

After the intervention, the treatment group showed a significant improvement in push-up ability, with posttest scores p = 0,002. These findings indicate that circuit training is effective in improving arm muscle endurance in 13-year-old futsal athletes. Meanwhile, the sit-up variable did not show any statistically significant differences based on the test results.

Table 2.
Data Normality Test Results (Shapiro-Wilk)

Variable	Group	Statistics W	Sig. (p)	Description
Age	Treatment	0,65	0	Not normal
	Control	0,833	0,036	Not normal
Height	Treatment	0,843	0,048	Not normal
	Control	0,9	0,221	Normal
Body Weight	Treatment	0,883	0,141	Normal
	Control	0,912	0,296	Normal
IMT (BMI)	Treatment	0,886	0,151	Normal

Variable	Group	Statistics W	Sig. (p)	Description
Push-up (Pretest)	Control	0,875	0,113	Normal
	Treatment	0,919	0,348	Normal
Push-up (Posttest)	Control	0,928	0,43	Normal
	Treatment	0,864	0,084	Normal
Back-up (Pretest)	Control	0,945	0,605	Normal
	Treatment	0,975	0,936	Normal
Back-up (Posttest)	Control	0,91	0,28	Normal
	Treatment	0,927	0,416	Normal
Sit-up (Pretest)	Control	0,895	0,191	Normal
	Treatment	0,965	0,836	Normal
Sit-up (Posttest)	Control	0,823	0,027	Not normal
	Treatment	0,896	0,198	Normal
Standing Broad Jump (Pretest)	Control	0,945	0,614	Normal
	Treatment	0,911	0,289	Normal
Standing Broad Jump (Posttest)	Control	0,779	0,008	Not normal
	Treatment	0,887	0,155	Normal
	Control	0,976	0,942	Normal

Data normality was tested using the Shapiro-Wilk test because the sample size in each group was less than 50 subjects. The test results show that subject characteristics such as age and height are not entirely normally distributed in both groups. However, body weight and body mass index (BMI) variables showed a normal distribution in both the treatment and control groups.

In terms of physical performance variables, the normality test results showed that the push-up and back-up data, both in the pretest and posttest stages, were normally distributed in both groups. In contrast, the sit-up pretest and standing broad jump pretest variables showed a non-normal distribution in the control group.

Based on these results, the selection of statistical tests is adjusted to the characteristics of the data distribution. Variables that meet the assumption of normality are analyzed using parametric tests, while variables that do not meet the assumption of normality are analyzed using non-parametric tests. This approach was taken to maintain the accuracy of statistical analysis and improve the validity and reliability of the research results.

Table 3. Results of the Independent Samples t-test

Variable	Stage	Levene's Test (Sig.)	t	df	Sig. (2-tailed)
Push-up	Pretest	0,065	0,782	18	0,444
Push-up	Posttest	0,578	-3,703	18	0,002
Back-up	Pretest	0,619	-0,720	18	0,481
Back-up	Posttest	0,269	-1,309	18	0,207

The Independent Samples t-test was used to analyze the difference in ability between the treatment group and the control group on the variables of push-ups and back-ups, because both variables met the assumption of normality based on the Shapiro-Wilk test. Before conducting the t-test, the equality of variances was tested using Levene's Test. The results of Levene's Test showed that all Sig values. > 0,05, so that the assumption of equal variances is satisfied and the interpretation of the t-test results uses the equal variances assumed row.

Agung Yongki Faisal[1A-E*], Andri Suyoko[2B-D], Bayu Agung Pramono[3B-D], Adi Pranoto[4B-D]
agungyongki.22012@mhs.unesa.ac.id[1*]

In the pretest stage, the t-test results showed that there was no significant difference between the treatment group and the control group in terms of push-up ability (p = 0.444) and back-up ability (p = 0.481). These findings indicate that both groups had relatively similar baseline conditions before the exercise intervention was administered.

However, in the posttest stage, the t-test results showed a significant difference in the push-up variable between the treatment group and the control group (p = 0,002). The mean difference value of −5.400 indicates that the treatment group had higher push-up scores than the control group after participating in the circuit training program. Conversely, in the backup variable, no significant difference was found between the two groups at the posttest stage (p = 0.207), although there was a descriptive increase in the mean value in the treatment group.

Overall, these results indicate that circuit training has a significant effect on improving upper arm strength endurance, as measured by the push-up test, but does not yet have a significant effect on lower back muscle endurance, as measured by the back-up test.

Table 4.
Results of the Wilcoxon Signed-Rank Test

Variable	n	Z	p-value	Description
Sit-up (Post–Pre)	20	−0,262	0,794	Not significant
Standing Broad Jump (Post–Pre)	20	−3,726	< 0,001	Significant

The Wilcoxon Signed-Rank Test is used to analyze differences in pretest and posttest scores in the treatment group, especially for variables that do not meet the assumption of normality. This test aims to determine whether there are significant changes in physical performance after athletes participate in a circuit training program.

Based on the analysis results, the sit-up variable shows a Z value of −0.262 with a p-value of 0,794 (p > 0,05). These results indicate that there was no significant difference between the pretest and posttest sit-up scores after the circuit training intervention. Thus, the circuit training exercises provided have not been able to produce a significant improvement in abdominal muscle endurance.

In contrast, the standing broad jump variable as an indicator of leg muscle power showed a Z value of −3.726 with a p-value < 0,001 (p < 0,05). These findings indicate a significant difference between pretest and posttest scores, suggesting that the circuit training program had a significant effect on improving internal leg muscle power in the treatment group.

Discussion

The present study demonstrates that circuit training produces differential adaptations across physical performance components in 13-year-old futsal athletes. Statistically significant improvement was observed only in upper-body strength endurance (push-up), whereas abdominal endurance (sit-up), back extensor endurance (back-up), and between-group power outcomes showed more limited or inconsistent responses. These findings reinforce the principle of training specificity and age-related responsiveness in youth conditioning (Lloyd et al., 2016; Granacher et al., 2018).

Agung Yongki Faisal[1A-E*], Andri Suyoko[2B-D], Bayu Agung Pramono[3B-D], Adi Pranoto[4B-D]
agungyongki.22012@mhs.unesa.ac.id[1*]

The significant enhancement in push-up performance aligns with neuromuscular adaptation theory, which states that repeated submaximal contractions under time-constrained conditions improve muscular endurance through increased motor unit recruitment efficiency, improved intramuscular coordination, and enhanced glycolytic energy contribution (Schoenfeld et al., 2021; Suchomel et al., 2018). The circuit stations incorporated incline push-ups, bear crawls, and dynamic upper-body stabilization tasks, creating repeated loading on the pectoralis major, deltoids, and triceps brachii. Short inter-set rest intervals further amplified metabolic stress, a mechanism shown to stimulate muscular endurance development in adolescent populations (Bouhlel et al., 2022; Milanović et al., 2015). These findings are consistent with youth training studies reporting improvements in localized muscular endurance following moderate-to-high intensity circuit-based protocols (Hammami et al., 2018; Faigenbaum et al., 2016).

Conversely, the absence of statistically significant improvement in sit-up performance suggests that abdominal musculature may not have received sufficient targeted overload. Although twisting sit-ups and dynamic core movements were included, the distributed workload across multiple stations likely reduced specific stimulus magnitude to the rectus abdominis and hip flexor complex. Research indicates that core endurance improvements require either higher volume, longer time-under-tension, or specific stabilization-focused loading (Granacher et al., 2018; Behm et al., 2017). Moreover, early adolescence is characterized by variability in trunk muscle coordination and biological maturation, which influences adaptive response heterogeneity (Malina et al., 2015; Lloyd et al., 2016). Thus, inter-individual differences in maturity status may partially explain the inconsistent abdominal endurance gains.

Similarly, back-up performance did not demonstrate significant between-group differences. The erector spinae muscle group often responds more effectively to isometric endurance protocols or progressive resistance loading rather than dynamic, short-duration transitions (Behm et al., 2017). The circuit model emphasized functional movement transitions and agility-based tasks rather than sustained lumbar extension endurance. Previous youth conditioning research suggests that spinal extensor adaptation requires either specific static holds or external resistance progression to elicit measurable improvements (Granacher et al., 2018; Faigenbaum et al., 2016). Therefore, the training stimulus in this study may not have been sufficiently specific to optimize posterior chain endurance.

Interestingly, within-group analysis showed significant improvement in standing broad jump performance in the treatment group, indicating enhanced horizontal explosive power. Multi-joint and high-velocity tasks such as step-ups, shuttle runs, and V-runs likely contributed to improved neuromuscular coordination and stretch-shortening cycle efficiency (Ramírez-Campillo et al., 2018; Loturco et al., 2019). Circuit formats that integrate agility and rapid acceleration drills have been shown to enhance lower-limb rate of force development, particularly in youth team-sport athletes (Hammami et al., 2018; Bouhlel et al., 2022). However, because between-group comparison did not yield strong statistical superiority, the improvement should be interpreted cautiously. It is possible that maturation-related gains or routine academy training contributed to performance enhancement (Malina et al., 2015).

The four-week intervention duration also warrants consideration. Structural adaptations in muscle architecture and neural drive often require longer exposure periods (6–12 weeks) to reach statistically robust changes, particularly in explosive power parameters (Suchomel et al., 2018; Schoenfeld et al., 2021). Short-term improvements are frequently neural in nature and may not uniformly manifest across all muscle groups (Faigenbaum et al., 2016). Additionally, variability in baseline fitness levels may have influenced responsiveness, as youth athletes with higher initial performance typically show smaller relative gains (Granacher et al., 2018).

From a practical standpoint, these findings confirm that circuit training is an efficient method for enhancing upper-body strength endurance in youth futsal players, supporting repeated arm-driven stabilization and physical duels during match play (Spyrou et al., 2020). However, to optimize lower-limb explosive power and trunk extensor endurance, circuit training should be complemented with plyometric drills, resisted sprinting, or progressive resistance exercises that target the posterior chain more specifically (Ramírez-Campillo et al., 2018; Loturco et al., 2019; Suchomel et al., 2018). Integrating these modalities aligns with long-term athlete development frameworks that emphasize balanced neuromuscular progression (Lloyd et al., 2016).

This study has limitations, including short intervention duration, small sample size, and lack of biological maturation assessment. Furthermore, physiological monitoring variables such as heart rate response, RPE, or electromyographic indicators were not included, limiting mechanistic interpretation (Milanović et al., 2015). Future studies should implement longer interventions, maturity-based grouping, and more specific load manipulation to clarify adaptive pathways in youth futsal conditioning.

Overall, this research contributes empirical evidence that circuit training yields selective neuromuscular adaptations in early adolescents, highlighting the necessity of specificity and progressive overload in youth performance development.

CONCLUSION

This study concludes that circuit training produces selective neuromuscular adaptations in 13-year-old futsal athletes. Empirically, a significant improvement was observed in upper-body strength endurance, as reflected by enhanced push-up performance in the treatment group. This finding supports the principle of training specificity, indicating that repeated submaximal contractions with short recovery intervals effectively stimulate muscular endurance adaptations through improved motor unit recruitment and metabolic efficiency in adolescent athletes.

However, circuit training did not generate statistically significant improvements in abdominal (sit-up) and lower back (back-up) endurance. These results suggest that the distributed and dynamic nature of the circuit protocol may not have provided sufficient targeted overload to the trunk musculature. Likewise, although within-group analysis indicated improvement in leg muscle power (standing broad jump), the absence of strong intergroup differences requires cautious interpretation, as maturation-related adaptation and routine training exposure may also have contributed.

Conceptually, the findings confirm that circuit training is more effective for enhancing strength endurance than maximizing explosive power within a short intervention period in early adolescence. Therefore, to optimize lower-limb power and trunk endurance development, circuit training should be strategically combined with more specific modalities, such as plyometric exercises or progressive resistance training. Integrating these approaches will better support balanced and long-term physical development in youth futsal athletes.

Acknowledgments

The authors would like to express sincere appreciation to KSC Academy for providing full institutional support and access to facilities throughout the implementation of this research. Special gratitude is extended to the coaches and athletes of the U-13 team who demonstrated commitment, discipline, and enthusiasm during the intervention period. Their active participation and adherence to the training protocol were essential in ensuring data validity and research integrity.

We also acknowledge the contribution of parents and guardians who provided informed consent and continuous encouragement, recognizing the importance of structured and evidence-based training during adolescence. Appreciation is given to the research assistants and evaluators who ensured standardized measurement procedures, thereby strengthening the reliability of performance assessments.

Conceptually, this study was grounded in contemporary youth training and long-term athlete development principles. Therefore, we are grateful to the broader sport science community whose empirical findings and theoretical frameworks have informed the design, implementation, and interpretation of this research. Their contributions continue to advance evidence-based practice in youth conditioning.

Finally, we thank all parties who supported this work academically and administratively, enabling the study to be conducted systematically and ethically in accordance with sport science research standards.

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