

ผลการฝึกแบบผสมผสานที่มีต่อสมรรถภาพทางกายในนักกีฬาฟุตบอลชาย

มหาวิทยาลัยราชภัฏสุรินทร์

Effects of Complex Training on Physical Fitness in Male Football Players

at Surindra Rajabhat University

ภัทรพล ทองนำ^{1*}Pattarapol Thongnum^{1*}¹สาขาวิชาวิทยาศาสตร์การกีฬา คณะครุศาสตร์ มหาวิทยาลัยราชภัฏสุรินทร์ จังหวัดสุรินทร์¹Department in Sports Science, Faculty of Education, Surindra Rajabhat University, Surin Province

*Corresponding Author: jeffyswucukku@sru.ac.th

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บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อศึกษาผลของการฝึกแบบผสมผสานที่มีต่อสมรรถภาพทางกายในนักกีฬาฟุตบอลชายมหาวิทยาลัยราชภัฏสุรินทร์ กลุ่มตัวอย่างที่ใช้เป็นนักฟุตบอลชายมหาวิทยาลัยราชภัฏสุรินทร์ จำนวน 30 คน ได้มาโดยการเลือกแบบเจาะจง แบ่งออกเป็นกลุ่มควบคุม 15 คน และกลุ่มทดลอง 15 คน โดยกลุ่มควบคุมทำการฝึกซ้อมด้วยโปรแกรมฝึกฟุตบอลตามปกติ ส่วนกลุ่มทดลองทำการฝึกซ้อมด้วยโปรแกรมฝึกฟุตบอลตามปกติควบคู่กับโปรแกรมการฝึกแบบผสมผสาน เป็นระยะเวลา 6 สัปดาห์ 3 วันต่อสัปดาห์ วันละ 2 ชั่วโมง (16.30 – 18.30 น.) ทดสอบอัตราการเต้นของหัวใจขณะพัก ความเร็ว ความแข็งแรงของขา ความอ่อนตัว และพลังกล้ามเนื้อขา ก่อนการฝึก หลังการฝึกสัปดาห์ที่ 4 และสัปดาห์ที่ 6 วิเคราะห์ข้อมูลโดยใช้ค่าเฉลี่ย ส่วนเบี่ยงเบนมาตรฐาน วิเคราะห์ความแปรปรวนทางเดียวแบบวัดซ้ำ (One-Way Analysis of Variance with Repeated Measures) เปรียบเทียบความแตกต่างเป็นรายคู่ เมื่อพบความแตกต่างจะทำการวิเคราะห์เป็นรายคู่ด้วยวิธีของตุกี (Tukey) กำหนดนัยสำคัญทางสถิติที่ระดับ 0.05 ผลการวิจัยพบว่าหลังการฝึกสัปดาห์ที่ 6 นักฟุตบอลกลุ่มทดลอง มีอัตราการเต้นของหัวใจขณะพัก ความอ่อนตัว และพลังกล้ามเนื้อขา ดีขึ้นกว่าก่อนการฝึกอย่างมีนัยสำคัญทางสถิติที่ระดับ 0.05 จากผลการวิจัยชี้ให้เห็นว่าการฝึกแบบผสมผสานมีประสิทธิภาพในการพัฒนาอัตราการเต้นของหัวใจขณะพัก ความอ่อนตัว และพลังกล้ามเนื้อขาในนักฟุตบอลได้

คำสำคัญ: การฝึกแบบผสมผสาน, นักฟุตบอลชาย, มหาวิทยาลัยราชภัฏสุรินทร์

Abstract

This research aimed to examine the effects of complex training on physical fitness in male football players at Surindra Rajabhat University. The sample consisted of 30 male football players selected using purposive sampling and assigned to groups using matched-pair assignment: a control group (n = 15) and an experimental group (n = 15). The control group followed the regular football training program, whereas the experimental group followed the regular football training program in conjunction with a complex training program. The training lasted 6 weeks, 3 days per week, 2 hours per day (4:30 PM–6:30 PM). Resting heart rate, speed, leg strength, flexibility, and leg muscle power were assessed before training, after Week 4, and

after Week 6. Data were analyzed using means and standard deviations. One-way analysis of variance with repeated measures was used, and pairwise comparisons were performed using Tukey's method at a significance level of 0.05. The results showed that after Week 6, the experimental group demonstrated significant improvements in resting heart rate, flexibility, and leg muscle power compared with pre-training ($p < 0.05$). These findings suggest that complex training is effective for improving resting heart rate, flexibility, and leg muscle power in football players.

Keywords: Complex training, Male football players, Surindra Rajabhat University

1. Introduction

Football is a globally popular team sport that provides many benefits. Physically, it helps develop strength and overall fitness. Mentally, it helps players learn to accept defeat, acknowledge victory, and forgive others, supporting a positive life in society. This is consistent with Pokrajcic et al. (2018) and Ferrini et al. (2025), who stated that football is one of the most popular sports today. Football can also promote physical, intellectual, emotional, and social development. Similarly, Michailidis et al. (2025) and Khan & Yadav (2025) concluded that football is one of the most popular sports worldwide, with millions of male and female athletes participating. Football competitions are organized in almost every country, and the competition that every team dreams of participating in is the FIFA World Cup, held every four years. Therefore, each country organizes domestic competitions to identify skilled players for the national team. Furthermore, football is widely popular in Thailand, as evidenced by strong interest and participation whenever major competitions are held. Thailand recognizes the importance of the goal, "We want Thai football to reach the World Cup." Therefore, domestic football leagues have been established, and youth leagues have also been initiated to provide young players with experience. This lays the foundation for football development and promotes progress toward becoming future players for the Thai national team.

Basic football skills are fundamental and form the foundation of playing football. Football players should practice these skills correctly, understand the principles and methods, and train until they achieve proficiency. Each skill is important and can ultimately contribute to scoring a goal. Thongnum (2019) summarized the basic football skills as follows: stopping the ball, dribbling, passing, heading, kicking, throwing in, and shooting. This aligns with Lucas et al. (2025), who stated that football is a highly complex sport that requires the integration of physical, technical, and cognitive skills. Similarly, Tutar et al. (2024) explained that football is a popular team sport that requires a high level of tactical, technical, and physical ability to succeed. In addition to practicing the basic skills mentioned above, components of physical fitness are also essential for football players—for example, dribbling past an opponent, moving quickly and changing direction to intercept the ball, sprinting to receive the ball, and tackling to win possession. This is consistent with Turgut et al. (2025) and Shamshuddin et al. (2020), who concluded that football requires exceptional physical exertion, including jumping, pivoting/turning, tackling, high-speed running, short-distance sprinting, high power output, and rapid changes in direction. This is also consistent with Erol (2022),

who stated that the main components of soccer-specific physical fitness include acceleration, repeated anaerobic sprint ability, and explosive muscle power.

Currently, various training methods are used to enhance physical fitness, such as plyometric training followed by sprinting or hurdle jumps followed by sprinting. These methods stimulate the muscular and nervous systems and provide variety in training. Therefore, complex training can be considered an effective approach for developing football players and improving multiple components of physical fitness by incorporating diverse training methods. Debnath & Kumar (2021) explained that complex training is a highly effective form of exercise combining plyometric training and resistance training, which is especially beneficial for increasing athletes' muscular power. In addition, Choudhary et al. (2025) noted that complex training is widely used to increase strength, power, speed, agility, and jumping performance in athletes. This is also consistent with Nandakumar & Ramesh (2020), who reported that complex training is one method for developing explosive power, an essential component of athletic performance. It is widely used across many sports. Moreover, Yang et al. (2025) concluded that in modern football, the combination of technique and physical fitness is a crucial factor in developing athletic performance (Sun et al., 2025). To effectively design an exercise program that also supports psychological benefits, enjoyment is an important consideration. Exercise that is fun and satisfying can help prevent boredom (Seelamad, 2014).

For these reasons, the researcher was interested in applying a complex training model in football. Football requires the integration of various skills and physical fitness components. Currently, the football teams at Surindra Rajabhat University primarily focus on tactical patterns and playing strategies, with limited emphasis on specialized training to enhance physical fitness. The researcher believes that implementing this complex training program may positively affect resting heart rate, speed, leg strength, flexibility, and leg muscle power in football players. By using more diverse training modalities, athletes may significantly enhance their physical capabilities, providing a competitive advantage. Furthermore, the findings may serve as a valuable resource for further study and can be practically applied to benefit football athletes at all levels.

2. Materials and methods

2.1 Population

The population in this study comprised 60 male university football players from Surindra Rajabhat University.

2.2 Sample

The sample consisted of 30 male football players from Surindra Rajabhat University who participated in the 48th Thailand University Games, selected using purposive sampling.

2.3 Inclusion Criteria

2.3.1 Being a male football player at Surindra Rajabhat University who participated in the 48th Thailand University Games.

2.3.2 Having no history of, and not currently experiencing, severe or chronic injuries.

2.3.3 Voluntary participation and provision of written informed consent.

2.4 Exclusion Criteria

2.4.1 Any injury or condition that prevents participation, including injuries to the legs, ligaments, or joints sustained during training or due to accidents.

2.4.2 Having a serious communicable disease.

2.5 Research Instruments

2.5.1 The Complex Training Program (Wicharn, 2019) (Cronbach's $\alpha = 0.74$) consisted of:

- 1) 30-meter sprint.
- 2) Box jumps followed by a sprint, a slide, and another sprint.
- 3) High-knee jump run over hurdles, followed by a sprint.
- 4) High-knee run over hurdles, followed by a sprint.
- 5) High-knee jumps onto and off a box, followed by a forward-to-backward run.
- 6) Alternating step-ups on a box, followed by a lateral shuffle around cones.
- 7) High knees in place, followed by a W-drill run.
- 8) Single-leg high-knee hops in and out of a circle, followed by a square run.

2.5.2 Leg-strength dynamometer

2.5.3 Sit-and-reach test

2.5.4 Standing long jump test

2.5.5 Stethoscope

2.5.6 50-meter sprint test

2.5.7 Weighing scale

2.5.8 Stadiometer

2.5.9 Stopwatch

2.5.10 Whistle

2.5.11 Data recording form

2.6 Procedure

This study employed a quasi-experimental design with repeated measures. The study was approved by the Surindra Rajabhat University Institutional Review Board (approval no. HE 642011).

2.6.1 The researcher submitted a formal letter to the Dean of the Faculty of Education, Surindra Rajabhat University, requesting permission to conduct the study and use facilities for data collection.

2.6.2 The researcher explained the objectives, procedures, duration, complex training program, and regular football training program to the participants and emphasized strict adherence to the instructions. The researcher also explained participants' rights and benefits, including confidentiality, the right to accept or decline participation, and the freedom to decide whether to take part.

2.6.3 The participants completed a 50-meter sprint test to assess speed, and sprint times were recorded.

2.6.4 Participants were ranked from 1 to 30 based on sprint time, from the lowest (fastest) to the highest (slowest).

2.6.5 Participants were assigned to two groups ($n = 15$ each) using a matching method. Based on the recorded sprint times (seconds), participants were ordered from the lowest (fastest) to the highest (slowest). Individuals with similar times were paired (matched subjects), and each member of the pair was allocated to a different group. This process was repeated until each group had 15 participants.

2.6.6 One representative from each group drew lots to determine group assignment. Lot no. 1 was designated as the control group (regular football training program), and lot no. 2 was designated as the experimental group (regular football training program plus the complex training program).

2.6.7 After being briefed on the testing procedures, the participants completed the pre-test. Measurements included body weight, height, resting heart rate, speed, leg strength, flexibility, and leg muscle power.

2.6.8 Training was conducted on Mondays, Wednesdays, and Fridays for 6 weeks, 2 hours per day (4:30 PM–6:30 PM). The control group followed the regular football training program, whereas the experimental group followed the regular football training program combined with the complex training program. Post-tests were conducted after Week 4 and again after Week 6 using the same testing procedures as the pre-test.

2.6.9 All results were recorded for subsequent statistical analysis.

3. Results

As shown in Table 1, the control group had a mean body weight of 67.67 ± 6.70 kg and a mean height of 171.67 ± 4.75 cm. The experimental group had a mean body weight of 68.27 ± 6.86 kg and a mean height of 174.13 ± 4.47 cm.

Table 1. General characteristics of the participants

Group	Weight		Height	
	$\bar{x}$	S.D.	$\bar{x}$	S.D.
Control Group	67.67	6.70	171.67	4.75
Experimental Group	68.27	6.86	174.13	4.47

As shown in Table 2, within the experimental group, complex training resulted in statistically significant changes ($p < 0.05$) in resting heart rate, flexibility, and power when comparing pre-training, after 4 weeks of training, and after 6 weeks of training. No statistically significant changes ($p > 0.05$) were observed for speed or leg strength.

Therefore, Tukey's post hoc test was used to conduct pairwise comparisons for resting heart rate, flexibility, and power across the three time points (pre-training, Week 4, and Week 6).

Table 2. Comparison of the effects of complex training on resting heart rate, speed, leg strength, flexibility, and power in male football players at Surindra Rajabhat University within the experimental group (pre-training, Week 4, and Week 6)

List	SS	df	MS	F	Sig
Resting heart rate					
Between Groups	336.178	2	168.089	9.337*	0.000
Within Groups	756.133	42	18.003		
Total	1092.311	44			
Speed					
Between Groups	0.250	2	0.125	0.517	0.600
Within Groups	10.174	42	0.242		
Total	10.425	44			
Legs Strength					
Between Groups	0.637	2	0.318	1.356	0.269
Within Groups	9.868	42	0.235		
Total	10.505	44			
Flexibility					
Between Groups	301.733	2	150.867	28.153*	0.000
Within Groups	225.067	42	5.359		
Total	526.800	44			
Power					
Between Groups	645.378	2	322.689	40.871*	0.000
Within Groups	331.600	42	7.895		
Total	976.978	44			

*p-value < 0.05

As shown in Table 3, Tukey's pairwise comparisons for resting heart rate within the experimental group indicated statistically significant differences ($p < 0.05$) between Week 4 and Week 6 and between pre-training and Week 6.

Table 3. Results of Tukey's pairwise comparisons for resting heart rate within the experimental group (pre-training, Week 4, and Week 6)

Testing period	Mean Difference	Sig
Pre-training and Week 4	2.800	0.180
Week 4 and Week 6	3.867*	0.043
Pre-training and Week 6	6.667*	0.000

*p-value < 0.05

As shown in Table 4, Tukey's pairwise comparisons for flexibility within the experimental group indicated statistically significant differences ($p < 0.05$) between pre-training and Week 4, between Week 4 and Week 6, and between pre-training and Week 6.

Table 4. Results of Tukey's pairwise comparisons for flexibility within the experimental group (pre-training, Week 4, and Week 6)

Testing period	Mean Difference	Sig
Pre-training and Week 4	-2.867*	0.004
Week 4 and Week 6	-3.467*	0.001
Pre-training and Week 6	-6.333*	0.000

* p -value < 0.05

As shown in Table 5, Tukey's pairwise comparisons for power within the experimental group indicated statistically significant differences ($p < 0.05$) between pre-training and Week 4, between Week 4 and Week 6, and between pre-training and Week 6.

Table 5. Results of Tukey's pairwise comparisons for power within the experimental group (pre-training, Week 4, and Week 6)

Testing period	Mean Difference	Sig
Pre-training and Week 4	-5.000*	0.000
Week 4 and Week 6	-4.267*	0.000
Pre-training and Week 6	-9.267*	0.000

* p -value < 0.05

4. Discussion

The objective of this study was to compare changes in physical performance variables within the experimental group at three points in time: pre-training, after 4 weeks of training, and after 6 weeks of training.

4.1 Resting heart rate

The results showed that within the experimental group, resting heart rate improved significantly after Week 6, indicating a time-dependent training adaptation between Week 4 and Week 6 and between pre-training and Week 6. This suggests that the complex training program influenced participants' resting heart rate. A possible explanation is that the heart muscle requires a sufficiently long period of regular exercise to adapt, leading to a lower resting heart rate. For example, the resting heart rate in the general population is typically around 70 beats per minute, whereas individuals who exercise regularly often show values around 60 beats per minute. This indicates that the heart muscle has become stronger and more efficient at pumping blood throughout the body. In the present study, the training stimulus may have

increased cardiac efficiency and supported recovery. This is supported by Moges et al. (2024), who summarized evidence that endurance athletes training at low and moderate intensity experience positive changes in blood composition and improved heart rate recovery. In addition, Lin et al. (2022) reported that higher-intensity resistance training can improve resting heart rate and heart rate variability (HRV). Similarly, Kuswoyo & Lahinda (2020). found that high-intensity training significantly improved physiological variables, including VO2max and resting heart rate, in university-level football players.

4.2 Flexibility

The findings showed that within the experimental group, flexibility improved significantly after Week 6, indicating a time-dependent training adaptation between pre-training and Week 4, between Week 4 and Week 6, and between pre-training and Week 6. This suggests that the training program contributed to improved flexibility. Flexibility refers to the ability of the body and joints to move through a full range of motion and is an important component of physical fitness. Improving flexibility typically requires regular stretching of ligaments, joint capsules, and fascia surrounding the muscles. In this study, the experimental group performed stretching exercises before and after each training session, which may explain the improvement observed. This is supported by Pranoto et al. (2025), who found that regular exercise can substantially increase flexibility, especially in athletes, and that athletes respond better to training programs than non-athletes. Similarly, Ihsan et al. (2023) reported that stretching techniques are necessary for improving flexibility and may help prevent sports injuries. Esposito et al. (2025) also concluded that resistance training may increase flexibility while simultaneously enhancing athletes' psychological and physical self-awareness more effectively than traditional stretching.

4.3 Power

The results showed that within the experimental group, leg muscle power improved significantly after Week 6, indicating a time-dependent training adaptation between pre-training and Week 4, between Week 4 and Week 6, and between pre-training and Week 6. This suggests that the training program influenced leg muscle power. A possible explanation is that the complex training program included several exercises designed to develop power (e.g., multiple forms of jumping). Leg muscle power is produced by combining strength and speed during muscle contraction and relaxation, which is essential for athletes who require fast and forceful movements. As lower-limb muscles become stronger and more explosive, power performance can improve. In addition, the program likely targeted the muscle groups commonly used in football, contributing to the observed changes. This is supported by Apriantono et al. (2023), who suggested that a 10-week sprint training program can improve athletes' physical fitness, including VO2max, agility, and vertical jump power in futsal athletes. Krzysztofik et al. (2024) summarized evidence that complex training (CT) performed at moderate to high intensity for 6 weeks can increase jumping performance, running speed, and maximal lower-body strength in football players. Likewise, Kyung & Park (2024) reported that a 6-week complex training (CPT) program was more effective than compound training (CT) in increasing strength and jump power. Xu et al. (2025) also summarized findings that an 8-week combined strength and plyometric training program is more effective than strength training alone for improving jumping ability in high-level athletes, particularly males, and suggested that plyometric formats

can be incorporated into pre-competition training cycles. Thomas et al. (2021) similarly reported that the complex training group showed a slightly better and statistically significant improvement in jump power. In addition, Hu et al. (2025) concluded that an 8-week complex training program produced greater improvements in leg muscle power, acceleration, and agility than traditional resistance training in female badminton players. Chantra (2024) also reported that the S.A.P. complex training program is effective in enhancing speed, agility, and leg power among volleyball athletes.

4.4 Speed

The results showed that within the experimental group, speed did not differ significantly across pre-training, Week 4, and Week 6. This may be because the program emphasized movements that are similar to football actions (e.g., starting, accelerating, decelerating, changing direction, and re-accelerating), which require a foundation of strength, power, and agility. Although the statistical analysis did not show a significant difference, the mean sprint time in the experimental group showed a decreasing trend (i.e., faster performance). Therefore, it is possible that a longer training duration and/or higher intensity could produce statistically significant changes. This is supported by Sun et al. (2025), who summarized evidence that SAQ training improves speed performance. Choudhary et al. (2025) also stated that complex training (CT) is an effective method for developing explosive strength, speed, and agility, especially in young athletes. Furthermore, Naveen et al. (2024) concluded that complex training can enhance several abilities in intermediate-skilled football players, including agility, speed, power, and kicking accuracy. Nugroho et al. (2024) also reported that complex training results in greater improvements in speed than plyometric training. In addition, Ceviz et al. (2025) found that a combined endurance and resistance training program lasting 12 weeks can significantly improve aerobic endurance and speed in male U-17 football players. Similarly, Purnamasari et al. (2025) summarized evidence that contrast training can significantly increase speed and lower-body strength in futsal athletes.

4.5 Leg Strength

The results showed that within the experimental group, leg strength did not differ significantly across pre-training, Week 4, and Week 6. One possible explanation is that strength refers to the ability of muscles to generate tension and exert force against external or internal resistance. Maximum strength depends on the biomechanics of the movement, the muscle groups involved, the number of muscle contractions, and the intensity of neural impulses that stimulate muscle activation. Although no statistically significant difference was observed, the mean values showed an upward trend, which may reflect that the program emphasized lower-limb training through a combination of training formats. It is possible that expanding the training methodology (e.g., increasing variety and/or adjusting the load and intensity) could produce clearer strength adaptations. This is supported by Nugroho et al. (2023), who concluded that resistance training was more effective than free-weight training for improving leg strength in athletes with high leg power, whereas free-weight training was more effective for athletes with low leg power. Therefore, strength training programs may need to consider an athlete's baseline level of leg power. In addition, Wang et al. (2023) concluded that complex training can improve maximal strength more effectively than plyometric training. Sabillah et al. (2022) also reported that Side-to-Side Box Shuffle training may be more

effective for athletes with low leg muscle strength, whereas Box Jump training may be more effective for athletes with high leg muscle strength. Finally, Zhai & Qin (2024) suggested that complex training (CT) may be valuable for developing performance variables in amateur futsal players and may offer advantages over resistance training (RT) for improving strength and muscle power.

5. Conclusion and suggestions

5.1 Conclusion

The results indicate that a complex training program can help improve resting heart rate, flexibility, and leg muscle power in football players. Therefore, complex training can be incorporated into football training to enhance these components of physical fitness.

5.2 Suggestions for future research

5.2.1 Future studies should compare complex training with other training methods to identify the most effective approach for improving football players' physical fitness.

5.2.2 Future studies should diversify complex training formats (e.g., exercise selection, intensity, and progression) to further enhance physical fitness in football players and athletes in other similar sports.

6. References

- Apriantono, T., Juniarsyah, A. D., Adnyana, i. K., Hasan, M. F., & Resmana, D.. (2023). The effect of speed training on the physical performance of adolescent futsal players. *Journal SPORTIF: Journal Penelitian Pembelajaran*, 9(1), 172 – 184. https://doi.org/10.29407/js_unpgri.v9i1.19047
- Ceviz, E., Genc, H., & Sabanci, G. (2025). The Effects of Combined Endurance and Strength Training on Endurance and Sprint Performance in Young Elite Football Players. *Sportive Perspective: Journal of Sports and Educational Sciences*, 12(2), 252-264. <https://doi.org/10.70736/spjses.307>
- Chantra, D. (2024). The Development of the Integrated S.A.P. Training Model Affecting Leg Muscle Power, Speed, and Agility of Volleyball Players at Sisaket Rajabhat University. *Science and Technology Journal of Sisaket Rajabhat University*, 4(2), 95 – 103. <https://li01.tci-thaijo.org/index.php/STJS/article/view/265237>
- Choudhary, S., Choudhary, P. K., Rajpoot, Y. S., Singh, D., Hooda, N., & Saini, A. (2025). Evaluating the Effects of Complex Training on Athletic Performance: A Systematic Review. *Physical Education Theory and Methodology*, 25(5), 1255-1267. <https://doi.org/10.17309/tmfv.2025.5.25>
- Debnath, P., & Kumar, A. (2021). Complex Training is highly effective from physical exercise that combination of plyometric explosive power training and weight training which to be most useful for improving athletic power. *Aegaeum Journal*, 9(7), 148 – 155.
- Erol, S. (2022). An investigation of the effects of 8-week complex and contrast strength trainings applied to soccer players on some physical properties. *International Online Journal of Education and Teaching (IOJET)*, 9(4), 1600-1613.
- Esposito, G., Ceruso, R., Invernizzi, P. L., Manzi, V., & Raiola, G. (2025). Effects of Stretching and Resistance Training on Psychophysical Awareness: A Pilot Study. *Applied sciences*, 15(15), 8259. <https://doi.org/10.3390/app15158259>
- Ferrini, M., Clemente, J. A., Bagattini, G., and Arrones, L. S. (2025). A Combined 7-Week Strength and Power Training: Effects on Body Composition, Strength, Speed, and Agility in U14 and U16 Youth Elite Soccer Players. *Applied Sciences*, 15(5), 2470. <https://doi.org/10.3390/app15052470>

- Hu, R., Zhao, M., Shen, X. & Wang, Z. (2025). The effects of an 8-week complex training program on lower limb explosive power and movement agility in adolescent female badminton players. *Frontiers' journals*, 16, 1678866. <https://doi.org/10.3389/fphys.2025.1678866>
- Ihsan, F., Karyono, H. T., Primasoni, N., et al. (2023). The effect of stretching techniques on flexibility and sports injuries: A literature review. *Journal Olahraga Prestasi*, 19(3), 220-230. <https://doi.org/10.21831/jorpres.v19i3.70745>
- Khan, A. U & and Yadav, S. K. (2025). Impact of Complex Training with and Without Skill Work on Male Football Performance. *Shodhshauryam International Scientific Refereed Research Journal*, 8(5), 12 - 20. <https://doi.org/10.32628/SHISRRJ25853>
- Krzysztofik, M., Jarosz, J., Urbanowski, R., Aschenbrenner, P., & Stastny, P. (2024). Effects of 6 weeks of complex training on athletic performance and post-activation performance enhancement effect magnitude in soccer players: a cross-sectional randomized study. *Biology of Sport*, 42(1), 211-221. <https://doi.org/10.5114/biolsport.2025.139849>
- Kuswoyo, D. D., & Lahinda, J. (2020). The effects of high-intensity interval training (HIIT) in improving VO2 max football student activity unit, University of Musamus. *Enfermería Clínica*, 30, 507-511. <https://doi.org/10.1016/j.enfcli.2019.10.130>
- Kyung, L. H., & Park, H. Y. (2024). Effects of complex training on muscle stiffness, half squat 1-RM, agility, and jump performance in healthy males. *Journal of Men's Health (JOMH)*, 20(10), 79-88. <https://doi.org/10.22514/jomh.2024.168>
- Lin, L. L. C., Chen, Y. J., Lin, T. Y., & Weng, T. C. (2022). Effects of Resistance Training Intensity on Heart Rate Variability at Rest and in Response to Orthostasis in Middle-Aged and Older Adults. *International Journal of Environmental Research and Public Health*, 19(17), 10579. <https://doi.org/10.3390/ijerph191710579>
- Lucas, J. M. R., Montilla, J. A. P., Linares, J. C. C., & Román, P. A. L. (2025). Enhancing Physical and Cognitive Performance in Youth Football: The Role of Specific Dual-Task Training. *Journal of Functional Morphology and Kinesiology*, 10(4), 404. <https://doi.org/10.3390/jfmk10040404>
- Michailidis, Y., Stafylidis, A., Mandroukas, A., et al. (2025). The Effect of a High-Frequency Exercise Program During the Transition Period in Young Football Players. *Sports (Basel)*, 13(9), 297. <https://doi.org/10.3390/sports13090297>
- Moges, T., Dhamodharan, M., Gebretensay, M., Kiflu, A., & Kentiba, E. (2024). Effects of Altitude training on Ethiopian endurance athletes recovery heart rate and hematological variables. *Pedagogy of Physical Culture and Sports*, 28(3), 213-221. <https://doi.org/10.15561/26649837.2024.0306>
- Nandakumar, D., & Ramesh, S. (2020). Effect of complex training on selected physical fitness variables among football players. *International Journal of Physical Education, Sports and Health*, 7(6), 160-162.
- Naveen, R. A., Kamalakannan, M., Anitha, A., & Ramana, K. (2024). Recent Experimental Investigation on the Effectiveness of Complex Training for Intermediate Football Players. *Indian Journal of Physiotherapy & Occupational Therapy*, 18, 237. <https://doi.org/10.37506/8rcwsf74>
- Nugroho, H., Septyana, M. T., Purnama, S. K., & Doewes, R. I. (2024). The differences in the effects of plyometric training and complex training on sprint ability viewed from leg length. *Revista iberoamericana de psicología del ejercicio y el deporte*, 19(2), 189-191.
- Nugroho, S., Annasai, F., Sumarjo, Arovah, N. I., & Pambudi, D. K. (2023). The Effect of Circuit and Strength Training on the Leg Power in Female Basketball Athletes. *International Journal of Human Movement and Sports Sciences*, 11(3), 572-578. <https://doi.org/10.13189/saj.2023.110309>
- Pokrajcic, V., Herceg, L., Dugonjić, B., & Vojvodić, M. (2018). Effects of speed and agility trainings at young football players. *SportLogia journal*, 14(1), 59-65. <https://doi.org/10.5550/sgia.181401.en.phd>
- Pranoto, N. W., Andika, H., Ockta, Y., et al. (2025). The effect of training on flexibility: a case study of athletes and non-athletes. *Federación Española de Asociaciones de Docentes de Educación Física (FEADEF)*, 62, 974-978. <https://doi.org/10.47197/retos.v62.109740>
- Purnamasari, R. B., Purnamasari, I., & Novian, G. (2025). The Effect of Contrast Training Methods on the Speed and Lower Body Strength of Futsal Athletes. *International Journal of Human Movement and Sports Sciences*, 13(1), 21-29. <https://doi.org/10.13189/saj.2025.130103>

- Sabillah, M. I., Tomoliyus, Nasrullo, A., & Yuniana, R. (2022). The effect of plyometric exercise and leg muscle strength on the power limb of wrestling athletes. *Journal of Physical Education and Sport*, 22(6), 1403 – 1411. <https://doi.org/10.7752/jpes.2022.06176>
- Seelamad, S. (2014). *Physical Activities for Wellness*. Bangkok: Chulalongkorn University Press.
- Shamshuddin, M. H. B. S., Hasan, H., Azli, M. S., Mohamed, M. N., & Razak, F. A. A. (2020). Effects of Plyometric Training on Speed and Agility among Recreational Football Players. *International Journal of Human Movement and Sports Sciences*, 8(5), 174-180. <https://doi.org/10.13189/saj.2020.080503>
- Sun, M., Soh, K. G., Cao, S., Yaacob, A. B., Ma, S., & Ding, C. (2025). Effects of speed, agility, and quickness training on athletic performance: a systematic review and meta-analysis. *BMC Sports Science, Medicine and Rehabilitation*, 17(1), 66. <https://doi.org/10.1186/s13102-025-01101-w>
- Sun, R., Qu, H., Zhang, Y., & Wang, H. (2025). The effect of complex training on strength, counter movement jump and change of direction skills in female junior table tennis players. *Scientific Reports*, 15, 1-8. <https://doi.org/10.1038/s41598-025-21076-5>
- Thomas, I., Gee, Harsley, P., & Bishop, D. C. (2021). Effect of 10 Weeks of Complex Training on Speed and Power in Academy Soccer Players. *International Journal of Sports Physiology and Performance*, 16(8), 1134 – 1139. <https://doi.org/10.1123/ijsp.2020-0139>
- Thongnum, P. (2019). *Football*. Surin: Surindra Rajabhat University.
- Turgut, A., Hazar, M., Sural, V., Şahin, M., & Serin, K. (2025). The Effect of Different Strength Training on Performance Success of U17 Football Team Athletes. Retrieved November 11, 2025, from <https://www.researchsquare.com/article/rs-6439756/v1>
- Tutar, M., Rudarlı, G., & Kayitken, B. (2024). Effects of Different Endurance Training Models on Players' Fitness Levels during the National Break in the Football Season. *Acta Kinesiologica*, 18(3), 69 – 77. <https://doi.org/10.51371/issn.1840-2976.2024.18.3.10>
- Wang, X., Lv, C., Qin, X., Ji, S., & Dong, D. (2023). Effectiveness of plyometric training vs. complex training on the explosive power of lower limbs: A Systematic review. *Frontiers in physiology*, 13, 1061110. <https://doi.org/10.3389/fphys.2022.1061110>
- Wicharn, A. (2019). *The Effects of Complex Training on Speed and Agility in Women's Handball of Institute of Physical Education Lampang Campus (Master's thesis)*. Chiang Mai Rajabhat University.
- Xu, Z., Sun, J., Gu, J., & Yu, L. (2025). Effects of 8 weeks of combined strength and plyometric training on lower limb vertical stiffness and jump performance in elite long jump athletes. *Frontiers in Physiology*, 16, 1692254. <https://doi.org/10.3389/fphys.2025.1692254>
- Yang, L., Morazuki, S. R., Wei Chen, W., & Li, J. (2025). The Short-Term Effects of Complex Training on Dribbling Agility and Shooting Efficiency of U9 Football Players. *Research Square*. <https://doi.org/10.21203/rs.3.rs-7872999/v1>
- Zhai, T., & Qin, G. (2024). A comparative study of 8-week complex training and resistance training on athletic performance of amateur futsal players. *Frontiers in Physiology*, 26(15), 1-11. <https://doi.org/10.3389/fphys.2024.1360440>