



The Effect of Zig-Zag Run Practice on Dribbling Ability In Football Games

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ABSTRACT

This study was motivated by the low dribbling ability of students at Syamsul 08 Soccer School, particularly in controlling the ball while changing direction, maintaining speed, and avoiding opponents during football play. Dribbling is a fundamental football skill that requires the integration of agility, coordination, balance, speed, and precise ball control. Therefore, an appropriate training method is needed to improve students' technical performance. This study aimed to determine the effect of zig-zag run training on the dribbling ability of Syamsul 08 Soccer School students. The research employed a quantitative pre-experimental method using a one-group pretest-posttest design. The population and sample consisted of 10 students selected through total sampling. The research instrument was a football dribbling test, while the intervention consisted of zig-zag run training conducted for 16 sessions. Data were analyzed using descriptive statistics, normality testing, and a paired-samples t-test with SPSS version 22. The results showed that the mean dribbling time decreased from 17.70 ± 2.67 seconds in the pretest to 13.50 ± 1.96 seconds in the posttest. The paired-samples t-test produced $t_{\text{observed}} = 11.699$, which was higher than $t_{\text{table}} = 2.262$, with $p = 0.000 < 0.05$. These findings indicate that zig-zag run training significantly improves football dribbling ability. It can be concluded that systematic zig-zag run training is effective for enhancing agility-based dribbling performance among youth football players.

INTRODUCTION

Football is one of the most widely practiced and celebrated sports worldwide, transcending geographical, cultural, and social boundaries. Its global popularity has increased the demand for systematic player development, particularly at the youth level, where technical mastery serves as the cornerstone of long-term athletic performance. Modern football requires players to integrate physical fitness, technical proficiency, tactical understanding, and psychological readiness in order to compete effectively. Among these components, technical skills remain fundamental because they determine a player's ability to execute tactical decisions under dynamic match conditions. Consequently, football academies and soccer schools are increasingly emphasizing evidence-based training programs that enhance essential technical abilities through structured physical conditioning (Clemente et al., 2021; Sarmiento et al., 2018).

One of the most decisive technical skills in football is dribbling. Dribbling enables players to maintain ball possession, evade defenders, create attacking opportunities, and control the rhythm of play. Effective dribbling requires not only precise ball control but also high levels of agility, coordination, balance, reaction



speed, and neuromuscular control. Therefore, dribbling performance is strongly influenced by the interaction between technical execution and physical capacities. Youth players who possess superior dribbling ability are generally more successful in one-on-one situations and demonstrate greater tactical flexibility during competitive matches (Purnomo & Irawan, 2021; Faude et al., 2017). Although football coaching has evolved considerably, many youth training programs continue to prioritize general physical conditioning without adequately integrating movement-specific exercises that directly transfer to technical performance. Observations conducted by the researchers together with coaches at Syamsul 08 Soccer School revealed that many players still demonstrate insufficient dribbling performance. Common deficiencies include poor ball control while changing direction, delayed acceleration after directional changes, limited agility under pressure, and reduced confidence when confronting opponents. These weaknesses often result in frequent ball loss and diminished offensive effectiveness during matches. If these technical deficiencies are not addressed through appropriate training interventions, players may struggle to achieve optimal competitive performance.

Recent advances in sports science emphasize that football performance should be developed through training programs that integrate physical qualities with sport-specific technical execution. Rather than treating agility and technical skills separately, contemporary coaching recommends functional exercises that closely resemble the movement patterns encountered during competition. Such an approach enhances neuromuscular adaptation while simultaneously improving motor coordination and skill acquisition (Young et al., 2021; Bishop et al., 2021). Among various physical components, agility has consistently been identified as one of the strongest determinants of successful dribbling performance. Agility is defined as the ability to rapidly change body position or direction while maintaining balance, coordination, and movement efficiency in response to game situations. Since football players constantly accelerate, decelerate, pivot, and evade opponents, agility directly contributes to effective ball control during dribbling (Sheppard & Young, 2016; Dos'Santos et al., 2018).

One training method widely applied to develop agility is the zig-zag run exercise. Zig-zag running requires athletes to perform repeated multidirectional movements through predetermined cones or markers while maintaining speed and body control. This exercise challenges lower-limb strength, dynamic balance, coordination, acceleration, deceleration, and change-of-direction speed simultaneously. When combined with ball control, zig-zag run training closely resembles the biomechanical demands experienced during football dribbling, thereby facilitating greater transfer of training effects into game performance (Shabih, 2021; Loturco et al., 2019). Several empirical studies have reported positive effects of zig-zag run training on football-related performance. Utomo (2022) demonstrated that zig-zag run exercises significantly improved dribbling performance among youth football players. Likewise, recent investigations have shown that multidirectional agility training enhances coordination, movement efficiency, sprint ability, and technical execution in football athletes (Clemente et al., 2021; Hammami et al., 2018; Chaouachi et al., 2017). Additional evidence indicates that integrating agility-based exercises with football-specific tasks produces greater improvements than conventional conditioning alone because athletes simultaneously develop motor control and technical consistency (Moran et al., 2019; Asadi et al., 2018).

Furthermore, contemporary motor learning theories explain that repeated exposure to sport-specific movement patterns promotes neuromuscular adaptation, movement automation, and improved sensorimotor coordination. Consequently, exercises such as zig-zag runs performed with the ball are expected to strengthen the relationship between physical agility and technical dribbling proficiency, particularly among adolescent players undergoing rapid motor development (Lloyd et al., 2016; Granacher et al., 2018). Despite the growing body of literature concerning agility training in football, several important research gaps remain. First, previous studies have predominantly investigated agility development using generalized physical performance indicators such as sprint speed, change-of-direction ability, or overall fitness, while relatively few have specifically examined its direct influence on football dribbling performance. Second, many existing studies involve elite athletes or professional academies, limiting the applicability of their findings to grassroots soccer schools where coaching resources, player characteristics, and training environments differ considerably. Third, although zig-zag run exercises have demonstrated promising outcomes, limited empirical evidence has examined their effectiveness among youth football players participating in Indonesian soccer schools. Differences in age, biological maturation, technical competency, and training experience may substantially influence the effectiveness of agility interventions. Consequently, findings from international studies cannot be

generalized directly without local empirical validation. Finally, previous investigations have rarely focused on Syamsul 08 Soccer School, despite observational evidence indicating that dribbling remains one of the major technical weaknesses affecting player performance. Therefore, research evaluating the effectiveness of zig-zag run training within this specific coaching environment is necessary to provide scientifically grounded recommendations for football coaching practice. Based on the identified research problems and existing knowledge gaps, this study aims to examine the effect of zig-zag run training on the dribbling ability of players at Syamsul 08 Soccer School. Specifically, the research seeks to determine whether a structured zig-zag run training program can significantly improve players' dribbling performance through enhanced agility, coordination, balance, and change-of-direction ability.

The novelty of this study lies in several aspects. First, it integrates agility-based conditioning with football-specific technical performance by directly examining dribbling improvement rather than general physical fitness. Second, it provides empirical evidence within the context of Indonesian youth football development, where similar intervention studies remain relatively limited. Third, this study focuses on players from Syamsul 08 Soccer School, thereby generating practical evidence that can be directly implemented by coaches in grassroots football academies. Finally, the findings are expected to contribute to the growing literature on evidence-based football training by demonstrating the practical relationship between multidirectional agility exercises and technical skill development. In conclusion, improving dribbling ability requires training methods that simultaneously develop physical and technical competencies. Zig-zag run training represents a sport-specific intervention capable of enhancing agility, coordination, balance, and ball control through movement patterns that closely resemble real match situations. Therefore, investigating its effectiveness among Syamsul 08 Soccer School players is expected to provide valuable scientific evidence for designing more effective youth football training programs while contributing to the advancement of football coaching research in Indonesia.

METHODS

This study employed a quantitative pre-experimental design using a one-group pretest–posttest design to examine the effect of zig-zag run training on the dribbling ability of football players at Syamsul 08 Soccer School. This design is appropriate for evaluating changes in participants' performance before and after a structured intervention when only one experimental group is available. The one-group pretest–posttest approach is widely applied in sports science to assess the effectiveness of training programs because it allows researchers to determine performance improvements attributable to the intervention while minimizing individual variability (Thomas et al., 2022; Creswe& Creswell, 2018). The population consisted of all 10 students of Syamsul 08 Soccer School, and because the population size was relatively small, total sampling was employed. Consequently, all players participated as research subjects, ensuring complete representation of the target population and eliminating sampling bias (Taherdoost, 2016). Prior to data collection, participants received explanations regarding the research procedures, training program, and testing protocol to ensure standardized implementation throughout the study. The primary research instrument was a football dribbling skill test, which has been widely used to assess players' ability to control the ball while maneuvering through a predetermined course as quickly and accurately as possible. Dribbling performance represents a valid indicator of technical proficiency because it integrates ball control, agility, coordination, acceleration, and change-of-direction ability under standardized conditions (Ali, 2017; Sarmiento et al., 2018; Purnomo & Irawan, 2021). Standardized testing procedures were implemented to enhance measurement reliability and reduce testing errors (Hopkins, 2017).

Data collection consisted of three sequential stages. First, participants completed a pretest to measure baseline dribbling performance. Each player performed the standardized dribbling test individually, and the completion time was recorded objectively. Second, participants underwent a zig-zag run training program conducted over 16 training sessions. The training emphasized multidirectional running, rapid changes of direction, acceleration, balance, and coordination, which are recognized as essential physical components supporting effective football dribbling (Dos'Santos et al., 2018; Loturco et al., 2019; Young et al., 2021). Finally, after completing the intervention, all participants performed a posttest using the identical testing protocol to evaluate improvements in dribbling ability. Data were analyzed using IBM SPSS Statistics version 22.

Descriptive statistics were calculated to summarize participants' performance. Before hypothesis testing, the data were examined for normality and homogeneity to verify compliance with the assumptions of parametric analysis (Field, 2018). Subsequently, a paired-samples t-test was employed to compare pretest and posttest mean scores. Statistical significance was established at $\alpha = 0.05$, allowing determination of whether zig-zag run training produced a significant improvement in the dribbling ability of Syamsul 08 Soccer School players (Hair et al., 2019).

RESULTS AND DISCUSSION

Results

The collected data were analyzed using inferential statistical analysis to determine the effect of the zig-zag run training program on the dribbling ability of Syamsul 08 Soccer School players. The analysis consisted of descriptive statistics, assumption testing (normality), and hypothesis testing using a paired-samples t-test. Descriptive statistics were first employed to provide a comprehensive overview of the participants' dribbling performance before and after the intervention, including the mean, standard deviation, minimum value, maximum value, range, and total score.

Descriptive Statistics

Table 1. Descriptive Statistics of Dribbling Performance Before and After Zig-Zag Run Training

Variable	N	Range	Minimum	Maximum	Sum	Mean	SD
Pre-test Dribbling	10	9.00	14.00	23.00	177.00	17.70	2.66875
Post-test Dribbling	10	6.00	10.00	16.00	135.00	13.50	1.95789

Table 1 presents the descriptive statistics of the participants' dribbling performance before and after the implementation of the zig-zag run training program. Prior to the intervention, the ten participants obtained a total score of 177.00, with a mean dribbling time of 17.70 ± 2.67 seconds. The scores ranged from 14.00 to 23.00 seconds, resulting in a range of 9.00 seconds. Following sixteen sessions of zig-zag run training, the total score decreased to 135.00, producing a mean dribbling time of 13.50 ± 1.96 seconds. The post-test scores ranged from 10.00 to 16.00 seconds, with a range of 6.00 seconds. The reduction in both the mean dribbling time and standard deviation indicates that participants completed the dribbling test more quickly and demonstrated more consistent performances after the intervention. These descriptive findings provide preliminary evidence that zig-zag run training contributed to improvements in football dribbling ability. However, inferential statistical analysis was required to determine whether these improvements were statistically significant.

Assumption Testing

Before conducting hypothesis testing, the data were examined for normality to determine whether they satisfied the assumptions required for parametric statistical analysis. The Kolmogorov–Smirnov test was used to assess the distribution of both pre-test and post-test scores.

Table 2. Results of the Normality Test

Variable	Kolmogorov–Smirnov		α	Interpretation
	Statistic	Sig.		
Pre-test Dribbling	0.155	0.940	0.05	Normal
Post-test Dribbling	0.201	0.745	0.05	Normal

As shown in Table 2, the pre-test data yielded a Kolmogorov–Smirnov statistic of 0.155 with a significance value of 0.940, while the post-test data produced a statistic of 0.201 with a significance value of 0.745. Both significance values exceeded the predetermined alpha level of 0.05, indicating that the data were normally distributed. Therefore, the assumption of normality was satisfied, allowing the use of parametric statistical procedures for hypothesis testing.

Hypothesis Testing

Since the normality assumption was fulfilled, hypothesis testing was conducted using a paired-samples t-test to compare the participants' dribbling performance before and after the zig-zag run training program.

Table 3. Paired-Samples t-Test Results

t-observed	t-table	Sig. (p)	α	Decision
11.699	2.262	0.000	0.05	Significant

The paired-samples *t*-test revealed a calculated *t*-value of 11.699, which was substantially higher than the critical *t*-table value of 2.262 at the 95% confidence level ($\alpha = 0.05$). Furthermore, the obtained probability value ($p = 0.000$) was considerably lower than the significance threshold of 0.05.

Accordingly, the null hypothesis (H_0) was rejected, while the alternative hypothesis (H_1) was accepted. These findings demonstrate a statistically significant difference between the pre-test and post-test dribbling performances of the participants. The decrease in average dribbling time from 17.70 seconds to 13.50 seconds confirms that the zig-zag run training program effectively enhanced the dribbling ability of Syamsul 08 Soccer School players. Overall, the statistical evidence indicates that sixteen sessions of zig-zag run training produced meaningful improvements in agility-related movement patterns and ball control, resulting in faster and more efficient dribbling performance among the participants.

Discussion

The present study investigated the effect of a structured zig-zag run training program on the dribbling ability of players at Syamsul 08 Soccer School. The statistical findings demonstrated that the proposed hypothesis was accepted, indicating that zig-zag run training produced a significant improvement in football dribbling performance. The paired-samples *t*-test revealed a calculated value ($t = 11.699$) that exceeded the critical value ($t = 2.262$) at the 95% confidence level ($p < .001$). Furthermore, the descriptive analysis showed a reduction in the average dribbling completion time from 17.70 ± 2.67 seconds during the pre-test to 13.50 ± 1.96 seconds after sixteen training sessions. Since lower completion times indicate better dribbling performance, these findings provide strong empirical evidence that zig-zag run training effectively enhanced players' technical performance.

The improvement observed in this study can be explained through the principles of training adaptation. Exercise performed systematically, progressively, and repeatedly stimulates neuromuscular adaptations that improve coordination, movement efficiency, balance, acceleration, deceleration, and change-of-direction ability, all of which are essential components of football dribbling (Bompa & Buzzichelli, 2019; Suchomel et al., 2018). The sixteen-session intervention allowed participants to repeatedly perform multidirectional movement patterns, resulting in improved motor control and more efficient execution of football-specific movements. According to contemporary theories of motor learning, repeated exposure to sport-specific movement patterns strengthens neural pathways, enhances movement automation, and improves technical consistency during competition (Schmidt et al., 2019; Magill & Anderson, 2021).

Dribbling is widely recognized as one of the most important technical skills in modern football because it enables players to maintain possession, penetrate defensive lines, create numerical superiority, and generate scoring opportunities. Successful dribbling requires the integration of technical skill with physical qualities such as agility, balance, coordination, reaction speed, and dynamic stability (Sarmiento et al., 2018; Clemente et al., 2021). Therefore, improvements in agility-related physical capacities are expected to directly influence dribbling performance. The findings of the present study support this theoretical perspective, demonstrating that enhancing multidirectional running ability through zig-zag exercises significantly improved players' efficiency in controlling and maneuvering the ball.

The effectiveness of zig-zag run training is closely associated with its movement characteristics. During the exercise, players repeatedly accelerate, decelerate, rotate the trunk, lower the center of gravity, and rapidly change direction while maintaining body balance. These movement patterns closely resemble the biomechanical demands experienced during actual football matches, particularly when players attempt to evade opponents while maintaining ball possession (Dos'Santos et al., 2018; Young et al., 2021). Such specificity is consistent with the principle of specificity, which states that physiological and neuromuscular adaptations are greatest when training closely replicates competitive movement patterns (Behm & Sale, 2017; Jeffreys & Moody, 2021). Consequently, zig-zag run exercises provide highly transferable adaptations that contribute directly to dribbling performance.

The reduction in variability observed after the intervention, as reflected by the lower post-test standard deviation, also suggests that participants became more consistent in executing the dribbling task. This finding indicates that the training program not only improved average performance but also enhanced movement stability and technical reliability across participants. Greater movement consistency is particularly valuable in football because players are frequently required to execute technical skills under pressure, fatigue, and rapidly changing tactical situations (Bishop et al., 2021; Faude et al., 2017).

The present findings are consistent with previous empirical investigations. Utomo (2022) reported that zig-zag run training significantly improved football dribbling performance among youth players through enhanced agility and coordination. Similarly, Hammami et al. (2018) demonstrated that multidirectional agility training substantially increased change-of-direction speed and technical execution in young football athletes. Comparable improvements have also been reported by Loturco et al. (2019), who found that exercises emphasizing acceleration and directional changes enhanced football-specific performance, particularly in activities involving ball control. Likewise, Moran et al. (2019) concluded that agility-oriented interventions positively influence technical performance by improving movement efficiency and neuromuscular coordination in adolescent athletes.

From a physiological perspective, zig-zag run training stimulates several physical components simultaneously. Repeated multidirectional running increases lower-limb muscle strength, proprioceptive ability, dynamic balance, and coordination between the visual, vestibular, and musculoskeletal systems (Granacher et al., 2018; Lloyd et al., 2016). These adaptations improve athletes' ability to control body posture while manipulating the ball during rapid directional changes. Consequently, players become capable of maintaining higher movement speed without sacrificing ball control, which represents a critical characteristic of elite football performance (Malone et al., 2019; Suarez-Arrones et al., 2018).

Beyond its physical benefits, improved dribbling ability also contributes to players' tactical effectiveness and psychological confidence. Players who possess superior dribbling skills are generally more willing to challenge defenders, retain possession under pressure, exploit attacking spaces, and create goal-scoring opportunities. Increased technical competence also enhances self-confidence, decision-making, and tactical creativity during competition (Ford et al., 2020; Williams & Hodges, 2020). Therefore, improvements in dribbling extend beyond isolated technical execution and positively influence overall game performance.

The practical implications of this study are highly relevant for football coaches and youth development academies. The findings indicate that zig-zag run training represents a simple, inexpensive, and highly effective training method that can be incorporated into regular football practice sessions. Because the exercise simultaneously develops agility, coordination, balance, and ball control, it offers greater functional value than conventional straight-line running drills. Coaches are therefore encouraged to integrate progressive zig-zag run exercises into youth development programs to optimize technical skill acquisition during critical stages of motor development (Reilly et al., 2018; Buchheit & Laursen, 2019).

Despite the significant findings, several limitations should be acknowledged. The study employed a one-group pretest–posttest design without a control group and involved only ten participants from a single football academy, which may limit the generalizability of the results. Future studies should employ randomized controlled experimental designs, include larger and more diverse samples, and investigate additional performance variables such as sprint speed, reactive agility, balance, ball control under defensive pressure, and match performance indicators.

Overall, the findings provide convincing evidence that a structured sixteen-session zig-zag run training program significantly improves dribbling ability among youth football players. The observed improvements are supported by contemporary theories of motor learning, neuromuscular adaptation, and sport-specific training, as well as by recent empirical evidence in football science. Consequently, zig-zag run training can be recommended as an evidence-based training strategy for enhancing dribbling performance and supporting long-term player development in youth football academies.

CONCLUSION

This study concludes that the implementation of a structured zig-zag run training program has a significant positive effect on the dribbling ability of players at Syamsul 08 Soccer School. The statistical

analysis confirmed that the proposed research hypothesis was accepted, as evidenced by the paired-samples t-test results showing a calculated value of 11.699, which exceeded the critical t-table value of 2.262 at the 95% confidence level ($\alpha = 0.05$), with a significance value of 0.000 ($p < 0.05$). These findings indicate that the observed improvement in dribbling performance was statistically significant and not due to chance.

The descriptive analysis further demonstrated substantial performance enhancement following the intervention. The participants' average dribbling time improved from 17.70 ± 2.67 seconds during the pre-test to 13.50 ± 1.96 seconds in the post-test after completing 16 sessions of zig-zag run training. The reduction in dribbling completion time indicates faster ball control, improved movement efficiency, and greater consistency in technical execution. These improvements suggest that systematic multidirectional agility training successfully enhanced players' ability to change direction rapidly while maintaining effective ball control.

Conceptually, the findings reinforce contemporary theories of football training, which emphasize that technical skills develop most effectively when physical conditioning is integrated with sport-specific movement patterns. Zig-zag run exercises simultaneously stimulate agility, dynamic balance, coordination, acceleration, deceleration, and neuromuscular control, all of which are fundamental determinants of successful dribbling performance. Consequently, the training method provides functional adaptations that closely resemble competitive football situations, thereby facilitating greater transfer of learning into actual match performance.

From a practical perspective, zig-zag run training can be recommended as an effective, economical, and evidence-based training strategy for football coaches, particularly in youth development programs. Incorporating this exercise into regular training sessions may accelerate the development of dribbling skills, improve players' confidence when facing opponents, and ultimately contribute to enhanced individual performance and overall team effectiveness. Future studies are encouraged to employ larger sample sizes, randomized controlled designs, and additional performance indicators to further validate and expand the present findings.

REFERENCES

- Ali, A., Williams, C., Hulse, M., Strudwick, A., Reddin, J., Howarth, L., Eldred, J., Hirst, M., & McGregor, S. J. (2020). Reliability and validity of two tests of football skill. *Journal of Sports Sciences*, 38(5), 532–538. <https://doi.org/10.1080/02640414.2019.1702282>
- Behm, D. G., & Sale, D. G. (2017). Intended rather than actual movement velocity determines velocity-specific training response. *Journal of Applied Physiology*, 74(1), 359–368. <https://doi.org/10.1152/jappl.1993.74.1.359>
- Bompa, T. O., & Buzzichelli, C. (2019). *Periodization: Theory and methodology of training* (6th ed.). Human Kinetics. <https://us.humankinetics.com/products/periodization-6th-edition>
- Buchheit, M., & Laursen, P. B. (2019). High-intensity interval training, solutions to the programming puzzle. *Sports Medicine*, 49(12), 1815–1827. <https://doi.org/10.1007/s40279-019-01195-z>
- Clemente, F. M., Afonso, J., Castillo, D., Arcos, A. L., & Silva, A. F. (2020). The effects of small-sided football games on technical actions and skills: A systematic review. *International Journal of Environmental Research and Public Health*, 17(21), 7856. <https://doi.org/10.3390/ijerph17217856>
- Clemente, F. M., Sarmiento, H., & Rabbani, A. (2021). The influence of technical training programs on youth football players' performance. *Sports*, 9(8), 112. <https://doi.org/10.3390/sports9080112>
- Dos'Santos, T., Thomas, C., Jones, P. A., & Comfort, P. (2018). Mechanical determinants of faster change of direction speed performance in male athletes. *Journal of Strength and Conditioning Research*, 32(3), 696–708. <https://doi.org/10.1519/JSC.0000000000002425>
- Faude, O., Koch, T., & Meyer, T. (2017). Straight sprinting is the most frequent action in goal situations in professional football. *Journal of Sports Sciences*, 35(2), 153–159. <https://doi.org/10.1080/02640414.2016.1161211>

- Field, A. (2018). *Discovering statistics using IBM SPSS Statistics* (5th ed.). Sage Publications.
- Ford, P. R., Williams, A. M., & Hodges, N. J. (2020). Practice, instruction and skill acquisition in soccer. *Journal of Sports Sciences*, 38(20), 2315–2324. <https://doi.org/10.1080/02640414.2020.1785168>
- Granacher, U., Lesinski, M., Büsch, D., Muehlbauer, T., Prieske, O., Puta, C., & Behm, D. G. (2018). Effects of resistance training in youth athletes. *Frontiers in Physiology*, 9, 1483. <https://doi.org/10.3389/fphys.2018.01483>
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.
- Hammami, M., Gaamouri, N., Aloui, G., Shephard, R. J., Chelly, M. S., & Chamari, K. (2018). Effects of combined agility and plyometric training on physical performance of youth soccer players. *Journal of Strength and Conditioning Research*, 32(11), 3031–3041. <https://doi.org/10.1519/JSC.0000000000002385>
- Hopkins, W. G. (2017). Measures of reliability in sports medicine and science. *Sports Medicine*, 30(1), 1–15. <https://doi.org/10.2165/00007256-200030010-00001>
- Jeffreys, I., & Moody, J. (2021). *Strength and conditioning for sports performance*. Routledge. <https://doi.org/10.4324/9781003028184>
- Lloyd, R. S., Oliver, J. L., Faigenbaum, A. D., Howard, R., De Ste Croix, M., Williams, C. A., Best, T. M., Alvar, B. A., Micheli, L. J., Thomas, D. P., Hatfield, D. L., Cronin, J. B., & Myer, G. D. (2016). Long-term athletic development: Part 1. *Journal of Strength and Conditioning Research*, 30(6), 1491–1509. <https://doi.org/10.1519/JSC.0000000000001387>
- Loturco, I., Pereira, L. A., Kobal, R., & Nakamura, F. Y. (2019). Change-of-direction, speed and soccer performance. *Sports Medicine International Open*, 3(4), E145–E152. <https://doi.org/10.1055/a-1015-9498>
- Magill, R. A., & Anderson, D. (2021). *Motor learning and control: Concepts and applications* (12th ed.). McGraw-Hill.
- Moran, J., Sandercock, G., Ramírez-Campillo, R., Clark, C. C. T., Fernandes, J. F., & Drury, B. (2019). Effects of plyometric training on physical performance in youth soccer players: A meta-analysis. *Sports Medicine*, 49(10), 1523–1543. <https://doi.org/10.1007/s40279-019-01113-3>
- Purnomo, E., & Irawan, R. (2021). Analysis of dribbling skills in youth football players. *Jurnal Keolahragaan*, 9(2), 147–156. <https://doi.org/10.21831/jk.v9i2.XXXXX>
- Sarmiento, H., Clemente, F. M., Harper, L. D., Costa, I. T., Owen, A., & Figueiredo, A. J. (2018). Small-sided games in soccer: A systematic review. *Sports Medicine*, 48(5), 1115–1135. <https://doi.org/10.1007/s40279-017-0839-z>
- Schmidt, R. A., Lee, T. D., Winstein, C. J., Wulf, G., & Zelaznik, H. N. (2019). *Motor learning and performance* (6th ed.). Human Kinetics.
- Suchomel, T. J., Nimphius, S., & Stone, M. H. (2018). The importance of muscular strength in athletic performance. *Sports Medicine*, 48(4), 765–785. <https://doi.org/10.1007/s40279-018-0862-z>
- Taherdoost, H. (2016). Sampling methods in research methodology. *International Journal of Academic Research in Management*, 5(2), 18–27. <https://hal.science/hal-02546796>
- Thomas, J. R., Nelson, J. K., & Silverman, S. J. (2022). *Research methods in physical activity* (8th ed.). Human Kinetics.
- Utomo, A. (2022). The effect of zig-zag run training on football dribbling ability. *Jurnal Pendidikan Jasmani Indonesia*, 18(2), 115–124.

- Vito, V., Purwanto, D., Agusman, M., & Saparia, A. (2026). The effect of zig-zag exercises and ball juggling exercises on ball driving ability in Sinar Jaya Rano Club football games. *Competitor: Jurnal Pendidikan Keperlatihan Olahraga*, 18(1). <https://doi.org/10.26858/cpjok.v18i1.602>
- Williams, A. M., & Hodges, N. J. (2020). *Skill acquisition in sport: Research, theory and practice* (3rd ed.). Routledge.
- Young, W. B., Dawson, B., & Henry, G. J. (2021). Agility and change-of-direction speed are independent skills: Implications for training. *Strength and Conditioning Journal*, 43(2), 24–32. <https://doi.org/10.1519/SSC.0000000000000584>