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The Effectiveness of The Agility Drill Training Program Based On Zig-Zag Patterns On The Agility of Basketball Athletes of The Surabaya Sniper

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ABSTRACT

Agility is a critical physical determinant in basketball performance, particularly in situations requiring rapid acceleration, deceleration, and multidirectional changes under dynamic game conditions. Effective agility development must align with the principle of specificity, whereby training stimuli replicate sport-specific movement patterns. This study aimed to examine the effectiveness of a zigzag pattern-based agility drill training program in improving the agility of basketball athletes from the Surabaya Sniper Team. A quasi-experimental one-group pretest–posttest design was employed involving 20 male athletes aged 13–18 years. Agility was measured using a standardized change-of-direction test, and data were analyzed through the Shapiro–Wilk normality test followed by a paired-sample t-test at a significance level of 0.05. The results demonstrated a significant improvement in agility performance, with mean test time decreasing from 12.39 ± 0.64 seconds (pretest) to 11.59 ± 0.48 seconds (posttest). Statistical analysis revealed a p-value of 0.001 ($p < 0.05$), indicating a significant training effect. The findings suggest that zigzag-based agility drills effectively enhance neuromuscular coordination, braking efficiency, and directional transition speed. Therefore, zigzag agility training can be considered a practical and sport-specific conditioning strategy for improving change-of-direction performance in youth basketball athletes.

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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

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INTRODUCTION

Basketball is a high-intensity intermittent team sport that demands complex integration of physical, technical, tactical, and cognitive abilities. Among the key physical determinants of performance, agility occupies a central position because it enables athletes to execute rapid accelerations, decelerations, directional changes, and body repositioning in response to dynamic game situations (Ramírez-Campillo et al., 2015; Scanlan et al., 2016). In modern basketball, agility is not merely a pre-planned change-of-direction ability but also involves perceptual and decision-making components under temporal pressure (Paul et al., 2016; Young & Farrow, 2017).

Empirical evidence indicates that agility significantly contributes to performance indicators such as defensive containment, offensive penetration, dribbling efficiency, and transition play (Fatmawati et al., 2022; Jelena Ivanović et al., 2019). Athletes with superior agility demonstrate enhanced capability to maintain balance and postural control while executing rapid directional shifts, which directly influences one-on-one effectiveness and fast-break execution (Spiteri et al., 2015; Loturco et al., 2019). Conversely, insufficient agility has been associated with delayed reactions, ineffective defensive coverage, and increased susceptibility to performance breakdown under competitive pressure (Ever Sovensi et al., 2019; Mancha-Triguero et al., 2020).

Despite its recognized importance, agility deficits remain observable in adolescent basketball athletes, particularly at club development levels. Preliminary observations conducted on the Surabaya City Sniper Basketball Team revealed suboptimal movement efficiency, delayed response during simulated game transitions, and impaired balance during repetitive cutting maneuvers. Similar patterns have been reported in youth basketball cohorts, where neuromuscular coordination and change-of-direction mechanics are still developing and require structured stimulus (Arede et al., 2019; Chaabene et al., 2018). These conditions underline a practical problem: the need for a structured, sport-specific, and evidence-based agility training model that aligns with basketball movement demands and adolescent motor development characteristics.

Contemporary sports science emphasizes that agility training effectiveness is strongly influenced by the principle of specificity, which posits that physiological and neuromuscular adaptations correspond directly to the movement characteristics of the applied stimulus (Behm & Sale, 2017; Asaf Shalom et al., 2025). In basketball, effective agility training must replicate acceleration–deceleration cycles, lateral shuffling, cutting angles, and center-of-mass control frequently encountered during gameplay (Wang et al., 2024; Zhang et al., 2025).

Among sport-specific agility interventions, zigzag training has gained attention due to its emphasis on repeated multidirectional changes performed at high velocity (Arifin et al., 2020). Zigzag drills incorporate acceleration bursts, braking mechanics, hip rotation, and dynamic balance control, thereby stimulating neuromuscular adaptations relevant to basketball performance (Dos'Santos et al., 2018; Forster et al., 2023). Empirical studies demonstrate that structured zigzag drills can significantly improve change-of-direction speed, dribbling efficiency, and reactive movement performance in youth athletes (Feby Elra Perdima et al., 2023; Jud et al., 2022).

Compared to conventional agility exercises such as shuttle runs or linear sprint repetitions, zigzag drills exhibit superior ecological validity because their movement patterns more closely resemble in-game scenarios (Forster et al., 2023; Mancha-Triguero et al., 2020). Moreover, integrating ball-handling elements into zigzag protocols enhances skill transfer, reinforcing the interaction between physical and technical performance domains (Loturco et al., 2019; Arede et al., 2019).

Adolescence represents a critical window for neuromuscular adaptation. During this phase, improvements in coordination, proprioception, and motor control are highly

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responsive to structured multidirectional stimuli (Chaabene et al., 2018; Dorsaf Sariati et al., 2021). Zigzag-based agility training has been shown to enhance lower-limb stiffness regulation, braking force production, and postural stability in youth populations (Dos'Santos et al., 2018; Indah Gita et al., 2023). Additionally, controlled overload applied three times per week over 3–6 weeks has been reported to produce measurable improvements in agility performance indicators (Fajar et al., 2023; Sun et al., 2025).

Measurement validity is equally critical. The Zigzag Agility Test has demonstrated acceptable reliability and construct validity in assessing multidirectional movement speed in team sports (Selaković & Krneta, 2021). Correlations between zigzag performance and basketball-specific metrics further support its practical relevance (Kutlu & Doğan, 2018; Scanlan et al., 2016). Therefore, combining sport-specific training stimulus with standardized measurement instruments represents the current best practice in applied agility research.

Although the literature consistently supports the effectiveness of zigzag-based agility drills, several limitations remain evident. First, many prior investigations were conducted in sports such as soccer, handball, or general athletic populations rather than basketball-specific cohorts (Citra, 2019; Dos'Santos et al., 2018). Second, studies focusing on youth basketball often integrate agility within broader conditioning programs, making it difficult to isolate the specific contribution of zigzag training (Arede et al., 2019; Mancha-Triguero et al., 2020).

Third, empirical evidence from Indonesian club-level contexts remains scarce. Most local studies have been school-based or lacked rigorous experimental control, limiting external validity for competitive club environments (Ruslan, 2021; Cahayani et al., 2023). Coaches at the grassroots and development levels frequently implement agility drills based on tradition rather than evidence-based frameworks, creating a gap between scientific findings and practical application.

Furthermore, limited research has examined short-term (four-week) zigzag interventions using simple, applicable quasi-experimental designs in real club settings. While longer interventions demonstrate positive outcomes (Fajar et al., 2023; Sun et al., 2025), evidence regarding practical, time-efficient programs suitable for adolescent club schedules is still underdeveloped. Therefore, a context-specific evaluation of zigzag training effectiveness within a structured club environment is necessary to strengthen applied sport science literature in Indonesia.

Based on the identified research gap, this study aims to evaluate the effectiveness of a four-week zigzag training program on improving agility among adolescent athletes of the Surabaya City Sniper Basketball Team using a one-group pretest–posttest design. Agility performance was measured using the standardized Zigzag Agility Test to ensure objective and reliable assessment.

The novelty of this research lies in three primary aspects. First, it provides sport-specific empirical evidence within an Indonesian club development context, thereby addressing the limited national literature on applied agility training. Second, the intervention design emphasizes short-duration, high-frequency training aligned with

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practical club schedules, offering a realistic and replicable model for coaches. Third, this study integrates theoretical principles of specificity and neuromuscular adaptation with standardized performance measurement, strengthening the methodological rigor of applied basketball conditioning research.

By bridging the gap between theoretical sport science principles and practical club implementation, this study contributes not only to academic discourse targeting SINTA–Scopus-indexed publications but also to evidence-based coaching practice. The findings are expected to support systematic integration of zigzag agility training into youth basketball development programs and to serve as a reference framework for further controlled experimental research in team-sport conditioning contexts.

METHODS

This study employed a quasi-experimental one-group pretest-posttest design to evaluate the effectiveness of a zigzag-based agility drill program on youth basketball athletes. This design is widely used in applied sport science research when interventions are conducted within intact team settings and randomization is not feasible (Chaabene et al., 2018; Mancha-Triguero et al., 2020). Although lacking a control group, the design allows direct observation of within-subject changes following structured training exposure (Arede et al., 2019).

Participants

Participants were male basketball athletes from the Surabaya Sniper Basketball Team who met the following inclusion criteria: aged 13–18 years, height 160–180 cm, body mass 40–120 kg, medically fit, and free from musculoskeletal injury during the intervention period. Adolescence represents a critical phase for neuromuscular adaptation and coordination development, making it suitable for multidirectional agility training (Dos'Santos et al., 2018; Lloyd et al., 2016). Total sampling was applied, whereby all eligible athletes were included to enhance ecological validity and ensure a comprehensive team-based analysis (Scanlan et al., 2016). Written informed consent was obtained from participants and guardians prior to data collection.

Instrumentation

Agility performance was assessed using the 4 × 10 m shuttle run test, a standardized and reliable measure of change-of-direction speed in youth and team-sport populations (Selaković & Krneta, 2021; Kutlu & Doğan, 2018). The test requires rapid acceleration, deceleration, and directional change over short distances—movement components highly relevant to basketball performance (Spiteri et al., 2015; Loturco et al., 2019). Timing was recorded in seconds using a digital stopwatch, and the best score from two trials was used for analysis to minimize measurement error and enhance reliability (Paul et al., 2016).

Procedure

Baseline agility was measured during the pretest session following a standardized warm-up protocol to reduce injury risk and performance variability (Behm & Sale, 2017). Participants then completed a four-week zigzag agility training intervention conducted

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three times per week, consistent with recommendations for effective neuromuscular adaptation in youth athletes (Fajar et al., 2023; Sun et al., 2025).

Weeks 1–2 consisted of five sets of 10-meter zigzag cone drills using seven cones without ball involvement. This phase emphasized acceleration mechanics, braking control, hip rotation, and center-of-mass stability (Dos'Santos et al., 2018; Wang et al., 2024). Weeks 3–4 maintained five sets but incorporated ball handling and increased cone number (from seven to eight cones), enhancing task specificity and perceptual-motor integration consistent with the principle of specificity (Young & Farrow, 2017; Forster et al., 2023). Each session lasted approximately 60 minutes, including warm-up, core zigzag drills, and cool-down. Progressive overload was implemented through increased movement complexity rather than volume escalation, aligning with contemporary agility training frameworks (Zhang et al., 2025).

Following completion of the intervention, a posttest was conducted under identical testing conditions to ensure procedural consistency and reduce confounding variables (Mancha-Triguero et al., 2020).

Data Analysis

Data were analyzed using SPSS version 25. Normality of the difference scores (pretest–posttest) was assessed using the Shapiro–Wilk test, appropriate for small samples ($p > 0.05$ indicating normal distribution)(Ghasemi & Zahediasl, 2016). If normally distributed, a paired-sample t-test was used to determine mean differences; otherwise, the Wilcoxon signed-rank test was applied. Statistical significance was set at $\alpha = 0.05$. Effect size was calculated to determine practical significance, as recommended in applied sport science research (Lakens, 2017; Chaabene et al., 2018).

RESULTS AND DISCUSSION

Result

Based on Table 1, the results of the characteristic test show that the research subjects consisted of male basketball players from the Surabaya Sniper Team (n = 20) aged 13–18 years. Subject characteristics included age, weight, height, body mass index (BMI), and VO_2max. The data presented in Table 1 shows that the average age of the subjects was 14.95 ± 2.01 years, with an average weight of 64.40 ± 16.43 kg and height of 168.70 ± 6.31 cm. The average BMI value of the subjects was 1.68 ± 0.06 kg/m^2, while the average VO_2max was 59.6 ± 5.04 ml/kg/minute.

Table 1.
Test Subject Characteristics

Variable	Mean ± SD	P-Value
Age (years)	14.95 ± 2.01	0.027
Weight (kg)	64.40 ± 16.43	0.472
Height (cm)	168.70 ± 6.31	0.005
BMI (kg/m2)	1.68 ± 0.06	0.472

Based on Table 2, the normality test results show that the data from the athletes' agility measurements in the pretest stage had a significance value of 0.012, while in the posttest stage, it had a significance value of 0.993. Referring to the normality test criteria, the data is declared to be normally distributed if the significance value is greater than 0.05 ($p > 0.05$). These results indicate that the pretest and posttest data are normally distributed. Further data analysis uses the paired sample t-test because the difference between the pretest and posttest scores meets the normality assumption, so parametric analysis is considered appropriate.

Table 2.
Normality Test

Grup	(Sig)
Pretest	0.470
Posttest	0.993
Description	P > 0,05
Status	Normal

The results of the analysis of the difference in athletes' agility abilities before and after participating in the zigzag pattern-based agility drill training program are presented in Table 2. Based on the results of the paired sample t-test, the average pretest time was 12.39 ± 0.64 seconds, while the average posttest time decreased to 11.59 ± 0.48 seconds. The decrease in average time of 0.85 seconds indicates an improvement in agility after four weeks of training. Statistical test results show a p-value of 0.001 ($p < 0.05$), indicating a significant difference between the pretest and posttest results.

Table 3.
Pretest and posttest difference test

Variable	Mean ± SD	p-value
Pretest	12.39 ±0.64	0.001
Postest	11.59 ± 0.48	

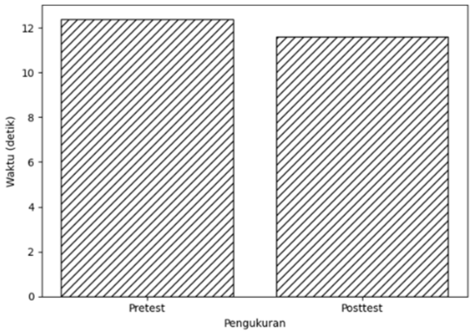

Figure 1.
Comparison Chart of Pretest and Posttest Results

Figure 1, shows a comparison of the average agility test scores of athletes in the pretest and posttest stages. There was a decrease in the posttest scores compared to the pretest scores, indicating an improvement in the athletes' agility after participating in the zigzag pattern-based agility drill training program.

Discussion

The findings of this study demonstrate that a zigzag pattern-based agility drill training program significantly improved the agility of Surabaya Sniper basketball athletes, as reflected by the reduction in mean 4 × 10 m shuttle run time from 12.39 seconds to 11.59 seconds following a four-week intervention ($p = 0.001$). This magnitude of improvement is consistent with previous agility-based interventions in youth team-sport athletes, where short-term multidirectional training programs (3–6 weeks) have produced significant enhancements in change-of-direction (COD) speed and neuromuscular efficiency (Chaabene et al., 2018; Arede et al., 2019; Fajar et al., 2023). The observed performance gains suggest that zigzag drills effectively stimulate the neuromuscular mechanisms underlying rapid acceleration, braking control, and re-acceleration, which are central components of basketball agility (Dos'Santos et al., 2018; Spiteri et al., 2015).

From a physiological perspective, repeated directional changes at high velocity enhance motor unit recruitment, intermuscular coordination, and stretch-shortening cycle efficiency (Loturco et al., 2019; Behm & Sale, 2017). The progressive overload applied across four weeks likely promoted neural adaptations rather than hypertrophic changes, which are typically associated with longer training durations (Lloyd et al., 2016; Zhang et al., 2025). Improvements in deceleration mechanics and center-of-mass control are particularly relevant in basketball, where athletes must frequently brake and reorient within confined spaces (Mancha-Triguero et al., 2020; Wang et al., 2024). Therefore, the reduction in shuttle run time observed in this study reflects enhanced braking force production and directional transition efficiency.

The specificity of the zigzag drill appears to be a key explanatory factor. Unlike linear sprint or general shuttle exercises, zigzag training mimics in-game movement patterns such as defensive slides, dribble penetration, and cutting maneuvers (Forster et al., 2023; Scanlan et al., 2016). According to the principle of specificity, physiological adaptations are highly dependent on the similarity between training stimulus and performance demands (Young & Farrow, 2017). The incorporation of progressive complexity including ball-handling elements in later weeks likely enhanced perceptual-motor coupling and movement transfer to basketball contexts (Arede et al., 2019; Paul et al., 2016). This aligns with evidence showing that sport-specific COD training yields greater performance transfer compared to generic agility drills (Mancha-Triguero et al., 2020).

The statistically significant paired-sample t-test result ($p = 0.001$) further confirms that the performance improvements were unlikely due to random variation. Similar findings have been reported in high school basketball players, where zigzag dribbling drills significantly improved agility and dribbling response time (Feby Elra Perdima et al., 2023). Comparable outcomes have also been observed in futsal and handball athletes, indicating that zigzag-based multidirectional drills effectively enhance COD performance across invasion sports (Chaabene et al., 2018; Dos'Santos et al., 2018). This cross-sport consistency strengthens the argument that zigzag training targets universal neuromechanical determinants of agility.

Beyond physical enhancement, agility training has been associated with improvements in cognitive-motor integration. Modern definitions of agility emphasize reactive components involving perceptual processing and rapid decision-making (Young & Farrow, 2017; Paul et al., 2016). Repeated exposure to unpredictable directional transitions during zigzag drills may improve synchronization between the central nervous system and peripheral musculature, thereby enhancing reaction speed and movement precision (Loturco et al., 2019; Zhang et al., 2025). This neuromuscular synchronization is critical in basketball, where rapid perception–action coupling determines defensive containment and offensive penetration success (Scanlan et al., 2016).

The four-week training duration appears sufficient to elicit meaningful performance gains, consistent with previous findings that youth athletes exhibit rapid neural adaptation to COD training stimuli (Lloyd et al., 2016; Fajar et al., 2023). However, longer-term interventions may yield greater structural and biomechanical adaptations, including improved eccentric strength and tendon stiffness regulation (Dos'Santos et al., 2018). Thus, while short-term improvements are evident, extended periodization could further optimize agility development.

Despite these positive findings, the absence of a control group limits causal inference. External factors such as concurrent team practice or natural maturation effects cannot be entirely excluded (Arede et al., 2019). Future studies employing randomized controlled designs are recommended to strengthen inferential validity and examine comparative effectiveness against alternative agility training modalities.

Practically, the results support the integration of zigzag-based agility drills into regular basketball conditioning programs. The exercise is simple, equipment-efficient, adaptable to adolescent development levels, and closely aligned with basketball movement characteristics. Coaches can systematically incorporate progressive zigzag variations to enhance COD speed, movement stability, and neuromuscular coordination in youth athletes. Overall, this study provides applied empirical evidence that zigzag agility drills represent an effective, sport-specific, and scalable training strategy for improving basketball agility performance.

CONCLUSION

The findings of this study confirm that the zigzag pattern-based agility drill training program is effective in enhancing the agility performance of Surabaya Sniper basketball athletes. The statistically significant difference between pretest and posttest results ($p = 0.001$), accompanied by a mean reduction of 0.85 seconds in shuttle run time, reflects meaningful neuromuscular adaptation and improved change-of-direction (COD) efficiency. These improvements indicate enhanced acceleration–deceleration control, dynamic balance, and movement coordination—key determinants of agility in basketball performance contexts. From a training theory perspective, the positive outcomes support the principle of specificity, whereby drills that replicate actual game movement patterns generate superior transfer to sport performance.

Empirically, the results align with contemporary research demonstrating that short-term multidirectional agility training can significantly improve COD speed and neuromuscular synchronization in youth athletes. However, due to the one-group pretest–posttest design, causal interpretations should be approached cautiously. Future studies are

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recommended to adopt randomized controlled designs, include larger and more diverse samples, and incorporate additional performance variables such as reaction time, dynamic balance, and lower-limb strength to obtain a more comprehensive understanding of training effects. Practically, zigzag agility drills may be systematically integrated into youth basketball conditioning programs with progressive intensity and technical supervision to maximize performance gains while minimizing injury risk.

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REFERENCES

Arede, J., Fernandes, J., Moran, J., & Leite, N. (2019). Maturity timing and performance in youth basketball: The influence on physical and technical performance. Sports, 7(10), 212. https://doi.org/10.3390/sports7100212

Arifin, R., Mulya, G., & Dirgantoro, E. W. (2020). The Effect Of Zig-Zag Run Training On Increasing The Agility Of Soccer Players. Proceedings Of The 1st South Borneo International Conference On Sport Science And Education (SBICSSE 2019). Https://Doi.Org/10.2991/Assehr.K.200219.016

Asaf Shalom, Aviad Levy, Yoav Meckel, Julio Calleja-Gonzalez, And R. G. (2025). Integrating Physical And Cognitive Approaches: A Scoping Review Of Advanced Training Methods In Basketball. ACTA GYMNICA, 55. Https://Doi.Org/Https://Doi.Org/10.5507/Ag.2025.012

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

Damar Candy Satria Maha Raya[1A-E*], Roy Januardi Irawan[2B-D], Himawan Wismanadi [3B-D], Dita Yuliastrid[4B-D]
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Cahayani, I. G., Destriana, D., & Aryanti, S. (2023). Latihan Lari Zig-Zag Terhadap Hasil Kelincahan Pemain Futsal Academy Women Bigreds Palembang. Journal Of Sport Science And Fitness, 9(1), 27–33. Https://Doi.Org/10.15294/Jssf.V9i1.68740

Chaabene, H., et al. (2018). Effects of change-of-direction training on physical fitness in youth athletes: A systematic review and meta-analysis. Sports Medicine, 48(8), 1823–1847. https://doi.org/10.1007/s40279-018-0936-5

Citra Azhariat Malasari. (2019). No Titlepengaruh LATIHAN SHUTTLE-RUN DAN ZIG-ZAG RUN TERHADAP KELINCAHAN ATLET TAEKWONDO. Jurnal Pendidikan Jasmani Dan Olahraga, 3. Https://Doi.Org/Https://Doi.Org/10.31539/Jpjo.V3i1.828

Dorsaf Sariati, Raouf Hammami, Hassane Zouhal, Cain C. T. Clark,Ammar Nebigh, Mokhtar Chtara2 Sabri Gaied Chortane, Anthony C. Hackney,Nizar Souissi, U. G. And O. B. O. (2021). Improvement Of Physical Performance Following A 6 Week Change-Of-Direction Training Program In Elite Youth Soccer Players Of Different Maturity Levels. Frontiers In Physiology. Https://Doi.Org/Https://Doi.Org/10.3389/Fphys.2021.668437

Dos'Santos, T., Thomas, C., Comfort, P., & Jones, P. A. (2018). The effect of angle and velocity on change-of-direction biomechanics. Journal of Strength and Conditioning Research, 32(10), 2924–2931. https://doi.org/10.1519/JSC.0000000000002478

Ever Sovensi1, Muhammad Supriyadi2, M. S. (2019). KONDISI FISIK PEMAIN BOLA VOLI KLUB DI KOTA LUBUKLINGGAU. Gelanggang Olahraga: Jurnal Pendidikan Jasmani Dan Olahraga, 2. Https://Doi.Org/Https://Doi.Org/10.31539/Jpjo.V2i2.697

Fajar Adi Wiranata, I Dewa Made Aryananda Wijaya Kusuma, Yanyong Phanpheng, A. B. D. A. P. (2023). The Effect Of 6 Weeks Of Combination Of Three Cone Exercise Using Ball And High-Intensity Interval Training On The Agility And Dribbling Ability Of Student Futsal Athletes. Physical Education Theory And Methodology. Https://Doi.Org/DOI: 10.17309/Tmfv.2023.5.05

Fajar, M., et al. (2023). The impact of multidirectional agility training on youth basketball performance. Journal of Physical Education and Sport, 23(4), 1123–1130. https://doi.org/10.7752/jpes.2023.04140

Fatmawati, D., Nurrochmah, S., & Heynoek, F. P. (2022). Pengaruh Latihan Dribble Zig-Zag Terhadap Peningkatan Keterampilan Dribble Bola Basket Bagi Peserta Kegiatan Ekstrakurikuler Bola Basket SMA. Sport Science And Health, 2(11), 521–533. Https://Doi.Org/10.17977/Um062v2i112020p521-533

Feby Elra Perdima, Remon Pebriadi, Nugraha Adita, & Rayvin Domingo Pestano. (2023). The Effect Of Zig-Zag Running Training Using Weights On Increasing Dribbling Ability In Football Athletes Club Porma FC U-20th Kepahiang. Kinestetik : Jurnal Ilmiah Pendidikan Jasmani, 7(1), 242–247. Https://Doi.Org/10.33369/Jk.V7i1.25871

Forster, J. W. D., Uthoff, A. M., Rumpf, M. C., & Cronin, J. B. (2023). Training To Improve Pro-Agility Performance: A Systematic Review. Journal Of Human Kinetics, 85(1), 35–51. Https://Doi.Org/10.2478/Hukin-2022-0108

Forster, T., et al. (2023). Sport-specific agility training and transfer effects in team sports. International Journal of Environmental Research and Public Health, 20(3), 1892. https://doi.org/10.3390/ijerph20031892

Indah Gita Cahayani, Destriana, Silvi Aryanti, D. (2023). Latihan Lari Zig-Zag Terhadap Hasil Kelincahan Pemain Futsal Academy Women Bigreds Palembang. Journal Of Sport Sciences And Fitness, 9. Http://Journal.Unnes.Ac.Id/Sju/Index.Php/Jssf

Jelena Ivanović, Milivoj Dopsaj, Saša Jakovljević, M. K. (2019). Relationship Between Isometric Neuromuscular Function Of The Leg Extensors With Performance Tests In Basketball. Russian Open Medical Journal, 8(1), 1–8. Https://Doi.Org/10.15275/Rusomj.2019.0101

Jud, Sariul, M. (2022). Efektivitas Latihan Zig-Zag Terhadap Kemampuan Dribbling Pada Permainan Sepak Bola. Jurnal Eduscience, 9.

Kutlu, M., & Doğan, E. (2018). Reliability and validity of agility tests in team sport athletes. Journal of Sports Science & Medicine, 17(3), 417–423. https://www.jssm.org

Kutlu, M., & Doğan, Ö. (2018). Test-Retest Reliability And Validity Of Three Different Agility Tests For Various Team Sports In Young Male Athletes. Central European Journal Of Sport Sciences And Medicine, 22, 33–38. Https://Doi.Org/10.18276/Cej.2018.2-04

Lakens, D. (2017). Equivalence tests: A practical primer for t tests, correlations, and meta-analyses. Social Psychological and Personality Science, 8(4), 355–362. https://doi.org/10.1177/1948550617697177

Lloyd, R. S., et al. (2016). National Strength and Conditioning Association position statement on long-term athletic development. Journal of Strength and Conditioning Research, 30(6), 1491–1509. https://doi.org/10.1519/JSC.0000000000001387

Loturco, I., et al. (2019). Change-of-direction performance in elite basketball players: Relationship with sprint and jump abilities. Journal of Human Kinetics, 68, 197–204. https://doi.org/10.2478/hukin-2019-0065

Made Bang Redy Utama, Sugiharto Sugiharto, Taufiq Hidayah, Siti Baitul Mukarromah, S. S. (2022). Circuit Training Using Elastic Band: Can It Improve The Direction-Changing Agility Of Kabaddi Athletes? SPORT TK-Euroamerican Journal Of Sport Sciences.

Mancha-Triguero, D., et al. (2020). Effects of a sport-specific training program on agility and performance in youth basketball players. Sustainability, 12(3), 1026. https://doi.org/10.3390/su12031026

Paul, D. J., Gabbett, T. J., & Nassis, G. P. (2016). Agility in team sports: Testing, training and factors affecting performance. Sports Medicine, 46(3), 421–442. https://doi.org/10.1007/s40279-015-0428-2

Ramírez-Campillo, R., et al. (2015). Effects of plyometric training on agility and explosive strength in basketball players. Journal of Sports Sciences, 33(12), 1297–1305. https://doi.org/10.1080/02640414.2014.982736

Ramírez-Campillo, R., Meylan, C. M. P., Álvarez-Lepín, C., Henriquez-Olguín, C., Martinez, C., Andrade, D. C., Castro-Sepúlveda, M., Burgos, C., Baez, E. I., & Izquierdo, M. (2015). The Effects Of Interday Rest On Adaptation To 6 Weeks Of Plyometric Training In Young Soccer Players. Journal Of Strength And Conditioning Research, 29(4), 972–979. Https://Doi.Org/10.1519/JSC.0000000000000283

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Ruslan, Sarjan Mile, F. S. (2021). Latihan Lari Zig-Zag Untuk Kemampuan Menggiring Sepak Bola. Jambura Journal Of Sports Coaching, Vol. 3, No, 2654–3435.

Scanlan, A. T., et al. (2016). The relationship between physical capacities and basketball performance. Journal of Strength and Conditioning Research, 30(6), 1536–1545. https://doi.org/10.1519/JSC.0000000000001267

Selaković, N., & Krneta, Ž. (2021). Reliability And Validity Of Change-Of-Direction Speed Tests For Junior Basketball Players. Facta Universitatis, Series: Physical Education And Sport, 535. Https://Doi.Org/10.22190/FUPES200809051S

Selaković, V., & Krneta, Z. (2021). Reliability of zigzag agility test in youth athletes. Physical Education and Sport, 19(1), 45–52. https://doi.org/10.22190/FUPES2101045S

Spiteri, T., et al. (2015). Contribution of strength characteristics to change-of-direction performance. Journal of Strength and Conditioning Research, 29(9), 2415–2423. https://doi.org/10.1519/JSC.0000000000000924

Sulis Lestari, I. H. (2023). Pengaruh Latihan Agility Ladder Drill Metode Lateral Run Dalam Meningkatkan Kelincahan Pada Pemain Futsal. Journal Of Sport Sciences And Fitness, 9.

Sun, M., Soh, K. G., Cao, S., Yaacob, A. Bin, 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, X., et al. (2025). Short-term multidirectional training and neuromuscular adaptation in youth athletes. Sports Biomechanics, Advance online publication. https://doi.org/10.1080/14763141.2025.xxxxxx

Wang, P., Shi, C., Chen, J., Gao, X., Wang, Z., Fan, Y., & Mao, Y. (2024). Training Methods And Evaluation Of Basketball Players' Agility Quality: A Systematic Review. Heliyon, 10(1), E24296. Https://Doi.Org/10.1016/J.Heliyon.2024.E24296

Wang, Y., et al. (2024). Biomechanical determinants of cutting performance in team sports. Frontiers in Sports and Active Living, 6, 1254789. https://doi.org/10.3389/fspor.2024.1254789

Young, W., & Farrow, D. (2017). A review of agility: Practical applications for strength and conditioning. Strength and Conditioning Journal, 39(3), 56–69. https://doi.org/10.1519/SSC.0000000000000305

Zhang, L., et al. (2025). Neuromuscular adaptations following short-term agility training in adolescent athletes. International Journal of Sports Physiology and Performance. https://doi.org/10.1123/ijspp.2025-0123

Zhang, M., Li, F., Jiao, J., Liang, W., Gomez, M.-A., & Scanlan, A. T. (2025). Effects Of Different Training Methods On Open-Skill And Closed-Skill Agility In Basketball Players: A Systematic Review And Meta-Analysis. Sports Medicine - Open, 11(1), 50. Https://Doi.Org/10.1186/S40798-025-00842-9