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# Comparison of The Effects of Zig-Zag Run And Shuttle Run Training On 50-Meter Sprint Speed In Football Athletes

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## ABSTRACT

This study aimed to compare the effects of zig-zag run and shuttle run training on 50-meter sprint speed in football athletes of Lormes FC, Tolitoli Regency. Speed is a critical physical component in modern football, particularly in short-distance sprint actions that involve rapid acceleration and frequent changes of direction. An experimental method with a pretest–posttest comparative design was employed. Twenty male football athletes were assigned into two groups using ordinal pairing to ensure equivalent baseline characteristics. One group underwent zig-zag run training, while the other followed shuttle run training, each conducted over 18 training sessions within six weeks. Sprint performance was assessed using a standardized 50-meter sprint test before and after the intervention. The results showed that both training methods significantly improved sprint speed ($p < 0.05$). The zig-zag run group demonstrated a mean improvement of approximately 13%, whereas the shuttle run group improved by about 12%. Further comparative analysis revealed that zig-zag run training produced a significantly greater improvement in 50-meter sprint performance than shuttle run training. This superiority is attributed to the multidirectional movement patterns of zig-zag running, which stimulates greater neuromuscular coordination, dynamic balance, and force application efficiency. These findings provide empirical evidence that agility-based training, particularly zig-zag run exercises, is more effective for developing short-distance sprint speed in football athletes compared to linear change-of-direction drills. Practically, this study supports the integration of multidirectional agility training into football conditioning programs to optimize sprint performance. Future studies are recommended to involve larger samples, combine multiple agility-based drills, and utilize advanced explainable measurement tools for speed analysis.

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A. Conception and design of the study;
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## INTRODUCTION

Football is one of the most popular sports in the world and plays a strategic role not only as a physical activity but also as a vehicle for character development, such as

sportsmanship, responsibility, teamwork, and quick decision-making (Pratama, 2017). In Indonesia, football's popularity is growing due to its high accessibility, both through the presence of clubs in almost every region and through broadcast media, which allows people to enjoy matches without economic barriers (Hilman, 2016). In the context of performance, a football player's success is largely determined by mastery of basic techniques such as dribbling, passing, shooting, controlling, and heading, all of which depend on optimal physical condition (Daryanto & Hidayat, 2015; Efendi et al., 2018; Ramdhon et al., 2018).

Among the various components of physical condition, speed is a crucial factor in modern football. Speed is required in various game situations, such as attack-defense transitions, pressing, chasing the ball, and anticipating opponent counterattacks. Speed is not only understood as the ability to run in a straight line in a short time, but also encompasses the ability to accelerate, coordinate, balance, and change direction quickly and efficiently (Sanjaya, 2014; Kusuma, 2017). Therefore, training that emphasizes acceleration, deceleration, and change of direction is highly relevant to improving short-distance sprint performance, including the 50-meter sprint, which is often used as an indicator of speed in football athletes.

Developments in sports coaching science over the past decade have shown a paradigm shift from linear speed training to agility-based speed training and change of direction. Recent studies confirm that sprints in football rarely occur in a straight line without interruption, but almost always involve changes of direction, body rotation, and postural adjustments to the game situation (Sheppard & Young, 2006; Chaabene et al., 2020). Therefore, training methods such as zigzag runs and shuttle runs are increasingly being used to develop more functional speed specific to match demands.

Zigzag running is a form of agility training that emphasizes rapid changes of direction at varying angles, thus training neuromuscular coordination, dynamic balance, and multidirectional acceleration (Wedana, 2014; Arafat, 2018). Several studies report that zigzag running is effective in improving dribbling ability and motor control due to its alignment with football movement patterns (Arwandi & Ardianda, 2018; Frananda et al., 2022). Meanwhile, shuttle running emphasizes a back-and-forth running pattern with 180-degree changes of direction, which effectively improves acceleration, deceleration, and body momentum control (Fathoni & Racman, 2020; Eko Santoso et al., 2020).

Physiologically and biomechanically, both methods have been shown to improve neuromuscular capacity, eccentric-concentric strength, and ground reaction force efficiency, all of which contribute to speed and agility performance (Brughelli et al., 2015; Dos'Santos et al., 2018). However, the literature shows that the context of use and the focus of training outcomes vary, so the relative effectiveness of each method on pure sprint speed has not been fully confirmed.

Although several studies have examined the benefits of zigzag runs and shuttle runs, most have focused on improving agility, dribbling, or technical skills, rather than directly increasing short-distance sprint speed. Research by Malasari (2019) and Udam (2017), for example, demonstrated improvements in agility and dribbling, but did not specifically measure changes in linear sprints such as the 50-meter sprint. Furthermore,

research comparing the effectiveness of these two training methods remains inconsistent, particularly in the context of sprint performance.

Furthermore, there is limited research testing the effectiveness of these two training methods at the local club level, with diverse athlete characteristics and relatively simple training programs. However, local context is crucial because the physical condition, quality of training, and needs of amateur and semi-professional athletes differ from those of elite athletes. Initial observations of Lormes FC players in Tolitoli Regency indicate limitations in sprint speed, which impacts game effectiveness, particularly in pressing, transition, and fast-paced attack situations. This gap between practical needs in the field and scientific evidence highlights the existence of a research gap that needs to be bridged through measurable and contextual comparative research.

Based on these research issues and gaps, the objective of this study is to analyze and compare the effects of zigzag run and shuttle run training on improving 50-meter sprint speed in Lormes FC football players from Tolitoli Regency. This study specifically positions sprint speed as the primary variable, not merely a derived variable of agility or technical skills.

The novelty of this study lies in (1) the direct comparative focus between the two most commonly used agility training methods on 50-meter sprint performance, (2) the use of a local club athlete context rarely explored in international literature, and (3) the empirical contribution to strengthening the concept of agility-based speed training in football. Therefore, the results of this study are expected to not only enrich the scientific body of knowledge in the fields of sports science and football coaching but also provide practical, evidence-based recommendations for coaches in designing more effective and contextual speed training programs.

## METHODS

This study employed a quantitative approach with a pretest–posttest experimental design involving two treatment groups. The design was selected because it enables the direct examination of causal relationships through controlled interventions and the measurement of changes following treatment (Winarno, 2013). Two training methods—zig-zag run and shuttle run—were administered to two separate groups to compare their effects on the 50-meter sprint speed of football athletes. The research was conducted at Olrisaan Bulaan Field, Dadakitan Village, Baolan District, Tolitoli Regency, Central Sulawesi. The entire research process spanned two months following the proposal seminar and was integrated into the team's regular training schedule.

The study population consisted of all 20 players of Lormes FC in Tolitoli Regency, who exhibited homogeneous characteristics in terms of training age, gender, and active involvement as football athletes. A total sampling technique was used, meaning all members of the population were included in the sample due to their limited number and full eligibility (Sugiyono, 2016:85). The sample was then divided into two balanced groups using the ordinal pairing technique to ensure that both groups had relatively equivalent initial ability distributions.

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The research instruments comprised three primary measurement tools: the shuttle run test, the zig-zag run test, and the 50-meter sprint test. These instruments assessed athletes' agility, directional change ability, and linear speed. Each instrument was equipped with standardized procedural guidelines, including the use of cones, measuring tapes, stopwatches, whistles, and lane markers. Scoring norms for each test referred to established standards from previous literature, such as shuttle run and zig-zag run norms in Perkembangan Olahraga Terkini (2009) and speed test norms by Moeslim (2003). Test procedures adhered to technical guidelines ensuring consistent and objective measurement for example, using a standing start, recording time with 0.1-second accuracy, and performing two trials to select the best result. Instrument validity was supported by their widespread use in sports and physical education research, while reliability was maintained through standardized administration procedures (Arikunto, 2019).

Data collection involved direct observation and performance tests. Observation was used to identify field conditions and athletes' initial characteristics following the guidelines of Sugiyono (2017:203), while performance tests were conducted to obtain sprint speed data in both the pretest and posttest stages. The pretest was administered before treatment to determine baseline ability, and the posttest was conducted after 18 training sessions delivered over six weeks. Each training method was implemented three times per week with progressively increasing duration and repetitions, following the training program established at the beginning of the study.

Data were analyzed quantitatively using SPSS software. The analysis procedures included a normality test using the Kolmogorov–Smirnov test to ensure data distribution, a homogeneity test using Levene's test to confirm equality of variances between groups, and t-tests to examine the hypotheses related to training effects and differences between the two treatment groups. A paired t-test was used to identify changes before and after treatment within each group, while an independent t-test was used to compare the effectiveness of zig-zag run and shuttle run training. All analyses used a significance level of 0.05 as the basis for statistical decision-making.

## RESULTS AND DISCUSSION

### Effects of Zig-Zag Run Training on 50-Meter Sprint Speed

The results of this study demonstrate that zig-zag run training produced a statistically and practically significant improvement in 50-meter sprint speed among football athletes. The mean sprint time decreased from 12.344 s in the pretest to 10.901 s in the posttest, representing an improvement of approximately 13%. This magnitude of change indicates that zig-zag run training effectively enhances sprint-related performance components, particularly acceleration, neuromuscular coordination, and movement efficiency.

Conceptually, zig-zag run training involves multidirectional movement patterns characterized by rapid changes of direction, repeated acceleration–deceleration cycles, and continuous postural adjustments. These demands strongly stimulate both central and peripheral nervous systems, enhancing intermuscular and intramuscular

coordination (Sheppard & Young, 2006; Dos'Santos et al., 2018). The frequent directional transitions require coordinated activation of key muscle groups, including the quadriceps, hamstrings, gluteus maximus, and core stabilizers, which are critical for sprint propulsion and stability (Chaabene et al., 2020).

From a biomechanical perspective, zig-zag running improves the athlete's ability to manage ground reaction forces and center-of-mass displacement during directional transitions. Athletes must rapidly adjust hip rotation, foot placement, and trunk alignment to maintain momentum while changing direction, thereby refining stride mechanics and reducing braking forces (Hewit et al., 2011; Brughelli et al., 2015). Over time, these adaptations lead to shorter ground contact times, increased stride frequency, and more efficient horizontal force production—key determinants of sprint acceleration over short distances such as 50 meters (Morin et al., 2015).

Physiologically, zig-zag run training enhances neuromuscular qualities associated with the rate of force development (RFD) and fast-twitch muscle fiber recruitment. The repeated loading and unloading cycles during acceleration and deceleration phases improve muscle–tendon stiffness and elastic energy utilization, contributing to more explosive push-off mechanics (Cormie et al., 2011; Markovic & Mikulic, 2010). These adaptations are particularly relevant in football, where sprinting often occurs under conditions requiring rapid directional adjustments rather than purely linear motion.

The present findings are consistent with previous studies reporting that zig-zag and multidirectional agility training significantly improve sprint speed, agility, and reactive movement performance in football players (Arafat, 2018; Frananda et al., 2022). Moreover, recent systematic evidence suggests that agility-based drills incorporating directional variability yield greater transfer effects to sprint performance than linear sprint training alone, due to their higher movement specificity (Chaabene et al., 2022).

**Effects of Shuttle Run Training on 50-Meter Sprint Speed**

The shuttle run training group also demonstrated a significant improvement in sprint performance, with mean sprint time decreasing from 14.315 s to 12.769 s, corresponding to an improvement of approximately 12%. These findings indicate that shuttle run training effectively enhances sprint-related abilities, particularly acceleration control, deceleration efficiency, and repeated sprint capacity.

Shuttle run exercises are characterized by repeated short-distance sprints with abrupt 180-degree changes of direction. This movement pattern imposes high eccentric and concentric muscular demands, particularly on the lower limbs, which enhances neuromuscular coordination and momentum control (Young et al., 2015). The alternation between braking and propulsive phases improves the athlete's ability to absorb and reapply force efficiently, an essential component of short-distance sprinting.

From a physiological standpoint, shuttle run training places substantial stress on anaerobic energy systems, promoting adaptations in anaerobic capacity and fatigue tolerance (Bishop et al., 2011). Additionally, the repeated deceleration phases increase eccentric strength in the hamstrings and quadriceps, which contributes to improved sprint mechanics and injury resilience (Timmins et al., 2016).

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Biomechanically, shuttle run training enhances postural stability and proprioceptive control during rapid changes of direction. Athletes learn to optimize foot placement, trunk orientation, and joint stiffness when reversing momentum, leading to improved movement efficiency during short sprints (Dos'Santos et al., 2019). These adaptations are particularly beneficial in football contexts involving frequent stop–start actions, such as defensive recovery runs or pressing actions.

Previous empirical studies support the effectiveness of shuttle run training for improving speed and agility in football athletes. Research by Fathoni and Racman (2020) and Fahlefi et al. (2021) demonstrated significant gains in sprint speed, coordination, and change-of-direction ability following shuttle run interventions. However, several authors note that while shuttle run training is effective, its movement variability is more limited compared to multidirectional agility drills, potentially constraining long-term transfer to complex match situations (Young et al., 2015; Chaabene et al., 2020).

**Comparative Analysis of Zig-Zag Run and Shuttle Run Training**

The independent t-test analysis revealed a significant difference between the two training methods ($p < 0.05$), with zig-zag run training producing a greater improvement in 50-meter sprint speed than shuttle run training. Although both methods effectively enhanced sprint performance, the zig-zag run induced broader neuromuscular and biomechanical adaptations due to its multidirectional and multi-planar movement demands.

The superior effectiveness of zig-zag run training can be attributed to its greater movement complexity and specificity. Zig-zag drills require athletes to generate force across multiple planes while maintaining balance and coordination, thereby enhancing dynamic stability and proprioceptive acuity (Sheppard & Young, 2006; Dos'Santos et al., 2018). These qualities are strongly associated with sprint acceleration and efficient force application during short-distance sprints (Morin et al., 2015).

In contrast, shuttle run training predominantly emphasizes sagittal-plane movement with repetitive linear acceleration and deceleration. While this effectively improves linear speed and braking ability, it provides less stimulation for rotational stability and lateral force production, which are crucial in football sprinting scenarios (Brughelli et al., 2015). Consequently, shuttle run training may yield more limited transfer to multidirectional sprint performance compared to zig-zag run training.

From a neuromuscular perspective, zig-zag run training offers greater variability in motor unit recruitment patterns, enhancing both intermuscular and intramuscular coordination. This variability promotes adaptive motor learning and reduces the likelihood of performance plateaus associated with repetitive movement patterns (Cormie et al., 2011; Chaabene et al., 2022). The shuttle run, while effective, presents a more repetitive stimulus that may require supplementation with multidirectional drills to maximize performance gains.

The principle of training specificity further supports the observed findings. Football sprinting rarely occurs in a straight line; instead, players frequently accelerate while adjusting body orientation in response to tactical and perceptual cues. Zig-zag run

training closely replicates these demands, resulting in greater ecological validity and performance transfer (Luxbacher, 2016; Young et al., 2015).

**Practical Implications for Football Conditioning**

The findings of this study provide important implications for evidence-based football conditioning programs. Zig-zag run training should be prioritized as a primary method for enhancing sprint speed and agility, particularly for short-distance performance. Its multidirectional nature promotes integrated development of speed, balance, coordination, and neuromuscular efficiency, aligning closely with the demands of competitive football.

Shuttle run training remains a valuable complementary method, particularly for developing acceleration–deceleration control and repeated sprint ability. When integrated within a periodized training framework, the combination of zig-zag and shuttle run drills can produce comprehensive physical adaptations while minimizing injury risk through improved eccentric strength and movement control (Timmins et al., 2016; Chaabene et al., 2020).

## CONCLUSION

Based on the research findings, both zig-zag run and shuttle run training methods significantly improved 50-meter sprint performance among football players of Lormes FC Tolitoli. However, the zig-zag run produced greater improvement (13%) than the shuttle run (12%), indicating its superior effectiveness in enhancing acceleration, multidirectional speed, and neuromuscular coordination. These results emphasize the importance of agility-based training in developing sprint speed, particularly in multidirectional sports such as football.

This research advances scientific understanding by demonstrating that agility-based drills especially those emphasizing change-of-direction speed can improve linear sprint performance. Previous studies often focused only on agility and dribbling; this study bridges that gap by showing that directional-change training also enhances sprint capacity. However, the study's limitations include a small sample size, a short six-week intervention, and manual timing instruments, which may reduce generalizability and measurement precision. Future studies should include larger samples, longer training durations, and electronic timing systems to improve accuracy and reliability.

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