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The Effect of Combination of Cone Drill (Zigzag) with Core Stability, Combination of Ladder Drill (Snake Jump) with Core Stability, and Speed on Agility of Futsal Players: A Factorial Experimental Design

Efecto de la combinación del ejercicio de conos (zigzag) con la estabilidad del núcleo, la combinación del ejercicio de escalera (salto de serpiente) con la estabilidad del núcleo y la velocidad en la agilidad de los jugadores de fútbol sala: Un diseño experimental factorial

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Abstract. The game of futsal, known for its high intensity and dynamic nature demanding skill and robust physical fitness, particularly in agility, presents a significant challenge. Incorporating variations of cone and ladder drills in agility training, with a focus on enhancing balance through core stability training in conjunction with speed modulation as a key factor, is believed to impact players' agility players. Despite recognizing the individual significance of these training modalities in boosting agility performance, there remains a gap in fully comprehending their combined effects during futsal engagements. This research seeks to scrutinize the group differentials in agility training, factoring in speed variations in relation to futsal players' agility levels. The study defined agility training cohorts as a combo group of cone drill with core stability and a combination group of ladder drill alongside core stability, while speed was categorized as high or low. Employing an experimental methodology with a 2 x 2 factorial design, the study enlisted 20 players aged 17.1 ± 0.76 years through random selection. Agility training, conducted thrice weekly over a six-week period, emphasized swift and dynamic movements alongside maintaining balance. Speed and agility metrics were assessed using the 30m acceleration test and Illinois agility test, then subjected to statistical scrutiny via a two-way ANOVA at a significance level of 0.05. Results revealed that both training methodologies benefited participants with elevated speed ($P<0.05$). Notably, agility training incorporating ladder drill exercises and core stability training exhibited superior outcomes for high-speed performers ($P<0.05$). Conversely, individuals with lower speed levels potentially benefitted more from a combination of ladder drill and core stability ($P<0.05$). These findings furnish crucial insights for futsal coaches and trainers looking to craft tailored training regimens aimed at enhancing agility performance effectively.
Keywords: Cone Drill, Ladder Drill, Core Stability, Speed, Agility, Futsal

Resumen. El juego de futsal, conocido por su alta intensidad y naturaleza dinámica que requiere habilidad y una sólida condición física, particularmente en agilidad, presenta un desafío significativo. La incorporación de variaciones de ejercicios de conos y escalera en el entrenamiento de agilidad, con un enfoque en mejorar el equilibrio a través del entrenamiento de estabilidad central junto con la modulación de la velocidad como un factor clave, se cree que impacta en la agilidad de los jugadores. A pesar de reconocer la importancia individual de estas modalidades de entrenamiento en el aumento del rendimiento en agilidad, queda una laguna en la comprensión completa de sus efectos combinados durante las actividades de futsal. Esta investigación busca examinar las diferencias grupales en el entrenamiento de agilidad, considerando las variaciones de velocidad en relación con los niveles de agilidad de los jugadores de futsal. El estudio definió los grupos de entrenamiento de agilidad como un grupo de combinación de conos con estabilidad central y un grupo de combinación de ejercicios de escalera junto con estabilidad central, mientras que la velocidad se clasificó como alta o baja. Mediante una metodología experimental con un diseño factorial de 2 x 2, el estudio reclutó a 20 jugadores de entre 17.1 ± 0.76 años mediante selección al azar. El entrenamiento de agilidad, llevado a cabo tres veces por semana durante un período de seis semanas, enfatizó movimientos rápidos y dinámicos junto con el mantenimiento del equilibrio. Las métricas de velocidad y agilidad se evaluaron mediante la prueba de aceleración de 30m y la prueba de agilidad de Illinois, luego se sometieron a un análisis estadístico a través de un ANOVA de dos vías con un nivel de significancia de 0.05. Los resultados mostraron que ambas metodologías de entrenamiento beneficiaron a los participantes con velocidad elevada ($P<0,05$). Especialmente, se observaron resultados superiores en el entrenamiento de agilidad que incorporaba ejercicios de escalera y entrenamiento de estabilidad central para los deportistas con velocidad alta ($P<0,05$). Por otro lado, los individuos con niveles de velocidad más bajos pudieron beneficiarse más de una combinación de ejercicios de escalera y estabilidad central, arrojando conclusiones clave para los entrenadores de futsal interesados en desarrollar programas de entrenamiento personalizados para mejorar efectivamente el rendimiento en agilidad.
Palabras clave: Ejercicio de Conos, Ejercicio de Escalera, Estabilidad del Núcleo, Velocidad, Agilidad, Futsal

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Introduction

Futsal is a team game consisting of five people, which aims to score goals into the opponent's goal (Spyrou et al., 2020). Futsal games can be played indoors or outdoors, where the size of the futsal field is (40x20m) (Alvarez et al., 2020). Futsal is characterized by high-intensity and dynamic play, which requires skill and good physical condition (Berhimpong et al., 2023; Milanović et al., 2011; A. P. Pratama, Sukamti, Suhartini, Sulistiyowati, Sepdanius, et al., 2024; Sekulic et al., 2019; Tanyeri & Öncen, 2020). In fact, when compared to football, the technical competence of futsal players is higher than that of football players characterised by a high number of goals and a high speed of play

(Barbero-Alvarez et al., 2008; Dimyati et al., 2023; Guerra Echevarria & Valencia Sánchez, 2022; Sridadi et al., 2021). Playing with a ball that bounces less than thirty percent is a difficult task for players to control and carry it quickly, so the characteristics of futsal reflect the physical and physiological capacity of athletes (Farhani et al., 2019; Ünveren, 2015). To support the implementation of techniques, tactics, and mentality, it needs to be supported by a qualified physical condition in order to achieve the goals in the futsal game (Dimyati et al., 2023; Ilham & Dimyati, 2021; Naser et al., 2017). The components of physical condition consist of endurance, strength, speed, agility, power, flexibility, accuration, coordination, balance, and reaction (Ferraz et al., 2020; Li et al., 2023; A. P. Pratama, Sukamti, Suhartini, Sulistiyowati, Sepdanius, et al., 2024; Rifki et al., 2023; Sari, Kurniawan, et al., 2023). In futsal games, the dominant physical condition components that need to be owned are endurance, strength, speed, agility, power, (Tanyeri & Öncen, 2020). Agility is the ability to move maximally to change direction quickly body parts without experiencing balance disturbances (Benvenuti et al., 2010; Farley et al., 2020; Sekulic et al., 2019; Ünveren, 2015). The movements performed are acceleration movements towards the point, stopping quickly and holding, immediately changing direction, and accelerating towards the next point performed with a specified number of repetitions as a feature of movement speed training in the form of agility (Lockie et al., 2013; Nygaard Falch et al., 2019; Selviani et al., 2024). In sports agility performance will provide a good basis for motor function skills and neuromuscular control, improve coordinating multiple movements, facilitate the mastery of high techniques, and most importantly the willingness to reduce the risk of injury (García-Unanue et al., 2020; Padrón-Cabo et al., 2020; Setiawan et al., 2017).

The influence of the dominant physical components will affect the basic techniques and strategies in futsal games, one of which is physical components such as good agility which is the key to a successful game (Hojka et al., 2016; Setiawan et al., 2017; Sridadi et al., 2021). The role of agility in a futsal game is needed when the player dribbles past the opponent's obstacles, the movement changes direction from the transition from defense to attack or vice versa, and avoids collisions with opponents to avoid injury. Thus, to master the expected quality, one must train by following various training principles such as intensity, repetitions, sets, intervals, and types of training to be able to improve physical conditions (Ihsan et al., 2024; Ilham & Dimyati, 2021; A. P. Pratama et al., 2024; Sari, et al., 2023). Seeing the importance of the agility element in futsal games, of course this needs to be a concern and provide an apoewrppropriate form of training (Benvenuti et al., 2010; Sekulic et al., 2019). To support the ability to play futsal, it is necessary to provide a form of agility training including cone drill, ladder drill, shuttle run, obstacle run, boomerang run, dodging run, hexagon run (Hojka et al., 2016). Cone drills can also be defined as exercises that use cone-shaped objects in their implementation. Through the training process with this method, players are accustomed to making movements quickly towards the cone and making changes in movement towards the next cone (Santoso et al., 2023). ladder drills are one of the tools to train speed and agility in the form of stairs placed on the ground to function to train leg muscles, this exercise requires body balance and simultaneous foot jumps (Ng et al., 2017).

Many factors affect agility including, speed and balance factors greatly affect agility ability (Pamungkas et al., 2023). Without good elements of both, a person cannot move agilely. With that in mind, it is necessary to include speed and balance training when practicing to train agility. The element of speed is always based on the basic concept, namely: the ratio between time and distance, so speed is always related to reaction time, frequency of motion per unit of time, and the speed of traveling a certain distance of motion speed (Bompa & Buzzichelli, 2015; Koestanto et al., 2017). Balance is a person's ability to control muscle nerve organs so that they can control movements properly and correctly. Based on this, it can be said that someone who has agility can change direction or position quickly and precisely without losing balance (Donie et al., 2022; Edmizal et al., 2023; Haryanto et al., 2021; Mccartney & Forsyth, 2017). Core stability is a form of balance training, which refers to the ability of the back muscles and abdominal muscles to control the position and movement of the center of the body (Araujo et al., 2015; Donie et al., 2023; Sukarmin et al., 2021; Szafraniec et al., 2020). This structure is maintained or kept in optimal alignment so that the muscles and joints in the lower limbs can function efficiently (Manchado et al., 2017). That way futsal players can move agilely to carry out techniques and strategies so as to master the match and win.

Many studies have investigated how ladder drill can affect agility such as ladder drill training and Plyometric training improves agility, it can be a useful training strategy to improve player performance, ladder drill training is more effective and also helps players to catch, attack, and block opponents (Ilham et al., 2024; Makadada et al., 2024; Prakash et al., 2021). Aspects of the kinetic characteristics resulting from ladder drills on agility have also been studied (Scoles et al., 2023). It has been measured and analyzed the effect of ladder drill on improving the agility of athletes aged 14 - 16 years, The importance of this training model can provide variety for coaches to train athletes so that athletes' agility can develop and athletes can develop strategies and tactics (Hikmah et al., 2023). In addition, the effect of a combination of 6 weeks of cone drill variation training such as Three-Cone Drill using the Ball on the agility and dribbling ability of futsal athletes concluded that it is effectively applied to improve the agility and dribbling ability of futsal players (Wiranata et al., 2023). Cone drill exercises such as Shuttle-Run and ZigzagRun Training on agility have very different effects on agility, which are more influenced by zig-zagrunning training than shuttle run training (Alimuddin et al., 2023). A very commonly used exercise

and proven to improve agility is the ladder drill method. Meanwhile, training using the cone drill method is still under research and is still rarely done. Therefore, this study tries to fill the gap by focusing not only on the ladder drill method but also on cone drill. In addition, this study also pays attention to other important elements to improve agility, namely speed and balance. Where, the agility training method is given a combination with core stability to pay attention to the supporting factors of agility. So that Core stability combination exercises can build strength in postural muscles, this will increase stability in the trunk and posture, and can improve balance and agility (Cugliari & Boccia, 2017; Damrah et al., 2023; Haryanto et al., 2021).

Therefore, this study aims to analyze the differences in the influence of the intervention group of agility training methods by considering the level of speed on agility results. In this study, agility training was divided into two groups, namely a combination group of ladder drill exercises with core stability and a combination group of cone drill exercises with core stability. The results of this study are useful for coaches, physical education teachers, practitioners, and athletes to train agility in futsal sports. Therefore, trainers can take into account speed and balance to train agility.

Materials and Methods

Study design

This research is an experimental research with two-way ANOVA factorial design (Montgomery, 2013). Agility training (A) consists of two forms of treatment, namely Ladder drill (A1) and Cone drill (A2). Meanwhile, Speed (B) consisted of high speed (B1) and low speed (B2). The classification of these variables is illustrated in Table 1. In summary, this study included four treatments: Agility training with ladder drill combined core stability with high and low speed (A1B1 and A1B2) and agility training with cone drill combined core stability with high and low speed (A2B1 and A2B2).

Table 1.
The two-way factorial ANOVA design.

Speed (B)	Agility training (A)	
	ladder drill core stability combination (A1)	cone drill core stability combination (A2)
High (B1)	A1B1	A2B1
Low (B2)	A1B2	A2B2
Total	A1	A2

Participants

The study population consisted of Vamos Academy Padang Futsal Players. After random recruitment, the total number of participants who participated in this study was 20 futsal players who had signed informed consent as a condition of conducting the study. The age of the participants was 17.1 ± 0.768 years. Meanwhile, body weight was 61 ± 5.94 and height was 166.89 ± 4.27 cm and BMI was 22.03 ± 2.58 Kg/M^2.

Procedure

Distribution of treatment groups

For the first step, we obtained all permits and prepare the necessary equipment and infrastructure this research. Participants will undergo a pre-test. However, before carrying out the pre-test, they had already done it asked to sign a research consent form. A 30-meter spirit test was carried out to determine groups using a two-way ANOVA design. This test was carried out before providing agility training using cone drills and ladder drills combined core stability.

The 30-meter sprint test was carried out on 20 men futsal players, and speed is classified based on maximum and minimum results. After the result It is known that later the sample is paired with the A-B-B-A technique The test classifies participants into two groups. That the higher group (27%, n = 10) was considered high speed, while the lower group (27%, n = 10) classified as having low speed (Kettlety et al., 2023). The researchers classified the participants into upper and lower groups to make participants' speeds significantly different (high and low). Then, in the next step, the treatment group is placed into agility training methods with cone drills and ladder drills under the direction of the trainer. This placement is done by drawing randomly based on groups, whether they have a high or low speed level. The detailed process can be seen in Figure 1 and Table 2. As seen in Figure 1 and Table 2, there are 4 treatments groups, each group consisting of 5 participants.

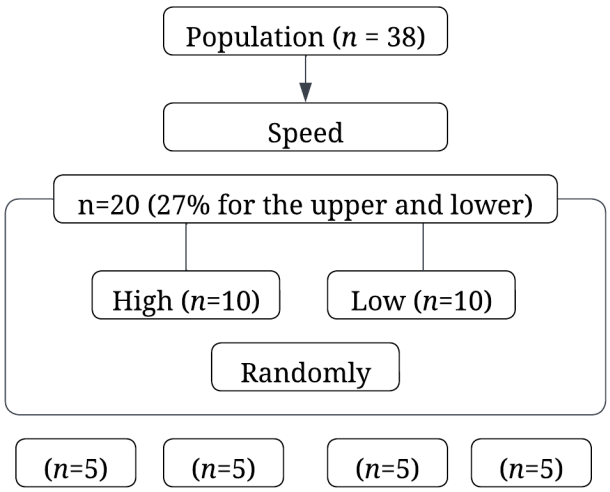

Figure 1. The flow of treatment group assignment in the research

Table 2.
The sample size for each treatment group.

Speed (B)	Agility Training (A)				Total (n)
	ladder drill core stability combination (A1)	*n*	cone drill core stability combination (A2)	*n*	
High (B1)	A1B1	5	A2B1	5	10
Low (B2)	A1B2	5	A2B2	5	10
Total	A1	10	A2	10	20

Treatment for Agility Training

This research uses agility training methods with ladder drill and cone drill. Agility training combine core stability is provided for ± 6 weeks, three times a week. Practice starts with 10 minute warm-up (static and dynamic), followed by practice on the futsal field (using the cone drill

and ladder drill methods combined core stability). It ends with recharging time. Routine technical training carried out by participants is always carried out as maintenance.

Agility training ranfor ± 6 weeks, 3 times per week. The increase in training load is constant because keep in mind the principles of agility training, that is, do it explosively. The training dosage is increased every week until the third week in a row. In accordance with the with training principles, overload, progressive and individual principles are applied. In some weeks, for example the fourth week, the training dose is the same as the training dose the second week, and the dose is the same as the dose the fourth week. This means there is a decrease in training load. This aims to prepare or recover from these efforts increase the dose of exercise. Increased training dose The model was continued until week 6, before a post-test was carried out held.

In accordance with the training method provided by researchers, namely combining agility training with core stability so that participants before doing agility training, participants do core stability exercises which can provide control over position and movement centered on the center of the body which is needed to control changes in position both when changing direction. and shifting movements when athletes perform agility. Core Stability Exercise aims to increase stability and balance, improve sensorimotor function, and make it easier for the body to move effectively and efficiently. In this study, only 90-90 alternate heel touches, 90-90 alternate leg extensions, Modified high plank exercises were used.

Agility training method using cone drills in the form of zigzag running aims to improve foot movement and speed. In this procedure, participants start with a Ready attitude. Stand facing a row of 10 cones, each cone 0.9 m apart. Step quickly diagonally forward, starting with the right foot and changing direction with the left foot then returning the right foot to the next direction, and so on. Do it with fast and explosive movements.

After that, ladder drill using the snake jump exercise. a form of exercise that trains agility in the form of a ladder placed on the ground or field which functions to train the leg muscles. Steps to do the snake jump agility ladder drill exercise. Start standing with 2 legs. Starting with your left foot on the side of the ladder and your right foot on the agility ladder. Jump your feet towards the next step with both feet between the steps and facing towards the stairs. right side, Jump your feet towards the side of the stairs with your left foot inside the stair column and your right leg outside or to the side of the stairs, Jump your legs towards the next stairs with both feet between the steps facing towards the left side, Repeat the steps along the stairs.

Both forms of agility training are very basic similar and aims to improve the agility of futsal players, especially agility in footwork. Training is carried out periodically for approximately 6 weeks. Additionally, this exercise uses the same terrain and distance on the field when performing the same range of motion. Therefore, they need to do it compared to see how effective they are. Besides that, The exercise is done in almost the same way, namely starting with warm-up, basic exercises with a similar progression dose increase, and then followed by cooling. On the other hand, The basic difference between the two agility training exercises is that significant differences between training methods can occur due to different forms of movement and different training demands. Ladder drill is a movement variation exercise which in the form of exercise contains elements of the basic motor movements of running, jumping, hopping. Compared to cone drills which only make fast movements to change direction forward through the cones that have been arranged, requiring high concentration and complex movement coordination. Once in all the program loop has been completed, data analysis has been completed carried out to present research findings.

Instrument

This study used several instruments to collect data. For example, speed was measured using 30m acceleration (Bompa & Buzzichelli, 2015). Then, to measure agility using the Illinois agility test (Hachana et al., 2013). They are required to do 3x trials, and record the data. After that, the researcher took 1 trial that was considered the best of the 3x trials. data collection using Stopwatch and cone as a barrier.

Statistical Analysis

Descriptive analysis was used to characterize the data from each treatment group. Normality test was analyzed based on standardized residual values, homogeneity was analyzed using Levene's test. Then, a two-way factorial ANOVA test was used to analyze the difference in effects. This study also conducted Tukey's further test to analyze significantly different groups or better results in one's agility. All data in this study were analyzed using the IBM SPSS version 25 statistical program.

Results

The study found that the mean and standard deviation of pre-test and post-test agility increased as follows: A1B1 (17.96±0.43 to 16.86±0.40), A1B2 (18.59±0.23 to 17.32±0.27), A2B1 (18.16±0.21 to 17.08±0.46), and A2B2 (18.92±0.48 to 18.22±0.13). The highest percentage occurred in group A1B2, with a rate of 6.82% (1.27), assessing this group first. This was followed by the A2B2 group, with an increase of 6.13% (1.10) and ranked second. After that, the A2B1 group showed the third highest percentage of 5.95% (1.08). Finally, the A1B1 group showed an increase of 3.69% (0.7) as the fourth place. For more details, please refer to Table 3.

Table 3.
The mean differences, standard deviations, and percentage improvements in pretest and posttest scores of agility for each treatment group

Agility Training Metode	Agility Exercise speed level of each group (n-=5)	Pre Test	Post Test	Differences	%
		$\bar{x}$ ± SD	$\bar{x}$ ± SD		
Ladder Drill (Snake Jump) combine Core Stability	High (A1B1)	17,96±0,43	16,86±0,40	0,7	3,69
	Low (A1B2)	18,59±0,23	17,32±0,27	1,27	6,82
Cone Drill (zigzag) combine Core Stability	High (A2B1)	18,16±0,21	17,08±0,46	1,08	5,95
	Low (A2B2)	18,92±0,48	18,22±0,13	1,10	6,13

The results of this study also reported that the average agility scores of groups A1 and A2 were 17.09 ± 0.41 and 17.66 ± 0.68. For groups B1 and B2, the averages were 16.97 ± 0.43 and 17.78 ± 0.52. The average agility scores of groups A1B1 and A2B1 were 16.86 ± 0.41 and 17.08 ± 0.46. Meanwhile, A1B2 and A2B2 were 17.32 ± 0.28 and 18.23 ± 0.13. Table 3 shows that the A1B1 group had the highest average increase compared to the other treatment groups. The data are presented in Table 4 and Figure 2. While Table 5 shows the results of the normality and homogeneity test of the data which shows that the data are normal and homogeneous (P > 0.05).

Table 4.
The results of the footwork agility of each treatment group

Group	*n*	Min	Max	*M* ± *SD*
A1	10	16.52	17.72	17.09 ± 0.41
A2	10	16.43	18.34	17.66 ± 0.68
B1	10	16.43	17.72	16.97 ± 0.43
B2	10	17.02	18.34	17.78 ± 0.52
A1B1	5	16.52	17.53	16.86 ± 0.41
A2B1	5	16.43	17.72	17.08 ± 0.46
A1B2	5	17.02	17.72	17.32 ± 0.28
A2B2	5	18.02	18.34	18.23 ± 0.13

Legend: The dependent variable is agility, the unit is seconds, "A1" is Ladder Drill (Snake Jump) combined with Core Stability, "A2" is Cone Drill (zigzag) combined with Core Stability, "B1" is high speed, "B2" is low speed, "A1B1" is Ladder Drill (Snake Jump) exercise combined with Core Stability with high speed, "A2B1" is Cone Drill (zigzag) Core Stability combination with high speed, "A1B2" is Ladder Drill (Snake Jump) exercise combined with Core Stability with low speed, "A2B2" is Cone Drill (zigzag) Core Stability combination with low speed.

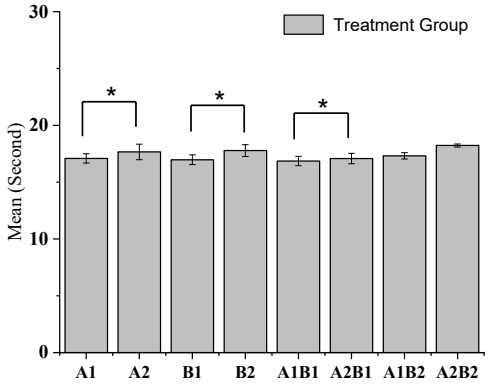

Figure 2. The average agility of each treatment group (*p<0.05) compared to each group. The data are presented with mean and standard deviation scores of agilities.

Table 5.
Normality and homogeneity testing

Normality test			Homogeneity test		
Shapiro-Wilk			Levene's		
Statistic	*df*	*p*	*df1*	*df2*	*P*
0.948	20	0.227	3	16	0.395

Legend: Data is normally distributed and homogeneous (P>0.05).

Table 6 below presents the results of the two-way ANOVA test. The table shows that the agility results of groups A1 and A2 (P<0.05) and groups B1 and B2 (P<0.05) are significantly different. Figure 3 adds that there is a significant interaction between groups A and B (P<0.05). To determine which treatment group had a better effect on agility, a follow-up test was performed using the Tukey test.

As presented in Table 7, Tukey's further test analysis showed that group A1 was better than group A2 (P<0.05) in improving agility. This is evidenced by the average of 17.09 < 17.66. Likewise, the speed results in group B1 were better than group B2 (P < 0.05), as shown by an average of 16.97 > 17.78. Then, the agility results in group A1B1 were not significantly different from group A2B1 (P > 0.05), as evidenced by an average of 17.08 > 16.86. Furthermore, the agility results in the A2B2 group were the highest and much better than the A1B2 group (P < 0.05) as evidenced by an average of 17.32 < 18.23.

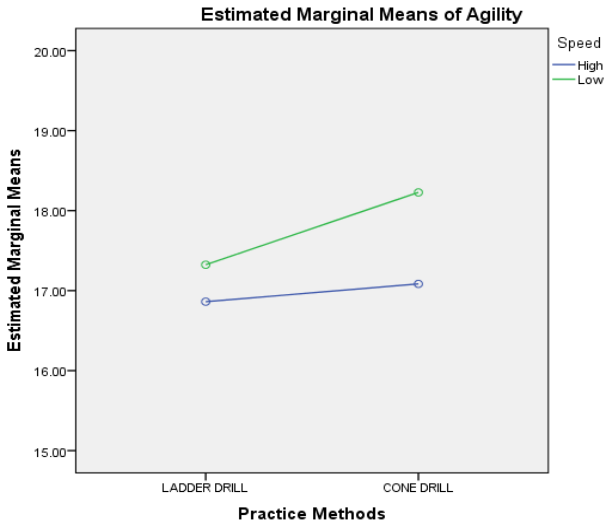

Figure 3. The interaction between agility training and speed

Table 6.
Two-way factorial ANOVA

Source	Type III Sum if Squares	*df*	Mean Square	*F*	*P*
Agility Training (A)	1.585	1	1.585	13.333	0.002
Speed (B)	3.224	1	3.224	27.124	0.000
Agility Training (A) * Speed (B)	0.581	1	.581	4.891	0.042

Legend: The dependent variable in this study was agility. A significant difference was observed between groups A1 and A2 in terms of "agility training" (P<0.05), indicating its impact on agility. It was found that there was a significant difference recorded between groups B1 and B2 regarding "speed" (P<0.05). Furthermore, the interaction between the "agility training" and "speed" groups (A and B) had a significant effect on agility (P<0.05).

Table 7.
Tukey's test

Compare Groups	*P*	Conclusion
A1 and A2	0.038	Significant
B1 and B2	0.001	Significant
A1B1 and A2B1	0.074	Not Significant
A1B2 and A2B2	0.004	Significant

Legend: The dependent variable is agility. The difference is significant (P < 0.05).

Discussion

The findings of this study revealed a significant effect of a combination of training methods on the agility of futsal players. This finding shows the effect that agility given with a combination of ladder drill and core stability training is better than the combination of cone drill and core stability training. This confirms previous research This ladder drill exercise is inseparable from leg muscle strength helping us to improve aspects of movement, improve balance, coordination of muscle strength and reaction time between all parts of the body and to change direction quickly for players even at high speeds (N. E. Pratama et al., 2018; Sungpook et al., 2022). These results are in line with previous research where the intervention program was carried out three times a week for more than six weeks of ladder drill training significantly had an impact on increasing foot speed, agility, and muscle strength (Labib Siena Ar Rasyid et al., 2023). ladder drill is a motion variation exercise in which the form of exercise contains elements of basic motor movements of running, jumping, jumping, which are closely related to the elements of motor skills (Ng et al., 2017; Prakash et al., 2021). Applying the basic principles of training systematically, repeatedly over a long period of time, will stress the muscles, so that the muscles will experience physiological adaptation (Donie et al., 2023; Pavillon et al., 2021; Yendrizal et al., 2023). Physiological adaptations that occur in leg muscles involving almost all muscles, especially leg muscles such as the quadriceps, hamstring, gluteus, gastrocnemius, and abductor hip muscles with hypertrophy (Boguszewski et al., 2014). The occurrence of hypertrophy is due to an increase in the number of myofibrils in each muscle fiber, increased capillary density in muscle fibers and an increase in the number of white or fast twitch muscle fibers, so that the leg muscles will become stronger which makes speed increase (A. P. Pratama, Sukamti, Suhartini, Sulistiyowati, Sepdanius, et al., 2024; Yuasa et al., 2018).

In addition, core stability also has a significant effect on improving agility. The core stability combination is an application for conditioning programs in sports, which explains that greater core stability can benefit sports performance by providing a foundation for producing greater strength in the upper and lower extremities (Sasaki et al., 2019). Core stability training can build strength in the postural muscles, this will increase stability in the trunk and posture, thus improving balance (Sasaki et al., 2019; Wilczyński et al., 2022). With the strength of the core, the muscles of the hip, knee, and ankle can improve agility (Chaeroni et al., 2022; Mitrousis et al., 2023; Zech et al., 2010). In this study, it is evidenced by the results of the analysis that the combination group of ladder drill (snake jump) and core stability has an average of 17.09 higher (good) than the combination of cone drill (zigzag) and core stability has an average of 17.65 with a posttest difference of 0.56.

The findings also reveal the interaction between the combination of training methods and speed on agility. The study showed that with a combination of ladder drill and core stability training, with a combination of cone drill and core stability training at high speed was not significant. But there was an increase in the group that had high speed. However, the results of agility given with a combination of ladder drill and core stability exercises have a good increase compared to the combination of cone drill and core stability exercises for high speed abilities. At low speed also gives the same results where, the results of agility given with a combination of ladder drill and core stability training are better than the combination of cone drill and core stability training. Agility is defined as the ability to change direction (and/or speed) of movement efficiently in response to stimuli (A. P. Pratama, Sukamti, Suhartini, Sulistiyowati, Ilham, et al., 2024; Sattler et al., 2015). It is an important motor quality in sports where changes in direction occur frequently (Delextrat et al., 2015). Changing direction of motion is often seen in a variety of sports and is believed to be a key factor in athletic performance. In a previous study, over 700 different situations requiring a change of direction were observed in a single match (Bloomfield et al., 2007). These findings suggest that in field sports, the ability to change direction quickly is as important as the ability to run fast or jump high. It is known that there is a positive correlation between the speed at which a person changes direction and their straight-line running speed (Gabbet et al., 2008; Yuasa et al., 2018). It involves moving the body as fast as possible, but agility has the added dimension of changing direction (Horicka et al., 2014). In practical terms, it refers to the ability to move the body as quickly as possible over a given distance. Good speed and agility components are the key to successful tactics and strategies, indicating that one's agility is influenced by speed (Kabacinski et al., 2022). At the time of training or application of treatment, all groups were not collected or quarantined so there was no control over what activities the sample did outside of training, but stayed at their respective homes. Indirectly this can affect the results of the study. As well as the schedule of days and hours of training that changed because the sample was still in school, so there was a change of schedule several times.

In summary, the study showed the effect that agility given with a combination of ladder drill and core stability training was better than the combination of cone drill and core stability training. High and low speed also affects agility. Based on the findings that showed an interaction between training methods and speed. This study highlights the significant contribution of training methods and speed to the agility of futsal players. Both factors play an important role in improving player performance on the field. In addition, the combined effect was greater than the sum of the individual effects, thus emphasizing the importance of incorporating agility, balance and speed training into futsal players' training routines. This combination is expected to excel in their sport. The findings provide valuable insights

for coaches and athletes looking to improve their overall movement agility and competitive performance. The implications of the results of this study for players can move quickly to change direction while dribbling, make transitions quickly ahead of opponents and most importantly can avoid collisions that cause injury. As well as being taken into consideration for futsal coaches and practitioners in creating the right training programme to improve agility.

Conclusions

This study concluded that the significant effect between the combination of ladder drill (snake jump) and core stability is better than the combination of cone drill (zigzag) and core stability on the agility of futsal players. This study also shows that high or low speed has a significant effect on agility in futsal play. In addition, there was no significant interaction between training methods and speed (high and low) on agility. The results of this study can serve as guidelines for futsal coaches and players in designing more effective training programs to improve agility in futsal games.

Conflicts of interest

The authors report that there is no potential conflict of interest.

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