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The Difference In The Effects Of Combining Core Stability Exercise With Plyometric Training Versus Ladder Training On Improving Speed And Agility In Futsal Extracurricular Students

Andi Yuliana Kamaluddin[1], Nila Wahyuni[2], Syahmirza Indra Lesmana[3]
[1]Master of Sport Physiology, Faculty of Medicine, Univeristas Udayana, 80234, Denpasar, Indonesia
[2]Department of Physiology, Faculty of Medicine, Universitas Udayana, 80234, Denpasar, Indonesia
[3]Department of Physiotherapy, Faculty of Physiotherapy, Esa Unggul University, 11510, Jakarta, Indonesia

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Corresponding Author:
Andi Yuliana Kamaluddin
Master of Sport Physiology, Medical Faculty, Udayana University, Bali, Indonesia
Email:
andi.yuliana150@gmail.com

ABSTRACT

Futsal is a sport that requires speed and agility. However, the physical fitness measurements of futsal extracurricular students at MAN 2 Soppeng indicated below average speed and agility. This study aims to compare the effects of combining core stability exercise with plyometric training and ladder training on improving speed and agility. This was a true experimental study with the randomized match two groups design involving 22 students, divided into two groups of 11. Group 1 received CSE+PT, while Group 2 received CSE+LT for 6 weeks. Speed was measured using a 30-meter sprint test, and agility was assessed with the Illinois Agility Test. Both groups showed significant improvements in agility (p=<0.001). For speed, Group 1 showed p=0.003 and Group 2 p=<0.001. However, there was no significant difference between groups for speed improvement (p=0.061), while there was a significant difference in agility (p=<0.001). This study suggests CSE+LT is more effective in enhancing agility).

Keywords: *Core Stability Exercise*, *ladder training, plyometric training, speed, agility*

1. INTRODUCTION

Futsal is a sport that emphasizes speed, agility, and coordination. Speed allows players to reach the ball and move efficiently, while agility enables rapid changes in direction and response to dynamic play[1]. Speed allows players to reach the ball and move efficiently, while agility enables rapid changes in direction and response to dynamic play. Speed is defined as the ability to move the body or parts of the body quickly in one direction in the shortest time possible, and is essential for quick sprints, attacking, and defensive transitions[2]. Agility is the ability to change direction accurately and rapidly with control and balance, allowing players to maneuver effectively in limited space[3]. These physical components are crucial for optimal performance. However, initial assessments at MAN 2 Soppeng showed that students had lower-than-normal levels of speed and agility. This highlights the importance of developing effective training strategies tailored to their needs.

Various training methods can be used to enhance these components, including plyometric and ladder training. Both are combined with core stability exercises. Plyometric training focuses on explosive strength through rapid muscle contractions, enhancing power and speed[4]. Ladder training improves footwork, rhythm, and neuromuscular coordination[5]. Meanwhile, core stability training strengthens deep trunk muscles that stabilize the spine and pelvis, providing a foundation for efficient movement[6].

Although studies have explored the individual benefits of these exercises, few have compared the combined effects of core stability with plyometric versus ladder training, particularly in populations with below-average physical abilities. Therefore, this study seeks to compare these combinations in improving speed and agility.

2. METHOD

This study used a true experimental design with the randomized match two groups design. A total of 22 futsal extracurricular students from MAN 2 Soppeng who met inclusion criteria were selected and divided into two equal groups. Group 1 received core stability and plyometric training; Group 2 received core stability and ladder training. The intervention lasted six weeks, with three training sessions per week. Participants were students enrolled

in the futsal extracurricular program at MAN 2 Soppeng. They were selected based on specific inclusion criteria, including having below-average speed and agility performance based on initial assessments. The inclusion criteria included: male students aged 15–17 years, actively participating in futsal extracurricular activities, and willing to commit to the training schedule for six weeks. The exclusion criteria were: students with musculoskeletal injuries, cardiovascular or respiratory disorders, or any other health condition that could interfere with physical activity. Participants who missed more than 20% attend training sessions consecutive training sessions or who experienced injuries during the intervention period were considered dropouts.

The sampling technique used was simple random sampling. From the population of futsal students, 22 individuals who met the inclusion and exclusion criteria were selected. These students were then randomly assigned into two equal groups: Group 1 received CSE+PT, while Group 2 received CSE+LT.

3. RESULTS AND DISCUSSION

In this section, it is explained the results of research and at the same time is given the comprehensive discussion. Results can be presented in figures, graphs, tables and others that make the reader understand easily [14], [15]. The discussion can be made in several sub-sections.

3.1. Data Characteristics

Table 1. Characteristics of research subjects based on age, body mass index (BMI), speed and agility pretest scores

Sample Characteristics	Group 1 (n=11) Mean±SD	Group 2 (n=11) Mean±SD	*P*
Age (Year)	16,36 ± 0,80	16,27 ± 0,78	0,79
BMI (kg/m^2)	19,41 ± 1,15	19,50 ± 0,94	0,84
Pretest speed	5,79± 0,54	5,74± 0,71	0,86
Pretest agility	19,86±0,95	19,82 ± 1,08	0,93
Physical activity (PAQ-A)	3,33±0,33	3,40±0,20	0,56

Based on Table 1, the subjects in both research groups in the adolescent category. The mean BMI was in the normal category. The mean physical activity level of students in both groups was classified as moderate physical activity. The mean speed of all subjects in both groups fell into the very low speed category, and the mean agility of subjects in both groups fell into the low agility category. The p-value for all groups showed p>0.05, indicating no significant difference between the two groups.

This study involved 22 male students, divided equally into two groups of 11. The average age in Group 1 was 16.36 years and in Group 2 was 16.27 years, which categorizes them as adolescents. Adolescents aged 15–17 are in a critical stage of physical, biological, cognitive, and emotional development, which can significantly impact performance, especially in speed and agility[7]. Statistical analysis showed no significant age difference between the groups ($p > 0.05$). The mean Body Mass Index (BMI) was 19.41 kg/m² for Group 1 and 19.50 kg/m² for Group 2, both falling within the normal category per WHO standards. Normal BMI is ideal for optimal athletic performance, allowing for efficient muscle contraction, faster acceleration, and better stability during direction changes. Normal BMI supports improved speed and agility while minimizing injury risk[8]. Physical activity levels measured by the PAQ-A questionnaire indicated that most participants had a moderate activity level, meaning they engaged in regular but not intensive physical activity across school and leisure domains.

The mean pretest speed was 5.79 s in Group 1 and 5.74 s in Group 2, both classified as very poor (based on 30 m sprint norms). Meanwhile, the mean agility score was 19.86 s and 19.82 s, respectively, which falls into the poor category. There were no significant differences between groups before the intervention ($p > 0.05$), ensuring a fair baseline for treatment comparison.

3.2. Normality and Homogenity Test

Table 2. Test of normality and homogeneity of data for speed and agility variables before and after treatment in both treatment groups

Variable	Normality (*Shapiro wilk*)		Homogenity (Levene's Test)
	Group 1	Group 2	
Speed :			
Pretest	0,98	0,37	0,39
Postest	0,89	0,09	0,56
Difference	0,02	0,39	0,99
Agility :			
Pretest	0,12	0,56	0,97
Postest	0,36	0,17	0,58
Difference	0,37	0,89	0,28

Based on Table 2, the Shapiro-Wilk test results showed that the difference in speed scores for Group 1 had a p-value of 0.018 (p<0.05), indicating that the data were not normally distributed. Therefore, the Wilcoxon test was used for speed in Group 1. In contrast, the agility data showed a p-value>0.05, indicating normal distribution, so the paired t-test was used. Meanwhile, the Levene's test for homogeneity showed a p-value >0.05, which means that the two groups were homogeneous.

3.3 Paired Group Difference Test on Speed and Agility Scores

Table 3. The results of the difference test of speed variables before and after treatment in both treatment groups

Group	Speed			*P*
	Before	After	Difference	
P1	5,83 ± 0,74•	4,56 ± 0,72•	-1,31 ± 0,33•	0,003*
P2	5,74 ± 0,71#	4,72 ± 0,57#	-1,02 ± 0,24#	<0,000†

p : *p-value*
* : Wilcoxon result
† : *Paired t-test result*
• : Median ± interquartile range
: Mean± standar deviation
P1 : *Core stability exercise* dan *plyometric training group*
P2 : C*ore stability exercise* dan *ladder training group*

Based on Table 3, the speed values before and after the intervention in Group 1 resulted in a p-value of 0.003 (p<0.05), indicating a significant difference after the combination of plyometric training and core stability exercise was administered to improve the speed of futsal extracurricular students at MAN 2 Soppeng. In Group 2, the p-value was <0.001 (p<0.05), also indicating a significant difference following the combination of ladder training and core stability exercise in enhancing the speed of the futsal extracurricular students at MAN 2 Soppeng.

Plyometric training enhances speed through rapid eccentric-concentric muscle contractions, known as the stretch-shortening cycle, which boosts muscular explosiveness and acceleration. Plyometric training significantly improved sprint speed in adolescents (p = 0.003) [9]. Plyometric training effective in improving speed, agility, and muscle power in sports contexts [10]. Core stability exercises contribute to speed by strengthening the trunk muscles, enhancing body control, and enabling efficient energy transfer during movement. Other literature sources core training significantly improved sprint speed (p = 0.001) in young athletes [11]. CSE improved neuromuscular control and trunk strength, which supports faster, more explosive movement, particularly in sprinting tasks [12].

Ladder training improves speed through faster neuromuscular activation and increased foot movement frequency. Ladder training significantly enhanced both speed and agility in school athletes aged 14–16. Rapid, repetitive footwork during ladder drills trains the central nervous system to transmit signals more quickly and improves muscle response in executing short, fast contractions [13]. Core training supports speed enhancement by improving trunk stability and neuromuscular coordination. Core training improved sprint performance over 10m and 20m distances in soccer players aged 18–30, although it had less impact on agility or anaerobic power. This suggests that core training enhances speed by stabilizing the torso and enabling efficient force transfer from the core to the lower limbs during acceleration. The activation of core muscles such as the transversus abdominis, multifidus**,** and gluteus muscles provides the stability needed during sprint phases [14].

Table 4. the results of the paired t-test for the agility variable before and after treatment in both treatment groups

Group	Agility (mean ± SD)			*P*
	Before	After	Difference	
P1	19,86 ± 0,96	19,18 ± 0,95	-0,63 ± 0,20	<0,001
P2	19,82 ± 1,08	18,22 ± 1,13	-1,60 ± 0,30	<0,001

p : *p-value*
P1 : *core stability exercise* dan *plyometric training* group
P2 : kelompok *core stability exercise* dan *ladder training* group
SD : standar deviation

Based on Table 4, the agility values before and after the intervention in Group 1 resulted in a p-value of 0.000 (p<0.05), indicating a significant difference following the combination of plyometric training and core stability exercise in improving the agility of futsal extracurricular students at MAN 2 Soppeng. In Group 2, the p-value was also <0.001 (p<0.05), indicating a significant difference after the implementation of ladder training combined with core stability exercise in enhancing the agility of futsal extracurricular students at MAN 2 Soppeng.

Plyometric training enhances agility by developing explosive lower-limb power and improving rapid muscle contraction, especially in muscles responsible for quick movements and direction changes. Plyometric training

optimizes the stretch-shortening cycle, improving neuromuscular reflexes and movement efficiency. Their study showed a significant increase in agility among young soccer players after four weeks of training ($p = 0.000$) [15]. Core Stability Exercise enhances agility by reinforcing trunk control based on the principle of "proximal stability for distal mobility." A stable core enables better control and force transfer during lower-body movements, supporting quick and responsive direction changes. Core training creates a solid foundation for explosive movements, helping athletes maintain balance and coordination in dynamic situations [16].

Ladder training enhances the body's ability to change direction quickly and in a coordinated manner. It improves muscle elasticity, joint flexibility, and dynamic balance. These improvements result from neuromuscular adaptations, including faster response from the brain and improved recruitment of fast-twitch muscle fibers, which allow quicker and stronger contractions. Ladder drills train the nervous system to respond more efficiently to rapid movement cues[17]. Another research showed that agility ladder training significantly improved agility in futsal players after 16 sessions ($p < 0.05$). The complex and repetitive footwork patterns in ladder drills enhance coordination between the brain and muscles, promoting faster directional changes. Core stability exercises play a crucial role in posture control, balance, and neuromuscular function. They help stabilize the trunk and improve movement efficiency during rapid transitions. Combining shuttle run and core training significantly improved agility in soccer players ($p = 0.01$), as the core muscles provide better support and control during directional shifts [18].

3.4 Intergroup Difference Test

Table 5. Results of the difference test on the increase in speed and agility variables in the two treatment groups

Variabel	Group		*P*
	P1	P2	
Speed difference	-1,31 ± 0,33•	-1,08 ± 0,32•	0,061*
Agility difference	-0,68 ± 0,20#	-1,60 ± 0,30#	<0,001†

p : *p-value*
* : Mann Whitney U Test result
† : *Independent t-test* result
• : Median ± interquartile range
: Rerata ± standar deviation
P1 : *Core stability exercise* dan *plyometric training* group
P2 : *Core stability exercise* dan *ladder training* group

Based on Table 5, the p-value for speed was 0.061 ($p > 0.05$), indicating no significant difference between Group 1 and Group 2. This suggests that although both groups showed im<provements in speed, the difference between the two interventions was not statistically meaningful. Therefore, the combination of plyometric training and core stability exercise is as effective as the combination of ladder training and core stability exercise in enhancing the speed of futsal extracurricular students at MAN 2 Soppeng.

The p-value for agility was 0.000 ($p < 0.05$), indicating a significant difference between the two groups. Group 2, which received ladder training combined with core stability exercise, demonstrated a greater improvement in agility compared to Group 1. Thus, it can be concluded that ladder training combined with core stability exercise is more effective than plyometric training combined with core stability exercise in improving the agility of futsal extracurricular students at MAN 2 Soppeng.

This finding differs found that ladder training alone improved speed and agility more significantly than plyometric training in young cricket players. Their results suggested that ladder drills enhance speed through faster neuromuscular activation, improved proprioception, quicker motor unit recruitment, and better step frequency [19]. Another study found significant speed and agility gains in futsal players after ladder training ($p = 0.001$), citing enhanced step rhythm, neuromuscular activation, and faster reaction times [20]. In both groups of this study, core stability training played a central role. Another study showed that a 6-week core training program significantly improved sprint speed, agility, and flexibility in soccer players. Mechanisms include anticipatory postural adjustments, improved neuromuscular coordination, and more efficient energy transfer from the trunk to the limbs [21].

The present study revealed no statistically significant difference between the effects of core stability exercise combined with plyometric training and core stability exercise combined with ladder training on improving speed among futsal extracurricular students. This result may be attributed to the suboptimal application of progressive overload and specificity principles, as the training design was not fully targeted toward enhancing linear sprint performance. Furthermore, the participants, who had limited prior exposure to structured physical training, were likely to exhibit similar physiological adaptations regardless of the training modality. The relatively short duration of the intervention may also have limited the manifestation of distinct adaptations between the two methods. Consequently, both training combinations yielded comparable general improvements rather than differentiated performance outcomes.

Ladder training significantly improved agility in high school students by enhancing nerve conductivity and intermuscular coordination, leading to more efficient and responsive lower-limb movement [22]. Nother study reported that ladder training produced better agility outcomes than plyometric training in kabaddi players ($p < 0.05$)

[23]. The progressive intensity of ladder training helps strengthen lower-limb muscles through rapid multidirectional foot movements these movements engage muscles such as the soleus, gastrocnemius, and tibialis, while simultaneously training the neuromuscular system for quick reactions and movement coordination. Another study found no significant difference in agility between core-only and core + plyometric groups after 3 weeks of training ($p = 0.130$), likely due to the short intervention duration. And that plyometric training did significantly improve agility in athletes over 6 weeks, although it involved more linear and vertical movements [24].

Although the study demonstrated a statistically significant improvement in agility, the observed changes were not substantial enough to reflect meaningful categorical or functional enhancement in actual futsal performance. This may be attributed to the participants' novice status and the suboptimal intensity and duration of the training program. Nonetheless, the combination of ladder training and core stability exercise yielded greater improvements in agility compared to the combination of plyometric training and core stability exercise.

4. CONCLUSION

This study shows that the combination of core stability exercise with either plyometric training or ladder training is equally effective in improving speed. However, the combination of core stability exercise and ladder training proves to be more effective in enhancing agility among futsal extracurricular students at MAN 2 Soppeng. This is likely due to differences in movement patterns and neuromuscular adaptations, with ladder training offering better alignment with the multidirectional agility demands required in futsal.

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