

The Effects of FIVE Neuromuscular Warm-up on Leg Strength among Young Futsal Players

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Abstract: The research aims to determine the effects of FIVE neuromuscular warm-up on leg strength improvement among young futsal players. This study was experimental research, recruiting two groups of high school futsal players by conducting purposive/ judgmental sampling in Yogyakarta, Indonesia. The Experimental Group (EXP) was trained by the FIVE program twice per week for eight weeks, and the Control Group (CON) was trained by standard exercise. Twenty-nine subjects were participated in this study (n EXP = 14; n CON = 15). Leg strength assessment using leg dynamometer performed twice before and after the intervention (pre and post-test). Changes of leg strength in each group were analyzed by paired t-test, and changes of leg strength between the EXP and CON group were analyzed by independent/ non-paired t-test. Significant level was set to 0.05 ($p < 0,05$). The result shows the leg strength improvement in both groups (p EXP = 0.006; p CON = 0.028). While the analysis using a non-paired t-test shows that there is not any significant difference between EXP and CON on the mean of leg strength improvement. This research demonstrates that FIVE neuromuscular warm-up could be an alternative exercise program to improve leg strength of young futsal players.

1 INTRODUCTION

Futsal is a popular and growing sport in Indonesia. Recently, both recreational and professional futsal increase rapidly. On the other hand, futsal characteristics (small pitch with fast movement) lead to a high incidence of injury (Baroni *et al.* 2008). A study from Schmikli, *et al.* (2009) show that futsal is one of the 10 high-risk sports, especially to young players. Injury incidence in futsal is 2.7 times higher than injury in football per 10.000 hours of sport participation. Young futsal players have a higher risk of injury due to the low physical fitness and technical error.

Physical fitness, especially musculoskeletal fitness, is an important factor in injury prevention program. Carter & Micheli (2011) show that muscle imbalance, muscle weakness, and low coordination can increase the risk of injury.

From the researcher's observation, it is found that high school and young futsal players have low musculoskeletal fitness. Lack of facilities and strength and conditioning coach, and low frequency of training are the cause of muscle weakness and imbalance in young futsal players. Neuromuscular

warm-up is a method that can be performed to enhance musculoskeletal fitness, thus prevent injury. It consists of warm-up and stretching combined with several neuromuscular training to improve strength, balance, power, and agility. Neuromuscular warm-up corrects several technical errors e.g., valgus knee and improper alignment. A study from Hewett *et al.* (1999) show that 14 weeks of neuromuscular warm-up can effectively reduce knee injury for female athletes. It is also stated that neuromuscular warm up is evidently effective in reducing knee injury risk for 14 weeks.

Neuromuscular warm-up in football (FIFA 11+) shows good results in reducing injury incidence of football players, especially in young and female athletes (Bizzini & Dvorak, 2015). Soligard *et al.* (2009) in Norway show that FIFA 11+ decreases injury risk for one third and a half of severe injury in young female football players.

Another program that focused on neuromuscular fitness is called Performance Enhancement Program (PEP) which also reduces injuries efficiently. Mandelbaum *et al.* (2005) show that PEP consists of a neuromuscular training program focusing on strength and stabilization of muscle coordination

surrounding knees joints to reduce the total of anterior cruciate ligament (ACL) injury incidents. Besides, the research concludes that PEP performed minimally 2-3 times per week can reduce total of ACL incidents for 2 to 4 times. Pollard *et al.* (2006) show that PEP improves hip abductor muscle strength and reduces hip rotation. Lim *et al.* (2009) show that PEP improves knee flexion and decreases maximum knee extension during landing in female basketball players. Further, Chappell & Limpisvasti (2008) suggest that PEP can decrease knee valgus during a jumping test in female football and basketball players.

Neuromuscular warm up in volleyball called "Volley Veiling" is also developed to prevent or reduce injuries in fingers, wrist, feet, wrist, and knees (Gouttebarga *et al.* 2017). Kiani *et al.* (2010) developed a knee injury program named HarmoKnee, purposively focusing on providing structural warming up protocol and improving the body's fitness components. HarmoKnee consists of five parts of exercise, including warm-up, muscle activation, balance, strength, and core stability (Daneshjoo *et al.* 2012). Eight months of HarmoKnee program can reduce 77% of acute knee injury in Sweden female football players (Kiani *et al.* 2010).

Saryono *et al.* (2019) developed specific neuromuscular warming up for futsal called as FIVE (*Futsal Injury Prevention and Enhance Performance*). FIVE consists of 5 neuromuscular warm-up components, namely (1) cardiovascular warm-up, (2) dynamic stretching, (3) strengthening, (4) balance, plyometric & agility, (5) preparing to play (with the ball). The purpose of the study is to determine the effects of FIVE neuromuscular warm-up on leg strength improvement among young futsal players.

2 RESEARCH METHOD

2.1 Research Type

The researchers recruited two groups of young futsal players by conducting purposive/ judgmental sampling from high school futsal teams in Yogyakarta, Indonesia. Two high schools were chosen in accordance with the criteria of participating selection in this research. The selection criteria, then, were comprised of several things as follows. (1) There is futsal extracurricular program; (2) It has a permanent facility and sufficient futsal exercise; (3) It has futsal coach or physical education teacher; and (4) It has regular exercise schedule, minimally two times

per week. Groups were arranged randomly to determine which school was chosen as an experimental (EXP) and controlled (CON) group. All subjects from both groups were the members of the school futsal team. Thus, there were a total of 29 futsal players fulfilling the criteria to participate in this research. Meanwhile, there are also some inclusion criteria; they are (1) the member of school futsal team, (2) only performing regular exercise in accordance with schedule of futsal extracurricular in school, (3) passing the medical examination, (4) obtaining permission from parents/ custody (signing on written agreement of research form), and (5) having commitment to attend a series of complete researches.

2.2 FIVE Intervention

The EXP group performed the FIVE program twice per week for eight weeks and the CON performed regular exercise. The FIVE consists of five parts with 19 types of exercise and it is performed as warm-up in each training session. Coach of the EXP was trained for the FIVE program, so that the FIVE program was performed correctly before the research was applied. Both groups performed physical fitness tests twice, pre and post-8 weeks intervention. This test was done in a similar time, field, and trained staff. Leg dynamometer was applied to measure the leg strength. Each test was conducted twice and the best result was taken for data analysis.

2.3 Data Collecting

Name, age, height, weight, body mass index (BMI), and leg strength (pre and post-intervention) were collected by the same trained staff.

2.4 Statistical Analysis

A paired t-test was performed in comparing the difference results between pre and post-intervention from both the EXP and CON groups. An independent t-test was performed to compare the mean difference between the EXP and CON groups. The normality test was performed using Shapiro Wilk test (sample is < 50). The parametric test was applied for normal distribution data, and non-parametric test (Mann Whitney and Wilcoxon) was applied if the data were not normal. All data were analyzed using SPSS 25.0. Significance level was set at $p < 0,05$.

3 RESEARCH RESULT AND DISCUSSION

Group	EXP (n=14)	CON (n=15)
Age (year)	17,7 ± 1.05	16 ± 1.12
BMI (kg/m ²)	22,66 ± 3,41	22,02 ± 3,98

3.1 Research Result

3.1.1 Characteristics of Subject

From 29 subjects, 7 players were 15 years old (24%), 4 players were 16 years old (14%), 8 players were 17 years old (27%), 6 players were 18 years old (21%), and 4 players were 19 years old (14%). Table 1 presents the characteristics of the subjects in the EXP and CON groups.

Table 1: Characteristics of the Subject

3.1.2. Intervention Effects

The results show that both EXP and CON groups had significant leg strength improvement ($p = 0,006$ and $p = 0,028$) (table 2). Independent t-test shows that no significant difference of improvement between EXP and CON groups (pre-test $p = 0.502$; post-test $p = 0.885$) (Table 3). However, the clinical analysis shows that the EXP group had more significant leg strength improvement (kg) compare to the CON group.

Table 2: Pre and post-test results in the EXP and CON Group

Groups	Legs Strength (kg)		<i>p</i>
	Pre-test	Post-test	
EXP	140,92 ± 45,44	190,85 ± 34,85	0,006
CON	153,10 ± 50,57	187,80 ± 70,66	0,028

*significance value applied (pre and post-test) was $p < 0,05$.

Table 3: Result of Legs Strength during Pre and Post-Test between the EXP and CON groups

Intervention	df	Mean of Dif.	Std. Error Dif.	<i>p</i>
Pre	27	-12.17143	17.90298	0,502
Post	27	3.05714	20.93622	0,885

* significance value applied (pre and post-test) was $p < 0,05$.

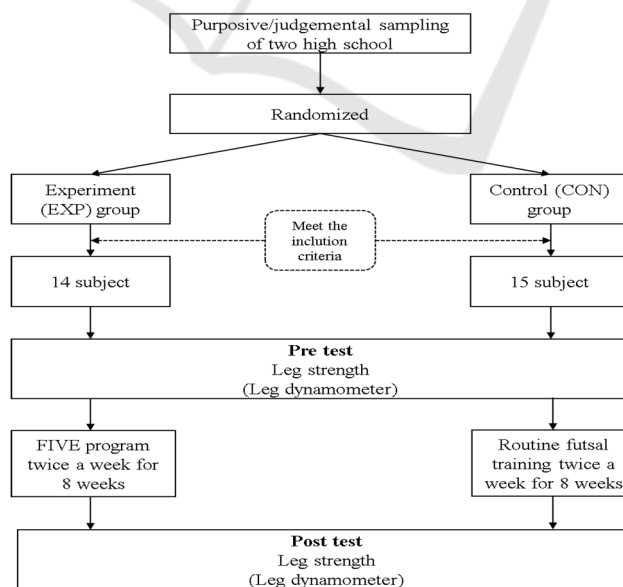


Figure 1: Enrollment and randomization of the studied participants

3.2 Discussion

The result of the research shows that both EXP and CON groups had significant improvement in leg strength. The leg strength in the EXP group had more clinical improvement than the CON group ($\pm 49,93$ vs. $\pm 34,7$ kg).

The leg strength improvement in the EXP group can be caused by the strength program in FIVE, including *single toe raises*, *nordic hamstring*, *Copenhagen exercise*, and *bounding side*.

The “single toe raises” can knowingly improve the muscle strength in ankles and calves and reduce the injury risk in Achilles' tendons. Thomee *et al.* (2001) argue that the patients suffering chronic issue in their Achilles' tendons express that significant toe raises exercise to reduce pain in Achilles' tendon during pre or post-physical activity.

Nordic hamstring can improve hamstring muscle strength, thus it reduces hamstring strain injury (Van Der Horst *et al.* 2015). It is also described that professional football players in the Netherland shown the result of Nordic hamstring, having ability to reduce the injury level of hamstring by 65% up to 70%. It is also followed by prevention effect in reducing repeated injury.

Copenhagen is a dynamic and high-intensity exercise that focuses on the lower extremity, especially on the abductor muscle group (Serner *et al.* 2014). Thorborg *et al.* (2014) show that the Copenhagen program has succeeded in preventing thigh injury in Danish football players.

Core strength exercise (plank and side-plank) in the FIVE program also contributes to improve the leg strength. A Study from Ekstrom *et al.* (2007) shows that plank and side plank are effective exercises for strengthening hip and lower extremity, improve stability, and prevent injury.

A short period (eight weeks) of training program in this study can improve the leg strength. The effect of FIVE can be optimal if the program is done in 9-12 weeks as the recommendation.

4 CONCLUSIONS

Eight weeks of FIVE program can improve leg strength in young futsal players. It can be an alternative program to enhance physical fitness and reduce injury. Further research to evaluate the effects of the FIVE program on a large scale population is needed.

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