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ORIGINAL ARTICLE

SPORT INJURIES AND REHABILITATION

The effects of the FIVE futsal injury prevention program on lower limb muscle strength among young futsal players

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ABSTRACT

BACKGROUND: Our previous study has developed FIVE, futsal neuromuscular warm-up program to improve physical performance components and prevent the incidence of futsal injury. Experimental research was needed to verify the effect of FIVE program on physical performance components affecting injury, such as lower limb muscle strength. This study aimed to investigate the effect of FIVE program on the lower limb muscle strength among young futsal players.

METHODS: Ninety-five young male futsal players were recruited using purposive random sampling from futsal clubs in Indonesia. The players were randomized into 2 groups; 42 players were in the experimental (EXP) group, and 53 players were in the control (CON) group. The EXP group performed FIVE exercises in addition to their regular futsal training, and the CON group performed their regular futsal training only. Both groups performed the intervention three times per week within 6 weeks. All players completed pre-and post-intervention lower limb muscle strength tests comprising the isometric leg strength, isometric hip abduction strength, and isometric hip adduction. The strength test was conducted using dynamometer. Changes in performance (pre- *vs*. post-intervention) of each group were analyzed using paired *t*-test and Wilcoxon Test. The pre- and post-strength test changes (Δ post-pre) between EXP and CON group was compared using independent T-test and Mann Whitney test. Statistical significance was set to $P<0.05$. Thirty-one players dropped out in this study.

RESULTS: This study showed all measurements on lower limb muscle strength improved significantly in the EXP group ($P<0.05$) while hip abduction and hip adduction strength were significantly decreased in the CON group. Improvement of isometric hip abduction and adduction strength in the EXP group was significantly different from the CON group ($P=0.00$ and $P=0.00$, respectively).

CONCLUSIONS: Results suggest that FIVE could be an alternative warm-up program to improve lower limb muscle strength among young futsal players.

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KEY WORDS: Wounds and injuries; Prevention and control; Muscle strength; Athletic performance.

Futsal or five-a-side indoor soccer is classified as a high-risk sport.[1-3] As a derivative from football, several studies showed futsal has higher injury rate compared to football. A national survey on sports injuries in the Netherlands reported that injury rate of futsal was 2.7 higher than football with 55.2 injuries and 20.3 injuries per 10,000 hours of practice, respectively.[1] Study from Junge *et al.* in professional players also showed that injury rate in three FIFA Futsal World cups was 2.6 times higher than the average of the three FIFA Football World Cups.[2] Study from Willick *et al.* showed that futsal has highest injury rate (22.4 injuries per 1000 hours of practice) compare to other 21 sports.[4] On the other hand, Emery et al showed that futsal has non-significant injury rate compared to football with 4.45 and 5.59 injuries per 1000 hours of practice, respectively.[5] Although the studies showed variation of the result, futsal is identified as sport with the high incidence injury rate.

Majority of injuries occur in the lower extremity, particularly in the knee, ankle and thigh with the most common diagnosis are sprain, strain and contusion.[2, 3, 6-8] The tendency of ankle and knee sprains occurs in male and female players, respectively.[9-11] High incidence of knee injuries in female players could be anatomical factor (Q angle) and

higher knee joint laxity.[12, 13] Based on playing position, goalkeepers present a higher injury incidence of the upper extremity injury compared to non-goalkeepers. There are still inconclusive results of the incidence rate for non-goalkeeper position. It could be explained through game structural of futsal, in which players are not limited to a specific area and constantly moving during the game.[11, 14]

Mechanism of injuries in futsal could be contact or non-contact. Study from Ribeiro and Costa[15] and Junge and Dvorak[2] showed that contact injury have higher injuries rate than non-contact injury. Most common causes of contact injuries are collision or direct fouls from the opponent.[16] Futsal characteristics such as high-intensity phase with multiple sprints and frequent changes in direction could be assumed to be the risk factor of high incidence in for non-contact injuries.[17, 18] On the contrary, some study showed non-contact injuries have higher rate.[9, 12] Non-contact injuries could be associated with lack of strength and conditioning preparation, overload, overuse, and inappropriate recovery.[12, 15]

Muscle strength of the lower extremities is very important factor in performance and injury prevention in most sports, including futsal.[19] Muscle weakness and imbalance are risk factors of injury.[20, 21] Improving muscle strength component can correct muscle imbalance. Thus, it reduces the risk of injury.[22, 23] Systematic review from Herman *et al.* also showed that injury prevention programs, which include strengthening exercise, could prevent incidence of injury effectively.[24]

Neuromuscular warm-ups are one of designated programs to prevent injury.[24-27] The program commonly consists of standard warms-up combined with several neuromuscular training.[24] FIFA-Medical Assessment and Research Centre (F-MARC) has introduced a football neuromuscular warm-up called FIFA 11+, and it has disseminated worldwide.[28, 29] Studies showed that implementation of FIFA 11+ could reduce the incidence of injury in young football players.[26, 30, 31]

Inspired by FIFA 11+, our previous study has developed a futsal neuromuscular warm-up called FIVE (Futsal Injury Prevention and Enhance Performance). Detailed of program development has presented in our prior publication.[32] The program was designed by sports medicine specialist, sports scientist, strength and conditioning coach, Asian Football Confederation (AFC) licensed coach instructors, and former futsal national coach and player.

FIVE consists of five parts which combine the cardiovascular warm-up and dynamic stretching with specific futsal neuromuscular exercises, such as strength, plyometric, balance, and agility. The training only requires ball and cones. FIVE is very practical for the amateur player, and it can be applied in 20 minutes as a warm-up session in every regular training.

Finch has proposed sports injury research framework, the Translating Research into Injury Prevention Practice framework, or TRIPP.[33] The model consists of six-staged approach that can be adopted by the researcher in prevention program development to gain the "real-world" implementation. Based on TRIPP, FIVE as new developed preventive program needs to be evaluated under ideal (controlled) condition (Step-4). Some settings for this evaluation include testing on a small number of participant or clinical settings. This step is very important to measure the effect of the program, before we evaluate it with larger sample size. Lower limb muscle strength is one physical fitness components affecting injury risk, which is important to investigate.

The objective of this study was to evaluate the effect of a 6-week FIVE futsal neuromuscular warm-up program on the improvement in lower limb muscle strength of young futsal players. We hypothesized that 6 weeks implementation of the FIVE program could positively affect lower limb muscle strength among young futsal players.

Materials and methods

Study design and participants

This experimental study was performed by recruiting young male futsal players from futsal clubs in Indonesia. The futsal clubs were chosen by a purposive sampling. Four clubs that met the selection criteria participated in this research. The selection criteria include: 1) adequate futsal training facilities; 2) regular futsal training schedule at least 3 times a week; 3) licensed futsal coach (minimum national level 1, Football Association of Indonesia). Randomization was performed to determine which clubs were selected as the experimental (EXP) and control (CON) groups.

All subjects from both groups were members of the futsal team. Total 95 futsal players who met the criteria were included in this research. The inclusion criteria were: 1) 15-19 years old male futsal player; 2) active member of the selected futsal clubs; 3) only performing regular training according to the futsal club; 4) passing medical check-up; 5) presenting the informed consent; 6) committed to attend the complete series of the study. This study was approved by review board of Universitas Negeri Yogyakarta, Indonesia.

Intervention

Futsal Injury Prevention and Enhance Performance (FIVE)

Subjects in the EXP group performed the FIVE exercises in addition to their regular futsal training, while the CON group performed their regular futsal training only. FIVE performed three times per week within 6 weeks as a warming-up program. Coaches of the EXP group were trained for performing the FIVE program before the intervention was started (training of trainer/ToT). All FIVE manual guidelines such as video, booklet, and poster have been given to the EXP coach during the ToT session.

FIVE consists of 5 parts, namely: 1) cardiovascular warm-up; 2) dynamic stretching; 3) strengthening; 4) balance, plyometric, and agility; 5) preparation to play (with the ball). Overall, 15 exercises of FIVE can be completed for 20 minutes as a warming-up session. Details of the FIVE exercises are shown in Table I. The FIVE exercises video can be accessed *via* YouTube link (https://www.youtube.com/watch?v=y_DNIJ9-Nmw).

TABLE I.—*FIVE exercises in EXP group.*

N.	Exercise	Set/duration/intensity
Part I. Cardiovascular warm-up		
1	Straight running (jogging)	2x16 m
Part II. Dynamic stretching		
2	Hip in – hip out	2x16 m hip in 2x16 m hip out
3	High heel – butt flicks	2x16 m high heel 2x16 m butt flicks
4	Smooth swing carioca	4x16 m
5	Groin swing – hamstring swing	2x16 m groin swing 2x16 m hamstring swing
Part III. Strengthening		
6	Single heel raises with squat	Week 1-3: 3-6x (each side) Week 4-6: 7-10x (each side)
7	Bounding side	2x16 m
8	Nordic hamstring exercise	Week 1-3: 3-6x Week 4-6: 7-10x
9	Copenhagen adductor exercise	Week 1-3: 3-6x (each side) Week 4-6: 7-10x (each side)
10	Plank	Week 1-3: 2x 20-30 s Week 4-6: 2x 40-60 s
11	Side plank	Week 1-3: 2x 20-30 s (each side) Week 4-6: 2x 40-60 s (each side)
Part IV. Plyometric, dynamic balance, agility		
12	Vertical jump 5x – sprint	1x16 m
13	Dynamic balance – plant and cut exercise	1x16 m
Part V. Prepare to play (with the ball)		
14	Passing – control – backward dribble	2x16 m
15	Man to man marking exercise	2x16 m

Data collection

Baseline data, including name, age, height, weight, and BMI, were collected in both groups. The lower limb muscle strength tests were conducted twice, before and after the 6 weeks of intervention. The tests were conducted in the same condition, in the same indoor futsal pitch with the same trained staff.

Three types of lower limb muscle strength tests were measured using dynamometer (T.K.K.3367b and TK.K.5402. Takei Scientific Instruments Co., Ltd., Niigata Japan). The tests consist of: 1) isometric leg strength test; 2) isometric hip abduction strength test; 3) isometric hip adduction strength test. Each test was performed 3 times, and the best result was taken for the data analysis.

Isometric leg strength test[34]

Isometric leg strength test was measured using a calibrated Takai leg dynamometer (TK.K.5402) (Figure 1). The strength was recorded in kilogram (kg). For the test, the subject was asked to stand on the base of dynamometer with bended knees approximately 110 degrees, then the length of the chain was adjusted by the examiner. The handle was positioned at the height of intra-articular space of the knee

Figure 1.—Isometric leg strength test.

joint. The subjects had to stand on the base, with knees and hips flexed slightly, while the lower back maintained an appropriate lordotic curve. The head should be held upright, and subjects should look straight ahead. The subject was asked to lift in a vertical direction by providing continuous isometric contraction of the extensors of the knees, hips, and lower back while holding the handle. The subject was asked to increase the pull in a safe manner gradually (no jerky movement) and to reach the maximum force in 3 seconds. Verbal encouragement was always given to the subject during force generation. The subject was demonstrated and performed a familiarization trial before the test. Maximum strength for the three trials was used for analysis.

Isometric hip abduction and adduction strength test[35]

Isometric hip abduction and adduction strength were measured using a calibrated Takai dynamometer (T.K.K.3367b) (Figure 2). The strength was recorded in kg. For the test, the subject was asked into seated position. The dynamometer was placed between the thighs. The fixation belts of the dynamometer were firmly worn around the distal end of each thigh. The subject was instructed to maximally perform 5-second isometric hip adduction by pushing the pads of the dynamometer or abduction by pulling the fixation belts of the dynamometer. Verbal encouragement was always given to the subject during force generation. The subject was demonstrated and performed a familiarization trial before the test. Maximum strength for the three trials was used for analysis.

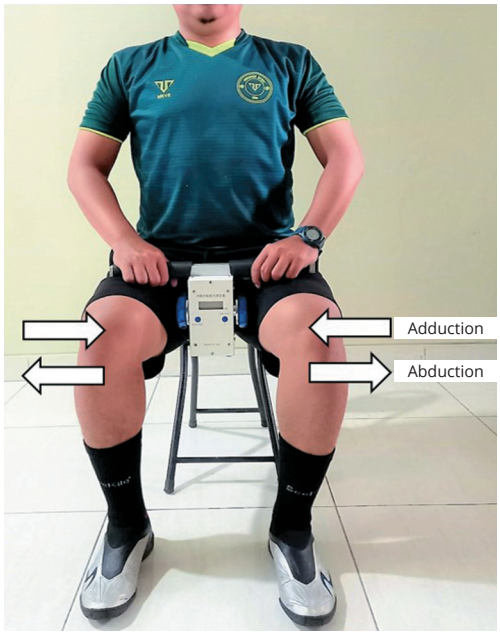

Figure 2.—Isometric hip abduction-adduction strength test.

Statistical analysis

Statistical analysis was conducted using SPSS v. 25.0 (SPSS Inc., Chicago, IL, USA). Normality test was performed using Shapiro Wilk Test (total subjects in each group were <50). Descriptive statistics were used to calculate the mean and standard deviation. The baseline characteristics between groups were compared using independent *t*-test or Mann-Whitney Test.

The paired *t*-test was used to compare the differences between pre- and post-intervention results in each group, and Wilcoxon Test was conducted if the data were not normally distributed. The independent *t*-test was performed to compare the post-test results between EXP and CON groups, and Mann-Whitney Test was conducted if the data were not normally distributed. A significant level was set to $P<0.05$.

Results

Participants

A total of 95 subjects (53 subjects in the EXP group and 42 in the CON group) participated in this study. During the study, 31 subjects dropped out, resulting in 25 subjects in the EXP group and 39 in the CON group for the final analysis. The flowchart diagram is presented in Figure 3.

The statistical analysis showed no significant differences for baseline characteristics between subjects in EXP and CON groups except the isometric hip abduction and adduction strength. The CON group presented higher baseline abduction and adduction strength test results than the EXP group. Baseline characteristics of subjects in each group are shown in Table II.

Effects of intervention in EXP and CON group

The pre-post intervention analysis of lower limb muscle strength using paired *t*-test or Wilcoxon Test was conducted based on normality test result. The normality test result presented in Table III.

The test result showed a significant improvement of the isometric leg strength (P=0.026), isometric hip abduction strength (P=0.00), and isometric hip adduction strength (P=0.00) in the EXP group. The isometric leg strength also improved in the CON group (P=0.00). The isometric hip abduction and adduction strength were significantly declined in the CON group (P=0.00 and P=0.02, respectively). The results are presented in Table IV.

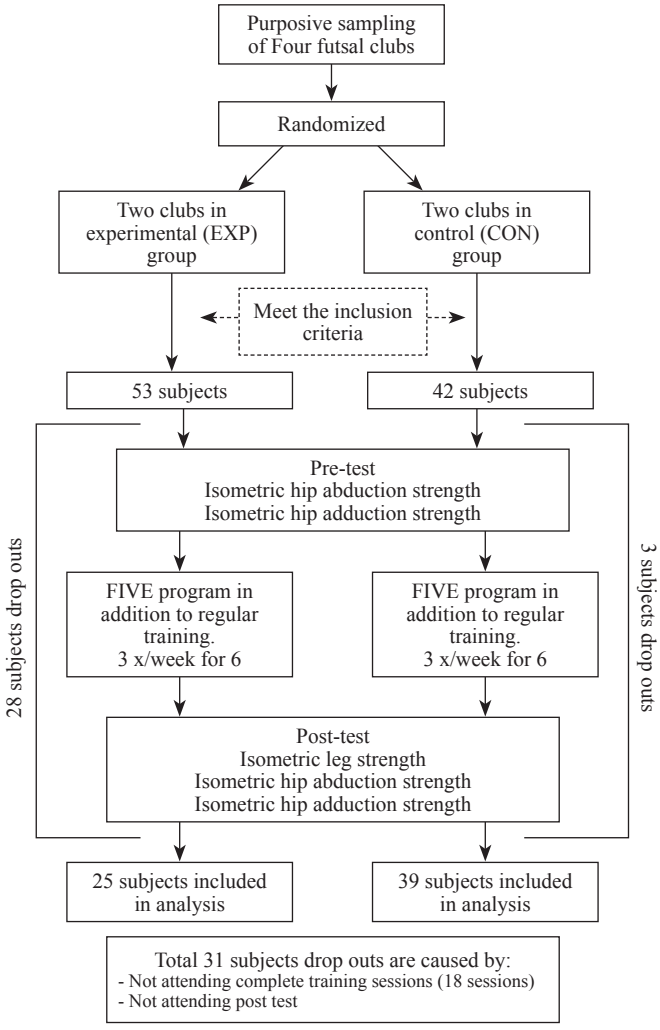

Figure 3.—Flowchart of the intervention.

Comparison of strength test changes between EXP and CON group

The comparison of post-pre intervention changes (Δ post-pre) between groups using paired *t*-test or Wilcoxon Test was conducted based on normality test result. The normality test result presented in Table V.

TABLE II.—*Baseline characteristics of the subjects.*

Characteristics	EXP group (N.=25)	CON group (N.=39)	P values
Age (years)	16.88±1.05	16.41±0.79	0.07#
Weight (kg)	56.88±8.41	57.15±7.64	0.74#
Height (m)	1.65±0.05	1.65±0.06	0.65#
Body Mass Index (kg/m²)	20.95±2.75	20.83±2.41	0.99#
Leg strength (kg)	29.09±6.82	36.04±38.63	0.69#
Hip abduction strength (kg)	29.80±11.68	41.88±9.22	0.00*
Hip adduction strength (kg)	22.25±8.27	30.38±6.56	0.00*

#Analysis was performed by Mann-Whitney Test; *statistically significant difference.

TABLE III.—*Normality test of pre and post strength measurement in EXP and CON group.*

Group		Components (kg)	Shapiro-Wilk P values
EXP	Pre-test	Leg strength	0.04*
		Hip abduction strength	0.06
		Hip adduction strength	0.06
	Post-test	Leg strength	0.01*
		Hip abduction strength	0.03*
		Hip adduction strength	0.50
CON	Pre-test	Leg strength	0.00*
		Hip abduction strength	0.92
		Hip adduction strength	0.34
	Post-test	Leg strength	0.00*
		Hip abduction strength	0.11
		Hip adduction strength	0.04*

*Data was not normally distributed.

Statistical analysis showed that improvement of isometric hip abduction and hip adduction strength in the EXP group was significantly different from the CON group (P=0.00 and P=0.00, respectively). Improvement of isometric leg strength test in both groups was not significantly different (P=0.45). The results of the analysis are shown in Table VI.

Discussion

To the authors' knowledge, this present study is the first experimental study that measured the effect of implementation FIVE program on lower limb muscle strength

TABLE IV.—*Changes of strength test in EXP and CON group.*

N.	Components	EXP Group (N.=25)			CON group (N.=39)		
		Pre-test	Post-test	P value	Pre-test	Post-test	P value
1	Leg strength (kg)	29.09±6.82	33.78±10.99	0.02*	36.04±38.63	37.82±13.61	0.00*
2	Hip abduction (kg)	29.80±11.68	43.33±7.62	0.00*	41.88±9.22	34.88±13.80	0.00
3	Hip adduction (kg)	22.25±8.27	34.18±6.64	0.00	30.38±6.56	26.51±7.95	0.02*

*Analysis was performed by Wilcoxon Test.

TABLE V.—*Normality test of strength changes in EXP and CON group.*

Group	Δ post-pre (kg)	Shapiro-Wilk
		P values
EXP	Leg strength	0.52
	Hip abduction strength	0.87
	Hip adduction strength	0.44
CON	Leg strength	0.00*
	Hip abduction strength	0.21
	Hip Adduction strength	0.35

*Data was not normally distributed.

TABLE VI.—*Comparison on changes in muscle strength test between EXP and CON groups.*

N.	Components	Group		P value
		Δ post-pre EXP (N.=25)	Δ post-pre CON (N.=39)	
1	Leg strength (kg)	4.69±9.84	1.77±41.62	0.45
2	Hip abduction (kg)	13.53±10.12	-6.99±15.29	0.00*
3	Hip adduction (kg)	11.94±7.13	-3.87±9.89	0.00*

Analysis was performed by Mann Whitney Test.
*Statistically significant difference.

in young futsal players. Our main finding was FIVE could improve three measurements of lower limb muscle strength, namely isometric leg strength, isometric hip abduction strength, and isometric hip adduction strength.

Improvement in isometric hip abduction and adduction strength in the EXP group were statistically significant compared to the CON group. Although it is not statistically significant, the improvement of isometric leg strength in EXP group was higher compared to CON group (Δpost-pre 4.69±9.84 *vs*. 1.77±41.62 kg). An average of 3-4 kg improvement in the leg strength could provide a good implication for performance and injury prevention aspect.

Several lower extremity strengthening exercises in FIVE program such as Nordic Hamstring Exercise (NHE), Copenhagen Adductor Exercise (CAE), and single heel raise with squat, were thought to lead the lower limb muscle improvement in this study. Studies showed that NHE could improve the hamstring muscles strength.[36-39] Systematic review from Jorge-Perez Gomez *et al.* showed CAE performed 2-3 times for 8 weeks is useful for improving eccentric hip adductor strength.[40] Studies from Lee *et al.* showed single heel raise exercise was useful for improving plantar flexor muscle strength.[41] Sprint exercise, which was also part of FIVE program, also had potential effect on lower limb muscle strength improvement. The study from Freeman *et al.* indicated sprint training had a beneficial effect on hamstring strength and sprint performance.[36]

Lower limb muscle strength played an important role in futsal, high-intensity sport characterized by multiple sprints and frequent direction change with lower extremity dominantly.[42] Improving lower limb muscle strength is not only for performance but also beneficial in reducing the risk of injury.[43-47]

Significant reduction of hip abduction and adduction strength showed in control group with -6.99±15.29 and -3.87±9.89, respectively. The ignorance or small portion of hip abductor/adductor exercise in CON group could be reasonable causes of the reduction. The similar result by Haroy *et al.* showed subjects performed standard FIFA 11+ program have 0.7% reduction in hip adduction strength compared to the other group which performed the additional Copenhagen exercise in their FIFA 11+ program. The study suggests that hip adductor strengthening exercise could be included in the FIFA 11+ program to potentially increase the preventive effect on groin injuries.[48]

In this study, we tried to design two comparable groups by meeting the inclusion criteria (age, sex, height, weight, and BMI); however, the statistical analysis showed a significant baseline difference in isometric hip abduction and adduction strength between groups. Low muscle strength at baseline in the EXP group could be a factor in the high improvement changes between pre-and post-interventions. Kraemer and Ratamess *et al.* showed that initial physical fitness and training status play an important role in progression during strength training.[49] Untrained person with low level of physical fitness will experience a significant improvement compared to the person with good level of physical fitness. However, our study also indicated that FIVE was useful for beginner futsal players as a conditioning program.

Our previous research designed the FIVE program to be completed in 20 minutes, but it takes longer in the implementation. The coaches in EXP group reported that they needed more than 20 minutes to complete the program. The prolonged exercise duration was caused by exercise adaptation and technical correction during the implementation of 15 exercise types. This condition definitely was not ideal for injury prevention program and had risks of low compliance.

The significant changes in strength were influenced by the duration of intervention time. The 6 weeks intervention in this study may be showing an improvement. But, it is considered as not enough to gain an optimum result. Similar to F-MARC recommendation, we suggest performing the FIVE program 2-3 times per week for 9-12 weeks for

the optimum effects. Nevertheless, the results of this study have shown a positive effect on the given intervention program and could serve as a basis for further research.

Limitations of the study

The drop-out rate was high (33%) in this study, especially in EXP group. One of the reasons was that many subjects in EXP groups did not meet total 18 sessions of intervention. The long duration of FIVE as warm-up session caused the coaches to start the training very on time, making the late attending players not join the complete exercise program.

Another reason for the high drop-out rate was the distance of each club. In this study, futsal clubs in the EXP group and CON group are located in different cities. Visiting the clubs for data collection process was very time-consuming. Eventually, data re-take for subjects who did not present during post-test day was difficult to be conducted.

Conclusions

This study demonstrated that the FIVE program could improve lower limb muscle strength among young futsal players. This improvement is considered to be beneficial in futsal performance and reducing injury risk.

We conclude that FIVE can be a promising warming-up alternative in young amateur futsal players. Further high-quality RCT research is needed to investigate the effect of FIVE on enhancing physical performance affecting injury risk and reducing the incidence of futsal injury.

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