The Effectiveness Of Neuromuscular Training Program To Improve Balance Among Female Futsal Players

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Abstract: ***The ability to maintain balance is essential for almost every daily life activity. Balance is a crucial aspect for many sporting and lifestyle activities, such as preventing falls and reducing the risk of injuries. The objective of this study is to identify the effectiveness of a six weeks neuromuscular training program to improve balance among female Futsal players in Sultan Idris Education University, Malaysia. The study design used was true experimental design. The purposive sampling method was utilised to recruit subjects. There were ten female Futsal players age ranging from 19 to 22 years old who fulfilled the inclusion criteria and were randomly assigned equally (N=5) into Control Group and Experimental Group. The Experimental Group undergone 18 sessions of neuromuscular training intervention in six weeks while the Control Group did not receive any intervention but continued their normal training routine. The Y-Balance Test was used to measure the dynamic balance before and after the intervention for both groups. Data was analysed using independent sample t-test and the significance level was predetermined at p<0.05 prior to study. The study finding indicated that the Experimental Group showed significant improvement on dynamic balance (p=0.004) after completing the intervention and when compared with Control Group (p=0.037) for post-intervention. The researcher suggests this program could be incorporated into the training regime for Futsal players to improve balance in hopes of reducing the risk of lower extremities injury.***

Keywords: Neuromuscular Training Program, Dynamic Balance, Futsal

1. INTRODUCTION

Balance is a crucial aspect for many sporting and lifestyle activities, such as preventing falls and reducing the risk of injuries. Furthermore, poor balance is associated to an increased risk of injuries, particularly ankle and knee injuries [1]. The ability to maintain the body's center of gravity within its base of support is known as balance. Balance can be considered as either static or dynamic balance [2]. In addition, balance is influenced by a variety of factors i.e. inputs from sensory system (from visual, vestibular and proprioception inputs), strength and range of motion [3]. The ability to maintain balance is essential for almost every daily life activity. Goldie et al. (1989) stated that static balance is the ability to sustain the body in

static equilibrium or within its base of support. It also refers to the ability of the body to maintain its center of gravity within its base of support without falling [2]. Dynamic balance is an important aspect for athletes that requires a lot of running, sudden change in direction and pivotal movements. With these kinds of movement, the athlete is in a constant state of falling, therefore, if the athlete has a good dynamic balance, they will minimise their risk of falling or risk of sustaining an injury [4].

Futsal is a popular sport especially in South America and it is featured in the SEA Games, Asian Games, and the 2018 Summer Youth Olympics. Futsal was invented in the early 1930s and it is similar to football but played on a smaller indoor court and with a smaller ball. Futsal players require good foundation and development of strength, power, endurance, and balance. Futsal is a sport where it involves a lot of cutting, pivoting, zig-zag running, sudden stopping and running. The relationship between balance ability and the risk of injuries may be greater for sports that involves high risk movements such as pivoting, zig-zag running and jumping [5]. Despite its popularity, Futsal has been rarely the subject of scientific investigations and research, especially regarding injuries risk of Futsal players [6, 7].

Balance plays an important role and is an important component in the maintenance of daily life activities and sporting activities. Lack of balance may affect the performance of physical activity and increase the risk of injuries [8]. Varkiani, et al. (2013) conducted an epidemiology study of Futsal injuries and it is shown that lower extremities injury is the most common injury for male and female Futsal players. They found that female Futsal players sustained higher frequency of injury to the lower extremities (52.9%). In addition, injuries in the knee (37.3%) and ankle (13.5%) were higher than other body parts, respectively [7]. Non-contact mechanisms, such as jumping and landing, pivoting with high speeds, frequently lead to joint or ligament injuries that could be due to the result of insufficient strength or lack of stability and balance [8]. Furthermore, the prevalence of injuries in female Futsal studies by Gayardo, et al. (2012) found that the lower extremities (86.5%) were the most common site of injuries, particularly the thigh, knee, and ankle. It was shown that out of the 135 subjects participated in the study, 73 (54.1%) presented with an injury in the year of 2010. Regarding the injury manner, 54 (51.9%) was non-contact injury and 48 (46.1%) was contact injury [9]. Similar data is found in a study conducted by Lee, et al. (2018) found that the most common injury location among contact-sports athletes in Perak, Malaysia was lower extremities (66.5%). The study finding revealed lack of fitness such as balance and postural stability which affected the athlete's performance in high performance sports. Athletes that lack balance and postural stability showed higher postural sway, hence, it may be a contributing factor for lower extremities injury [10]. This is aligned with the studies conducted by Lee, et al. (2017) and Lee, et al. (2018) stated that the most common injury site is lower extremities (51.1%). Sports that required the athletes to make sudden turns, sudden acceleration and stopping, abrupt change of direction and a lot of jumping are more prone to ankle and knee injuries [11, 12].

Poor balance, altered motor control, or lack of neuromuscular control have all been described as predictors of injury risk in the lower limbs of athletes [13]. As the body is in constant motion from its base of support, biomechanical deviation is likely to occur in the lower extremities. The greater ability to control these movements, it may reduce the excessive forces placed on the lower extremities and to decrease injury risk [14]. In addition, there is an inverse relationship between balance and injury risk as the higher the balance ability, the lower the injuries risk and vice versa [5]. A study conducted which found that neuromuscular training program can improve neuromuscular control which may lead to improved balance and joint stability [15]. Furthermore, various studies have shown that neuromuscular training program can improve balance [16, 17, 18, 19, 20]. However, currently there is no study regarding the effectiveness of neuromuscular training program to improve balance in female Futsal players. Therefore, the purpose of this study is to identify the effectiveness of Neuromuscular Training Program to improve balance among female Futsal players. If the Neuromuscular Training Program is effective to improve balance, the

researcher would like to suggest this program to be incorporated into the training regime of Futsal players in hopes of reducing the risk of lower extremities injury.

2. RESEARCH METHODS

Experimental design is commonly used for a research conducted systematically with a scientific approach, in which the researcher changes a set of variables while the other variables are kept constant and is measured for any change. An experimental research design is centrally concerned with constructing research that is high in causal validity [21]. Therefore, the research design used in this study was true experimental design with pre-test and post-test and random assignment of subjects between the Control Group and Experimental Group. The sampling method used in this study was purposive sampling where the entire female Futsal team (total 30 players) in Sultan Idris Education University, Malaysia, age ranging from 18 to 24 years old were identified as the subjects. However, only 17 female Futsal players volunteered in this study. The subjects were screened using a self-report questionnaire and ten female Futsal players who fulfilled the inclusion criteria and agreed to participate were recruited in this study. To eliminate any possible biases, all the subjects were randomly assigned into either Control Group or Experimental Group.The eligible subjects were required to provide details regarding demographic data, past injury, and sports history by completing a questionnaire. Written informed consent was distributed to all subjects to make sure they understood the research procedure. All the subjects were required to undergo a dynamic balance assessment before starting the Neuromuscular Training Program (pre-intervention) and after completing the training program (post-intervention). The instrument used to measure dynamic balance was Y-Balance Test. The test-retest Intraclass Correlation Coefficients (ICCs) for Y-Balance Test were 0.98, 0.98, and 0.99 on anterior, posteromedial, and posterolateral directions respectively, indicating excellent test-retest reliability for all three directions in Y-Balance Test [22].

After measuring baseline dynamic balance for both Control Group and Experimental Group using Y-Balance Test, the Experimental Group was instructed to undergo 18 sessions of Neuromuscular Training Intervention in six weeks, whereas, the Control Group did not undergo any intervention but continued with their normal training. The Neuromuscular Training Intervention were designed to challenge the balance components which consist of base of support, neuromuscular control, and proprioception. The training variations such as stance, base of support, plyometrics training and strength training were changed and progress gradually (see Table 1). The training intensity was gradually increased from low intensity in the first and second week, to moderate intensity for the third and fourth week and progressed to high intensity for the fifth and sixth week, in order to allow the body to adapt gradually to the training impact.

Table 1: The variations of 18 sessions Neuromuscular Training Program.

Sessions	**Variables**				**Intensity**
	Stance	**Base of Support**	**Plyometrics**	**Strength**	
1	Unilateral & Bilateral	Tiled Floor		Squats	Easy
2	Unilateral & Bilateral	Balance Pad		Squats on balance pad	Easy

3	Unilateral	Balance Pad		Squats on balance pad	Easy
4	Unilateral	Balance Pad & Balance Beam	Single leg hops on balance pad		Easy
5	Unilateral	Balance Pad & Balance Beam	Single leg lateral hops on balance pad		Easy
6	Unilateral	Balance Pad & Balance Beam	Single leg hops on balance pad and throw 5lbs medicine ball		Easy
7	Bilateral	Rocker Board		Lunges on rocker board	Moderate
8	Unilateral & Bilateral	Rocker Board		Lunges on rocker board	Moderate
9	Unilateral & Bilateral	Rocker Board			Moderate
10	Unilateral	Rocker Board		Lunges on rocker board	Moderate
11	Bilateral	BOSU Ball	Double leg hops on BOSU ball	Squats on BOSU ball	Moderate
12	Unilateral	BOSU Ball	Single leg hops on BOSU ball		Hard
13	Unilateral	BOSU Ball	Single leg hops on BOSU ball	Squats on BOSU ball	Hard
14	Unilateral	BOSU Ball	Single leg lateral hops on BOSU ball		Hard
15	Unilateral	BOSU Ball	Single leg hops on BOSU ball and throw 5lbs medicine ball	Squats on BOSU ball	Hard
16	Bilateral	Wobble Board		Calf raise on wobble board	Hard
17	Unilateral & Bilateral	Wobble Board		Lunges on wobble board	Hard
18	Unilateral	Wobble Board		Lunges on wobble board	Hard

The Neuromuscular Training Intervention required subjects to train a combination of three different aspects together in a single session. The intervention required the subjects to perform single leg stance, single leg rainbow, single leg medicine ball throws and tandem walks along with double leg hops on balance pad and squats on balance pad for the first and second week. These exercises are progressed by mainly changing the base of support every week. The base of support is progressed from tiled floor, balance pad, balance beam, BOSU ball, rocker board to wobble board. The plyometrics and strength training were performed on balance pad, balance beam and BOSU ball (see Table 1).

All the subjects were required to warm-up and cool-down before every training session to prevent injury. The training duration is estimated to be within 45 minutes to 60 minutes. There were one minute rest between sets and two minutes rest between exercises. The intensity and volume of the exercise of the Neuromuscular Training Program in this study was progressively increased to constantly challenge the body to adapt to the stress given and this leads to the adaptation of different neural and muscular adaptation [23]. The intensity of exercise was increased by changing difficulty from bilateral to unilateral limb to challenge the proprioception inputs, throwing and catching ball to mildly challenge the visual and vestibular inputs, and performing unilateral hops and jumps to greatly challenge the neuromuscular control and proprioception of the knee and ankle (see Table 1).

The researcher supervised and guided the subjects to make sure the exercises were performed with the correct technique throughout the six weeks intervention period. After completing the six weeks intervention, the outcome measures i.e. dynamic balance was recorded using Y-Balance Test and analysed using Independent Sample t-Test and Paired Sample t-Test in Statistical Package for Social Science (SPSS) version 23. The Independent Sample t-Test was used to compare the difference in dependent variable between Control Group and Experimental Group. The Paired Sample t-Test was used to compare the difference on dynamic balance before and after intervention in Experimental Group to determine the effectiveness of Neuromuscular Training Intervention. The level of significance was predetermined at $p<0.05$ prior to study.

3. RESULTS AND DISCUSSION

The comparison of pre-test for dynamic balance on absolute reach between Control Group and Experimental Group, study result revealed there was no significant difference of pre-test for dynamic balance, indicating that both Control Group and Experimental Group were recruited from homogeneous group (t = 0.775, p = 0.461) before Neuromuscular Training Intervention (see Table 2).

Table 2: The Comparison Between Control Group and Experimental Group for Dynamic Balance on Absolute Reach (cm) using Y-Balance Test Before and After Intervention.

	Control Group	Experimental Group	*T*	*p*
	(Mean+SD)	(Mean+SD)		
Pre test	80.04 ± 8.75	75.91 ± 8.09	0.775	0.461
Post test	79.03 ± 9.01	90.44 ± 4.77	-2.503	0.037*

* Level of Significance $p < 0.05$

The comparison between pre-test and post-test of Control Group, indicated that there was no significant difference in absolute reach (79.03 cm to 80.04 cm) for dynamic balance ($t = 1.229$, $p = 0.264$) (see Figure 1 & Table 3). The Control Group did not improve in dynamic balance because they did not undergo this intervention but continued their normal training. From the researcher's observation during the training of female Futsal players, their training regime did not include any balance training, instead their coaches focus more on skill development and game strategies.

Table 3: The Comparison of Pre-Test and Post-Test Between Control Group and Experimental Group for Dynamic Balance on Absolute Reach (cm) using Y-Balance Test Before and After Intervention.

	Pre test (Mean+SD)	Post test (Mean+SD)	*t*	*p*
Control Group	80.04 ± 8.75	79.03 ± 9.01	1.299	0.264
Experimental Group	75.91 ± 8.09	90.44 ± 4.77	-6.048	0.004*

*Level of Significance $p < 0.05$

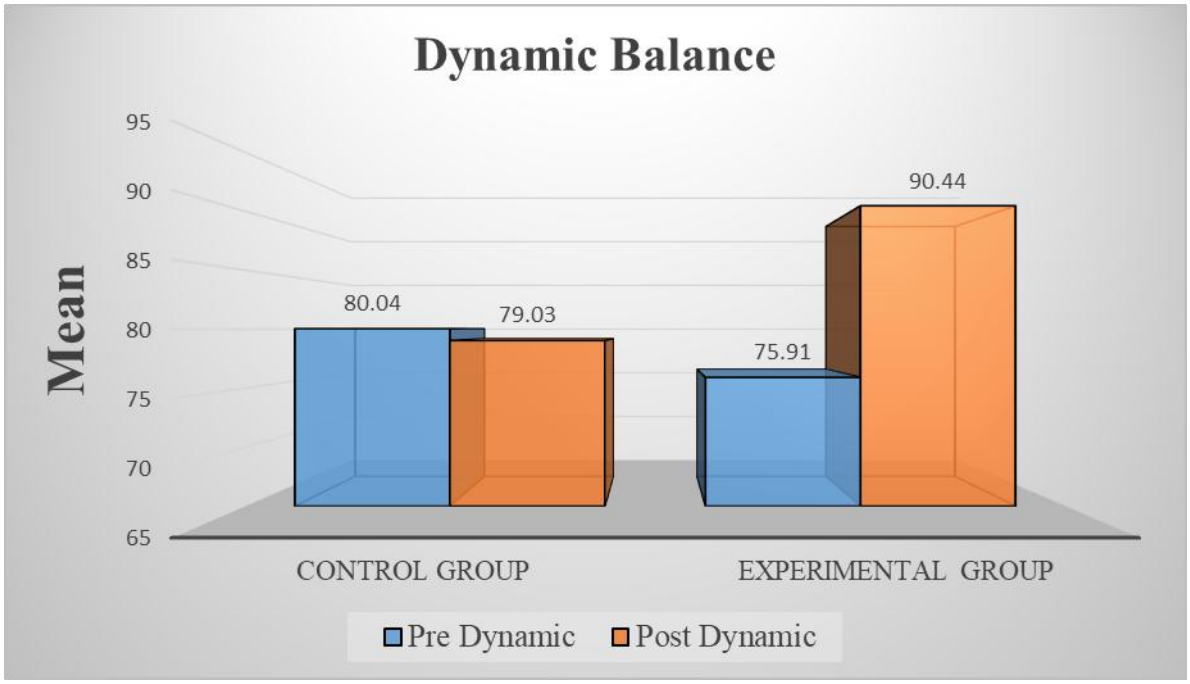

Figure 1: The Mean of Control Group and Experimental Group for Dynamic Balance

on Absolute Reach in Centimetres using Y-Balance Test Before and After Intervention.

The comparison before and after 18 sessions of Neuromuscular Training Intervention, the mean of absolute reach for dynamic balance of Experimental Group had increased by 14.53 cm i.e. from 75.91 cm to 90.44 cm (see Figure 1). The study finding revealed there was significant improvement in dynamic balance on absolute reach (t = -6.048, p = 0.004*) (see Table 3) for Experimental Group after intervention. When comparing post-test scores between Control Group and Experimental Group, the result showed that there was significant difference for dynamic balance (t = -2.503, p = 0.037*), indicating that the intervention is effective in improving dynamic balance of female Futsal players who undergone the 18 sessions of Neuromuscular Training Intervention (see Table 2).

This finding is in line with a previous study stated that an eight-week body-weight neuromuscular training program significantly improve dynamic balance in elite junior Skiing athletes [18]. It is also supported by Holm et al. (2004) and Filipa et al. (2010), both studies reported there was significant improvement in dynamic balance after neuromuscular training [16, 19]. The results showed improvements in dynamic balance from the neuromuscular training program introduced to the healthy female Handball players [16]. Filipa et al. (2010) found that after participation in the neuromuscular training program, the female Soccer players improved in dynamic balance [19]. The neuromuscular training intervention consisted mainly of core stability exercises and lower extremity strength training such as hops, jumps, swiss ball bilateral kneel, lunge jumps, single-leg lateral BOSU hop-hold, and single-leg 180° Airex hop-hold. These exercises focus on multisensory training to challenge the core stability, vestibular inputs, proprioception inputs and neuromuscular control [19].

Neuromuscular training aims to improve neuromuscular control, thus increasing functional joint stability and balance, which may have a protective effect against injury [15]. Neuromuscular training program includes strengthening, stretching, plyometric and balance training. It was suggested by the researcher to train all these aspects in a single session [24]. Moreover, the inclusion of balance training in these programs are thought to improve the coactivation of the muscles surrounding joints, increasing joint stiffness and active joint stability [24, 25]. Neuromuscular training requires the use of specific equipment, such as medicine balls or unstable bases but, on the other hand, a more practical and cost-effective solution is to implement this kind of training into the warm-up routines, with the use of body-weight overload [26, 27]. Therefore, the combination of core stability and plyometric exercises may provide a useful strategy to develop these body-control skills, such as strength, dynamic-balance, and coordination, hence to reduce injury incidence [28].

This study finding is also in agreement with a study conducted by Asha Hasnimy, M.H. & Lee, A.C. (2013), stated that a computerized neuromuscular control training was effective and able to improve dynamic postural control for athlete with patellofemoral pain syndrome (PFPS) [29]. The sport specific balance training program designed for male basketball players was found could improve balance ability. The researchers stated that the motor sensory perception of these basketball players was improved through balance exercises [30]. Lee, A. C. & Magee, D. J. (2017) suggested that a multisensory training program designed to specifically improve sensory function was effective in the improvement of postural sway control and balance control [31].

In addition, performance improvements in dynamic balance may be due to the improved neuromuscular control and proprioception but the extent of this improvement

remains unknown [16]. The neuromuscular training program used in this study mainly challenged the proprioception system, as these exercises did not challenge the visual system and only minimally challenged the vestibular system. The ankle proprioception is challenged the most as many of the exercises are done with single-leg stance and exercises were conducted on varying base of support. By sufficiently challenging the neuromuscular control and proprioception of the lower limbs, the six weeks Neuromuscular Training Program was able to significantly improve the dynamic balance of female Futsal players. These types of exercises which activates the mechanoreceptors within the muscles and tendons to respond to external stimuli quicker and more efficiently, reduction in time between neural stimuli to motor response. These findings are consistent with previous research which incorporated a six-week neuromuscular training program to improve balance among female high school athletes [17].

During the neuromuscular training intervention, the subjects are "forced" to continuously respond to the rapid change of posture and center of gravity due to the unstable base of support. The implementation of tandem walk on unstable surface and hops on unstable surface may have led to improvements in dynamic balance. Furthermore, tandem walk on unstable surface challenge the proprioception of the ankle. The subjects' ankle must realign and properly position as soon as the foot touches the unstable surface in order to perform the exercise without falling. Hopping and landing on an unstable surface challenge the proprioception and neuromuscular control of the ankle and knee to a greater extent, especially for the body to land on an unstable surface while maintaining balance on it. Meanwhile, by doing squats and lunges on an unstable surface, significantly challenge the subjects' ankle and knee proprioception as the subjects require to balance themselves while performing the exercise, otherwise they will lose balance and fall. Besides, in this study, the subjects did almost all exercises without shoes in order to allow the ankle to improve and rely on its own proprioception instead of depending on the support of the shoes. Shoes can improve the ankle stability as it provides support and prevents excessive movement of the ankle. Menz et al. (1999) suggested that shoes with high heel collars improved ankle stability by reducing the supination movement at the subtalar joint [32].

In conclusion, this study finding revealed that the 18 sessions of Neuromuscular Training Intervention is effective to significantly improve dynamic balance in female Futsal players. The nature of Futsal requires the player to run in a zig-zag fashion, cutting and pivoting movements, sudden stopping and acceleration during game, forces them to repetitively lose and regain balance without falling. There is an inverse relationship between balance ability and the risk of injuries for sports that involves high risk movements such as pivoting, zig-zag running and jumping [5]. Since the 18 sessions of Neuromuscular Training Intervention is effective in improving balance significantly, the researcher suggests that Futsal coaches and players may incorporate this intervention into their training regime to improve balance in hopes of reducing the risk of lower extremities injury. It is a known fact that injuries cause greatest negative impact to athletes, causing them fail to maintain their best performance. In addition, it is costly for health care expenses after injured, not only to athletes, to the team, but also to the country. Conversely, Futsal players that are free from injuries could perform confidently during competition, indirectly, increasing the winning opportunities.

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