

# Development of balance training program to improve balance control among Malaysian sports schools athletes

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Authors' Contribution: A-Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

## Abstract

**Background and Study Aim** Complex sports specific movements often require balance ability. This is accountable for injury prevention as well. Balance control is vital to athletes for all sports activities. It is the objective of the current study to develop and identify balance training program effectiveness in improving dynamic balance among athletes in Malaysian National Sport Schools.

**Material and Methods** This study used a true experimental with control group design, involved dynamic balance control measures before and after intervention. A total of 72 male and female athletes were randomly assigned into experimental group or control group after screening process for eligibility. The experimental group underwent 12 sessions of balance training program and the control group continued their usual training routine. The Y-Balance Test was utilized to quantify dynamic balance for both groups. Data was analyzed using independent and paired sample t-test.

**Results** The study finding indicated that the experimental group demonstrated significant improvement in the post-test compared to pre-test ( $p = 0.000$ ,  $p < 0.001$ ) but no significant changes happened to control group ( $p = 0.353$ ,  $p > 0.05$ ). Independent t-test showed during post-test, the experimental group attained better score compared to the control group ( $p = 0.000$ ,  $p < 0.001$ ).

**Conclusions** It is suggested that coaches and athletes may include this balance training program in their training regimen, hoping to help in improving dynamic balance, thus, to reduce risk of lower extremity injuries. Future studies are suggested to increase more variances of balance training and make comparison on their effectiveness as a way to obtain a more effective training program.

**Keywords:** balance control, multisensory system, visual, proprioception, vestibular

## Introduction

Lower extremity injuries often occur on sports and physical activities that required individuals for rapid dynamic movements such as running, jumping, turning and changing direction. Lower extremity is considered as the most common injury location accounted to 51.1%, and 66.5% respectively for Malaysian athletes who participated in contact and non-contact sports [1, 2]. According to Lee & Lee, poor postural stability is a contributing factor for lower extremity injuries [3].

Several studies have reported that sports and physical activity that necessitate one to a sudden stop or a cutting movement triggering greater chance to get injured. From the total injuries occurred for both contact and non-contact sports, it is reported that 75% of ankle injuries are accounted as ankle sprain [4]. Athletes with ankle sprains need to spend more money for health care costs and resources.

Above and beyond, the injured athlete also experiencing significant time loss from sports participation, indirectly causing him or her performance declined. Recurrent ankle sprain has become a menace to athlete's performance. The signs

and symptoms of ankle sprains indicate tendency for repeated ankle sprains such as ankle giving way, pain sensation, weakness, and instability has been reported to occur on 40% to 70% of individuals who have sustained a lateral ankle sprain or chronic ankle instability [5, 6].

Most of the sports required a certain level of stability to execute complex sport movements [7]. The ability to maintain center of body mass over base of support without falling is considered as having bodily equilibrium [8]. Athlete who suffered ankle sprain will definitely depict instability, hence decrease in balance control. Normally, balance is categorized into static balance when athletes maintain in fix position with little or without moving center of gravity, whereas dynamic balance require athlete to maintain postural stability when body is in motion. For activities that required athlete to frequently changing base of support without falling or injured, the athlete must have excellent dynamic balance to complete the task efficiently and safely [9].

Balance can be defined as the ability to maintain a position, the reaction to external disturbance, and postural adjustment to voluntary movements [10]. An intact balance system permits athletes to identify orientation with gravity, determine

motion's direction and speed, and make automatic postural adjustments to maintain stability in various conditions during activities. These abilities are vital in most of the sports in order to perform effectively and to prevent risk of injury.

However, are authorities of Malaysian National Sport Schools aware about the importance of balance control to athletes? Do sports coaches realize the importance of balance control for athletes to perform effectively? Are athletes being educated in physical education and sports science subjects by their teachers and coaches regarding the importance of balance control during sporting activities? Are athletes being trained on their balance control during sports training session? These adolescent athletes from national sports schools are considered as our country asset that have great potential to boost Malaysia sports achievement to international level. If the athletes are agonized with injuries particularly lower extremity injuries such as ankle sprain, their balance ability will be reduced undeniably. A deteriorated balance control will limit athletes' performance in short-term and there is a tendency to last for long-term, thus causing time loss for an athlete to prepare and compete. Indirectly, the injured athlete's performance will declined, hence, causing him or her became less comparative to their teammates.

The researchers realized about this misconception and ignorance towards the importance of balance control in sports performance and injury risk among sports authorities, coaches, physical educators and sports science teachers. Realizing this, the investigators proposed to engender awareness to all sports communities regarding the importance of athlete's balance control ability in helping to reduce and to prevent injuries particularly over lower extremities especially ankle sprain. Consequently, this study is directed to develop a balance training program to train athlete's balance control. Meanwhile, to determine the effectiveness of this newly developed balance training program on improving dynamic balance control among athletes in Malaysian National Sports Schools.

## Materials and Methods

### *Population and Sampling*

Study population was adolescent athletes studying in Malaysia National Sport Schools. Cluster sampling method was used in this study. The selected Malaysia National Sport Schools consisted of: 1) Bukit Jalil Sport School, Kuala Lumpur, 2) Gambang Sport School, Pahang, and 3) Bandar Penawar Sport School, Johor. The first 36 male and 36 female athletes' age ranging from 13 to 16 years old who met the inclusion criteria and agreed to participate were recruited from three selected national sport schools. Averagely, 12 male and 12 female athletes

(total N=24) voluntarily participated from each selected national sport schools with the permission from their guidance. An informed concern was obtained from every volunteered athlete. After screening process using a self-report questionnaire under supervision of the researchers, these athletes were then randomly assigned to experimental group (N=36) who undergone balance training program three sessions a week for four weeks, in a total of 12 sessions and control group (N=36) remained normal training without any intervention. This study was approved by the Sultan Idris Education University Ethics Committee.

### *Study Design*

This study used a true experimental with pre-test post-test control group design that involved measurement of balance control before and after balance training intervention to determine the effectiveness of newly developed balance training program in improving dynamic balance control among athletes in Malaysia National Sport Schools.

### *Balance Training Program*

The balance training program consisted of 24 variations that involve physical activities that focused on enhancing balance control. All the selected variations were designed to challenge and manipulated multisensory system to integrate visual, proprioception and vestibular inputs. These multisensory systems were altered or modified to trigger rapid integration among all inputs when being challenged with unexpected disturbance. The visual inputs were altered with eyes open and eyes closed conditions. The proprioception inputs were altered or modified by base of support i.e. unilateral stance and bilateral stance. Perturbations were applied on some variations to trigger more challenge on vestibular inputs with and without subjects' notice.

The combination of activities such as jumping, hopping, turning, pivoting, while throwing and catching ball with unilateral stance or bilateral stance were designed to optimally challenged all multisensory inputs for balance control. These variations seem to be the most challenging variations that can trigger one to integrate all multisensory inputs rapidly in order to stay balance.

The intensity of exercises was progressively increase to prevent plateau occur and boredom. Intensity of variations was increased by changing the difficulty level of exercises from bilateral stance to unilateral stance in order to challenge proprioception input; eyes open to eyes closed condition to challenge visual input; from without perturbation to with unexpected perturbation to challenge vestibular input; and lastly the combination of challenging all three multisensory inputs while executing sporting activities (Figure 1). Athletes in experimental group were instructed

to undergo this newly develop balance training program three times a week for four weeks, with a total of 12 balance training sessions. All athletes were administrated to warm-up before and cool-down after training sessions to prevent injury occurrence. A one-minute rest between sets was allowed. Each training variations were conducted with a two minutes rest in between. The training duration is estimated approximately 45 minutes per session.

#### *Measurement Tool*

Y-Balance Test (YBT) was utilized to quantify dynamic balance. This test was developed and simplified from the Star Excursion Balance Test and it is used to measure dynamic balance control that often involves completing a functional task without compromising one's base of support.

The YBT evaluated participant's strength, stability and balance in various directions. The participant is required to maintain on a base of support with one leg while maximally reaching in two directions with the opposite leg, without compromising base of support on the stance leg. In this study, all athletes in both training group and control group were instructed to balance on one leg while simultaneously reaching as far as possible with the other leg in three different directions i.e., anterior, posterolateral and posteromedial (Figure 2) during pre-test and post-test. They were allowed for a practice trial before two measurements were recorded.

Y-Balance Test were reported having excellent test-retest reliability for all three directions with test-retest Intraclass Correlation Coefficients (ICCs) i.e. 0.98, 0.98, and 0.99 on anterior, posteromedial, and posterolateral directions respectively [11].

#### *Data Collection*

Pre-test and post-test of dynamic balance were measured using Y-Balance Test for pre-test and post-test before and after balance training program to determine its effectiveness in improving dynamic balance control. During testing sessions, all athletes were permitted to complete two trials for each direction for pre-test and post-test. The mean scores of absolute reaches in centimeters from the two trials were calculated for data analysis to eliminate possible measurement errors.

#### *Statistical analysis*

Mean and standard deviation of Y-Balance Test were tabulated as dynamic balance before and after balance training program. Independent sample T-test in Statistical Package for Social Science (SPSS; version 28) was utilized to analyze the comparison of pre-test and post-test between experimental group and control group to determine the effectiveness of this newly developed balance training program. The paired sample T-test was used to determine the improvement on dynamic balance within experimental group before and after balance

training program to identify the effectiveness of this intervention in improving dynamic balance among athletes in Malaysia National Sport Schools. Significant level of this study was predominated with  $p < 0.05$  prior to research.

### Multisensory Inputs for Balance Control

#### Visual

##### Eyes Open



##### Eyes Closed



#### Proprioception

##### Bilateral



##### Unilateral



#### Vestibular

##### Proprioception Bilateral Unilateral



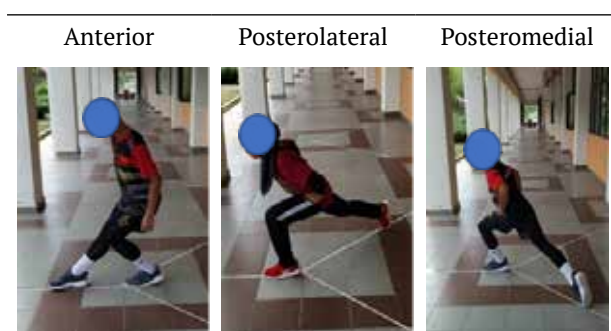
##### Jumping, Hopping, Turning, Pivoting



#### While Throwing and Catching Ball (Combination of Multisensory Inputs)



**Figure 1.** Balance training variations to challenge multisensory inputs for balance control



**Figure 2.** Y-Balance Test

## Results

The demographic data of both experimental group and control group were similar in age, height and weight for both gender groups, indicating that the study subjects were recruited from homogeneous group to eliminate sampling bias. The descriptive characteristics for the subjects in this study were presented in Table 1.

As Table 2 portrayed study finding, there was no significant difference for pre-test of dynamic balance when compared between experimental group and control group, indicating that both experimental group and control group were recruited from homogeneous group [ $t(70) = 0.621$ ,  $p = 0.537$ ] before balance training intervention.

Table 2 tabulated the comparison between pre-test ( $81.47 \pm 9.57$  cm) and post-test ( $81.40 \pm 9.06$  cm) of control group, indicated that there was no significant difference for dynamic balance [ $t(35) = -0.532$ ,  $p = 0.353$ ]. The control group did not improve in dynamic balance because they did not undergo the four weeks balance training program but remained normal training.

Table 2 also illustrated the comparison of post-test scores between experimental and control group. The result demonstrated that there was a significant

difference for dynamic balance [ $t(70) = -3.945$ ,  $p=0.000^*$ ]. Study finding indicated that the balance training program is effective in improving dynamic balance of athletes who studied in Malaysia National Sport Schools after undergone the 12 sessions of balance training intervention.

This study finding revealed there was significant improvement in dynamic balance after intervention [ $t(35) = -5.497$ ,  $p = 0.000^*$ ] when compared the results before (pre-test) and after (post-test) 12 sessions of balance training program. The mean scores for dynamic balance of experimental group indicated an increment of 9.85 cm i.e., from  $80.19 \pm 7.72$  cm to  $90.04 \pm 9.51$  cm after intervention (Table 2).

## Discussion

This study finding revealed that the four weeks balance training program is effective in improving dynamic balance among athletes in Malaysian National Sport Schools. Balance is defined as a complex process involving: a) coordinated activities of reception and integration of multiple sensory inputs, b) motor components for planning and execution of movement, and c) biomechanical components. The position of body in relation to gravity and its surroundings is sensed by combining visual, vestibular, and somatosensory (proprioception) inputs to achieve a goal requiring upright posture without falling.

In conjunction with this concept, the researchers decided to design the balance training program in order to challenge multisensory integration by altering and modifying visual, proprioception and vestibular inputs progressively. Each of the training variation was designed to challenge and to manipulate these multisensory inputs in order to train rapid integration among them once challenges being triggered. Rapid integration among multisensory inputs upon unexpected challenges

**Table 1.** Demographic data of experimental and control groups

| Variables/group<br>(Mean $\pm$ SD) | Experimental<br>(N=36) | Control<br>(N=36) |
|------------------------------------|------------------------|-------------------|
| Age (years)                        | 14.02 $\pm$ 0.62       | 14.04 $\pm$ 0.84  |
| Height (cm)                        | 159.00 $\pm$ 5.58      | 162.60 $\pm$ 5.72 |
| Weight (kg)                        | 49.28 $\pm$ 5.67       | 48.62 $\pm$ 5.41  |

**Table 2.** The improvement of 12 sessions exercise programs on dynamic balance (Y-balance) of subjects in experimental and control groups

| Dynamic Balance<br>(cm) |      | Control     | Experimental<br>t | Independent t-test |        |
|-------------------------|------|-------------|-------------------|--------------------|--------|
|                         |      |             |                   | p                  |        |
| Test                    | Pre  | 81.47 ±9.57 | 80.19 ±7.72       | 0.621              | 0.537  |
|                         | Post | 81.40 ±9.06 | 90.04 ±9.51       | -3.945             | 0.000* |
| Paired t-test.          | t    | -0.532      | -5.49             | -                  |        |
|                         | p    | 0.353       | 0.000*            | -                  |        |

could secure one's balance control. Postural and balance control measurements are important for performance, injury prevention and rehabilitation process. In this study, sphere on sensory motor abilities is focused especially on static and dynamic balance control abilities. Balance control is often described as maintaining a position with minimal movement i.e., static balance, and maintaining a stable base of support while completing a prescribed movement is called dynamic balance. The ability to stay steady and not falling while movement i.e., the orientation of space can be considered as good dynamic balance with intact multisensory systems.

In current study, the athletes who undergone the balance training program were asked to maintain their balance while performing various tasks on altered base of support. These tasks likely contributed to improve the athletes' balance control ability due to repeated sensory feedback. The ability of an athlete to move his or her body rapidly in different directions without losing body control requires good postural stability. It has been shown that balance can contribute to successful performance and play a major role in many athletic and sport-specific activities [12].

Proprioception is an important factor in maintaining balance and sensing the limbs position in space when both visual and vestibular inputs of balance component is removed or affected. Both visual and vestibular systems would render the only capable component to proprioception only, which consist of three receptors which is low threshold but respond to external stimuli rapidly. All these receptors work to sense the positioning of center of gravity to maintain body mass over its base of support after several successful postural perturbations.

The improvement of balance control ability after intervention of experimental group in this study demonstrated that balance disrupting force imposed by perturbation, forcing central nervous system must constantly making adjustments to keep center of mass over its base of support [13]. In study conducted by Loram and Lakie [14], subjects maintained their stability while resisting against balance disturbing force by perturbation using tension in elastic band which in turn impose an accentuated neural training effect that can improve balance ability [14].

Current study finding is in agreement with study conducted by Lee and Lim [15] who implemented sport specific trampoline training in improving dynamic balance among amateur Wushu athletes. They found that the four weeks trampoline training program was effective in improving dynamic balance among amateur Wushu athletes. The researcher stated that during trampoline training, athletes were asked to jump on trampoline, during on air, automatically, these athletes were forced

to continuously respond to the change of posture and the switch of center of gravity. Whereas, while landing on trampoline, the feet as base of support which provided proprioception input needed to integrate with other sensory inputs i.e., visual inputs and vestibular inputs in order to stay balance on trampoline without falling off [15]. When an athlete was rebounding on a trampoline, his or her body requires to be repetitively in movements, his or her eyes must continuously adjust to the different levels of vision i.e., visual input was challenged, thus, forcing one's visual input to integrate effectively with vestibular input and proprioception input to stay balance. In trampoline training program, the improvements in dynamic balance are perceived due to the alterations in complex sensory motor stimulation that triggered athletes to adapt to unstable surface, forcing them to maintain their stability on trampoline simultaneously [16].

This study finding shown consistency with Lee and Tan's [17] study stated that the 18 sessions of neuromuscular training intervention could improve dynamic balance in female Futsal players significantly. They stated that nature of Futsal requires player to execute multiple movements that need rapid reaction. They designed the neuromuscular training program merely to challenge proprioception system, whereas the vestibular system was minimally challenged. In their study, the researchers focused to challenge proprioception because exercises were conducted with single-leg stance and on varies bases of support. They revealed that by challenging neuromuscular control and proprioception of lower extremities, these six weeks neuromuscular training program was found to be able to improve dynamic balance of female Futsal players significantly [17]. Similarly, Hashim & Lee's [18] study demonstrated that computerized neuromuscular control training program could successfully improve athlete's dynamic postural control ability [18].

This study finding also supported by Puzi and Lee [19], indicated that a six weeks CoBAgi training was effective in improving dynamic balance of adolescent handball players. The integration of visual, vestibular and proprioception inputs enable to control body motion in space. They stated that the improvement in muscular synergies help to minimize the displacement for center of gravity, thus, contributing better balance control while execute motor task in handball and other sports [19].

Furthermore, study conducted by Lee and Kuang [20] reported that balance training program is believed could improve balance control ability in basketball male players. The basketball players' ability on neuromuscular control was improved through these balance exercises [20]. Therefore, the players were perceived may reduce lower extremity injuries risk. A multisensory training program was

designed to specifically improve sensory function by Lee & Magee [21]. They suggested that sensorimotor or balance training with unexpected disturbance or perturbation could be incorporated into rehabilitation programs for athletic populations to improve static balance and dynamic balance [21, 22].

A study conducted by McGuine and Keene [23] reported that the four weeks progressive balance training program could significantly overcome sensorimotor constraints related to chronic ankle ability, indirectly reduce ankle sprains rates by 38% in male and female high school soccer and basketball players [23]. This is in conjunction with McKeon et al. [24] reported that the six weeks of balance training could improve sensorimotor function in individuals with chronic ankle instability [24]. Similarly, a four-week developed program that included static single-leg balance on unstable surfaces with eyes open or eyes closed or dynamic movements is believed can improve dynamic postural control of individual with chronic ankle instability [25].

The application of mobilization with movement might have some stimulating effects on mechanoreceptors and assist in neutral feedback mechanisms used to help stabilize ankle during complex activities. These can be enhanced with the proprioception balance activities. The athletes could demonstrate improvements in both sports' specific activities and daily living activities after undergone the six weeks of MobEx intervention that consisted of proprioceptive balance exercises [25, 26, 27].

## Conclusions

Balance is important to every individual in order to maintain body position whilst performing a given task without instability. Numerous previous studies reported that balance training could improve balance control, thus, is believed may prevent injuries. Hence, the researchers developed these four weeks balance training program and measured its effectiveness on improving balance control in order to create awareness to sport schools' athletes,

coaches, as well as sport authorities regarding the importance of balance control in injury prevention. This developed balance training program was proven to be effective in improving balance control among athletes in Malaysian National Sport Schools. It is suggested that this balance training program could be referred and implemented to all athletes especially adolescent in secondary schools. Meanwhile, the researchers would like to suggest to athletes and coaches that they may include this freshly established balance training program in their daily training routine with the purpose to reduce and prevent lower extremity injuries.

This study findings also are important to school communities, sport authorizes, coaches, and athletes in order to give awareness how to progress balance control in order to reduce and prevent lower extremity injuries. Injury free athletes could save a big budget on healthcare cost either supported by individual or government. Furthermore, these athletes who studied in national sport schools are considered as country asset. They are trained to excel in sports, and they are expected to be able to boost Malaysia sports achievement to international level. The economy and reputation of country could be boosted if high performance athletes are produced to world class level. The nation will be recognized worldwide for their excellent achievements, as showcased by Malaysian badminton players.

## Conflicts of Interest

The authors declare no conflicts of interest.

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## References

1. Lee AC, Baharudin MY, Sankaravel M, Fairus FZ. A preliminary study on injury risk factors of Perak athletes. *International Journal of Engineering Technology*. 2018;7(4.15):173–7. <https://doi.org/10.14419/ijet.v7i4.15.21441>
2. Lee AC, Sankaravel M, Mondam S, Kuang P. Injury profile of non-contact sports for Perak SUKMA athletes. *Journal of Fundamental Applied Sciences*. 2017;9(6S):1141–51. <http://doi.org/10.4314/jfas.v9i6s.84>
3. Lee AC, Lee ZC. Injury profile of contact-sports for Perak athletes in Malaysia. *International Journal of Academic Research in Business and Social Sciences*. 2018;8(9):965–76. <http://doi.org/10.6007/IJARBS/v8-i9/4672>
4. Valovich McLeod TC. The effectiveness of balance training programs on reducing the incidence of ankle sprains in adolescent athletes. *Journal of Sport Rehabilitation*. 2008;17(3):316–23. <http://doi.org/10.1123/jsr.17.3.316>
5. McKay GD, Goldie PA, Payne WR, Oakes BW. Ankle injuries in basketball: injury rate and risk factors. *British Journal of Sports Medicine*. 2001;35(2):103–8. <http://doi.org/10.1136/bjsm.35.2.103>
6. Sefton JM, Yazar C, Hicks-Little CA, Berry JW, Cordova ML. Six weeks of balance training improves sensorimotor function in individuals with chronic ankle instability. *The Journal of Orthopaedic and Sports Physical Therapy*. 2011;41(2):81–9.

- http://doi.org/10.2519/jospt.2011.3365
7. Altay F. *Biomechanics Analysis of the Side Balance Activity after Chainé Rotation under the Two Varying Speeds in the Rhythmic Gymnastics* [PhD Thesis]. Ankara: Hacettepe University Health Sciences Institute; 2001.
8. Hrysomallis C. Relationship between balance ability, training and sports injury risk. *Sports Medicine (Auckland, NZ)*. 2007;37(6):547–56. <http://doi.org/10.2165/00007256-200737060-00007>
9. Irrgang JJ, Whitney SL, Cox ED. Balance and proprioceptive training for rehabilitation of the lower extremity. *Journal of Sport Rehabilitation*. 1994;3(1):68–83. <https://doi.org/10.1123/jsr.3.1.68>
10. Berg K. Balance and its measure in the elderly: a review. *Physiotherapy Canada*. 1989;41(5):240–6. <http://doi.org/10.3138/ptc.41.5.240>
11. Lee AC, Ong KB. The test-retest reliability of 'y-balance test' as dynamic balance measure on Malaysian primary school children. *Journal of Teaching Education*. 2012;1(7):331–7.
12. Cengizhan PA, Cobanoglu G, Gokdogan CM, Zorlular A, Akaras E, Ozer GE, et al. The relationship between postural stability, core muscle endurance and agility in professional basketball players. *Annals of Medical Research*. 2019;26(10):2181–6. <http://doi.org/10.5455/annalsmedres.2019.07.436>
13. Han K, Ricard MD, Fellingham GW. Effects of a 4-week exercise program on balance using elastic tubing as a perturbation force for individuals with a history of ankle sprains. *The Journal of Orthopaedic and Sports Physical Therapy*. 2009;39(4):246–55. <http://doi.org/10.2519/jospt.2009.2958>
14. Loram ID, Lakie M. Human balancing of an inverted pendulum: position control by small, ballistic-like, throw and catch movements. *The Journal of Physiology*. 2002;540(Pt 3):1111–24. <http://doi.org/10.1113/jphysiol.2001.013077>
15. Lee AC, Lim PC. The effectiveness of sport specific trampoline training on dynamic balance among amateur wushu athletes. *European Journal of Molecular Clinical Medicine*. 2020;7(2):5904–12. [https://ejmcm.com/article\\_3700.html](https://ejmcm.com/article_3700.html)
16. Giagazoglou P, Kokaridas D, Sidiropoulou M, Patsiaouras A, Karra C, Neofotistou K. Effects of a trampoline exercise intervention on motor performance and balance ability of children with intellectual disabilities. *Research in Developmental Disabilities*. 2013;34(9):2701–7. <http://doi.org/10.1016/j.ridd.2013.05.034>
17. Lee AC, Tan LG. The effectiveness of neuromuscular training program to improve balance among female futsal players. *European Journal of Molecular Clinical Medicine*. 2020;7(2):6060–70. [https://ejmcm.com/article\\_3717.html](https://ejmcm.com/article_3717.html)
18. Hashim AHM, Lee A-C. *The effects of computerized neuromuscular control training on athlete's dynamic postural control ability*. *Contemporary Trends Research in Sports, Exercise Physical Education* [Internet]. 2013 [cited 2022 Jan 15]. Available from: <http://www.malrep.uum.edu.my/rep/Record/my.utm.40870/Description>
19. Puzi MHB, Choo LA. The effect of six weeks CoBAGi training on coordination, dynamic balance and agility of adolescent handball players. *Pedagogy of Physical Culture Sports*. 2021;25(1):31–8. <http://doi.org/10.15561/26649837.2021.0105>
20. Lee AC, Kuang PF. The effectiveness of sports specific balance training program in reducing risk of ankle sprain in basketball. *International Journal of Physiotherapy*. 2016;3(6):681–6. <https://doi.org/10.15621/ijphy/2016/v3i6/124745>
21. Lee AC, Magee D. Multisensory training for postural sway control in non-injured elderly females. *Journal of Fundamental Applied Sciences*. 2017;9(6S):1116–31. <http://doi.org/10.4314/jfas.v9i6s.82>
22. Teichmann J, Suwarganda EK, Beaven CM, Hébert-Losier K, Lee JW, Tenllado Vallejo F, et al. Improvement of elite female athletes' physical performance with a 3-week unexpected disturbance program. *Journal of Sport Rehabilitation*. 2018;27(1):1–7. <http://doi.org/10.1123/jsr.2016-0082>
23. McGuine TA, Keene JS. The effect of a balance training program on the risk of ankle sprains in high school athletes. *The American Journal of Sports Medicine*. 2006;34(7):1103–11. <http://doi.org/10.1177/0363546505284191>
24. McKeon PO, Ingersoll CD, Kerrigan DC, Saliba E, Bennett BC, Hertel J. Balance training improves function and postural control in those with chronic ankle instability. *Medicine and Science in Sports and Exercise*. 2008;40(10):1810–9. <http://doi.org/10.1249/MSS.0b013e31817e0f92>
25. Hale SA, Hertel J, Olmsted-Kramer LC. The effect of a 4-week comprehensive rehabilitation program on postural control and lower extremity function in individuals with chronic ankle instability. *The Journal of Orthopaedic and Sports Physical Therapy*. 2007;37(6):303–11. <http://doi.org/10.2519/jospt.2007.2322>
26. Sankaravel M, Choo LA, Elumalai G. The effect of mobex intervention in university athletes with post lateral ankle sprain. *European Journal of Molecular Clinical Medicine*. 2020;7(2):5889–95.
27. Sankaravel M, Lee AC, Elumalai G. Effect of Mobex model intervention program on post lateral ankle sprain functional outcomes among athletes. *International Journal of Physiotherapy*. 2021;8(1). <http://doi.org/10.15621/ijphy/2021/v8i1/901>

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