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# Effectiveness of Single-Leg Stable Surface Exercise Versus Single-Leg Bosu Ball Exercise on Dynamic Balance Among Malaysian Trail Hikers

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KEYWORDS	ABSTRACT:		
Single-leg Stable Surface Exercise, Single-leg BOSU Ball Exercise, Dynamic Balance, Prevent Falls	<b>Introduction</b> : Effectiveness of Single-Leg Stable Surface Exercise versus Single Leg BOSU Ball Exercise on Dynamic Balance among Malaysian Trail Hikers. <b>Background &amp; Aim:</b> Single-leg balance training appears to enhance balance stability significantly in preventing falls and associated lower extremity injuries. There is a dearth of scientific study upon dynamic balancing among trail hikers from a local standpoint. To address this gap, this study aims to compare the effectiveness of Single-Leg Stable Surface Exercise versus Single Leg BOSU Ball Exercise on dynamic balance among healthy Malaysian Trail Hikers to mitigate the falls occurrence and lower limb injuries.		
	<b>Objectives</b> : To determine the effect of Single-Leg Stable Surface Exercise versus Single Leg BOSU Ball Exercise on Dynamic Balance among Malaysian Trail Hikers.		
	<b>Methods</b> : Thirty eligible participants are recruited and evenly divided into 2 groups. Group 1 will undertake the Single-Leg Stable Surface Exercise (SSSE), whereas Group 2 engage in the Single-Leg BOSU Ball Exercise (SBBE) for 4 weeks. A pre-test (1 <sup>st</sup> week) measurement was taken by Modified Balance Error Scoring System (mBESS) and the Y-Balance Test (YBT) for static postural stability and dynamic balance respectively followed by a post-test at 5 <sup>th</sup> week.		
	<b>Results</b> : The study's findings indicated both SSSE and SBBE yielded statistically significant enhancements in postural stability ( $p<0.05$ ). The pre and post result of SSSE and SBBE on YBT were showing mixed results. However, no significant difference observed between two intervention groups ( $p>0.05$ ).		
	<b>Conclusions</b> : The study c balance among hill hiker. H	oncluded both SSSE and SBBE fowever, SBBE exhibited higher	E were effective in improving dynamic significance compared to SSSE

#### 1. Introduction

Hiking has been characterized as an outdoor walking activity involving an individual or group of people that is accessible with minimal skills or equipment. Although injuries have been on the rise among Malaysian recreational trail hikers, however the popularity of hiking has surged in the country. (Outdoor Foundation Organization, 2022) Moreover, being exposed to nature through hiking has been linked to less cases of heart disease, better bone health and is advantageous for minimizing the effects of a sedentary lifestyle.(Mitten, D. et al, 2016).Dynamic balance refers to the ability to while maintain stability walking, both when

encountering internal or external disruptions and when standing still. (Tibor, H., et al., 2019) More specifically, the primary objective of dynamic balance is to ensure that the vertical projection of the center of mass (COM) remains within the base of support (BOS) while the COM is in motion during locomotion which allows individuals to cope with disturbances and stay steady throughout the movements. (ibid) Overall balance ability is influenced by three independent factors: strength, multi-joint coordination, and sensorimotor processing. (Werner, I. et al., 2023) Various inputs including visual, vestibular, tactile, and proprioceptive information play a crucial role in supporting multi-joint coordination and sensorimotor

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processing. (ibid) These inputs are weighted and integrated at different time scales, providing crucial information to the sensorimotor control loops and reflex responses responsible for generating motor commands to maintain dynamic balance. (Neptune, R., et al., 2018) Embarking on treks over natural rugged terrains with obstacles aplenty, be it climbing rocks, crossing glaciers, navigating narrow ridges, or traversing uneven surfaces and tree roots, hikers are faced with demands for dynamic flexibility, neuromotor strength, both static and dynamic balance. (Chopda, R. R. et al., 2022) Furthermore, downhill hiking has been found to carry the highest incident rate for lower extremity (LE) musculoskeletal injuries and an increased risk of falls due to the eccentric contractions of LE muscles leading to temporary exercise-induced muscle.

Single-leg stance is particularly utilized for training and assessment purposes as it can potentially indicate an elevated risk of ankle sprain if balance is poor during this stance.(Alfuth, M., et al., 2018) The sensorimotor subsystems rely heavily on feedback from joint mechanoreceptors suggesting the involvement of closedloop control mechanisms in regulating movements of the ankle and foot. (ibid) In addition, balance training plays role in preventing falls а significant and associated injuries by keeping the COM within BOS in relation to the transmission of force from the feet to upper body via the trunk. (Gebel, A., et al., 2018) Singleleg balance training appears to be an alternative method for enhancing balance stability significantly, offering a potential improvement compared to more conventional balance training programs that primarily focus on bipedal exercises. (Marcori, A. J., et al., 2022) Nonetheless, the BOSU® Ball posed the most significant challenge in terms of inversion-eversion variability, leading to heightened ankle kinematic and muscle activity parameters compared to the other surfaces (Strøm, M., et al., 2016). Notably, the study's results indicated that the peroneal muscle relative activity exhibited a significantly higher value when participants were balancing on the BOSU® Ball, reaching 32% of EMGmax  $\pm$  12%. (ibid)

### 2. Objectives

Primary Objectives: To determine the effect of single-leg stable Surface exercises and determine the effect of single leg BOSU ball exercises on dynamic balance among Malaysian trail hikers. Secondary Objectives: To compare the effect of single-leg stable surface exercise versus single leg BOSU ball exercise on dynamic balance among Malaysian trail hikers.

### 3. Methods

It is a quantitative approach of quasi-experimental design. Target samples will be selected using convenience sampling (CS) based on specified inclusion and exclusion criteria. Despite its non-probability nature, CS remains the gold standard in clinical research (Elfil, M., et al. 2017). The minimum recommended number of participants required to conduct this study was set at 28, hence 30 was chosen as the target size. Based on Althubaiti, A. (2022), participants in a comparison study should be split evenly between two intervention groups to maximise the sample's ability to detect a difference between the groups.

Total of 30 eligible participants are divided into 2 groups based on chance: Group 1 will undertake the Single-Leg Stable Surface Balance Exercise, whereas Group 2 will engage in the Single-Leg BOSU Ball Balance Exercise. The Y-Balance Test (YBT) and the Modified Balance Error Scoring System (mBESS) will be used to conduct a preliminary evaluation of both groups and kept as baseline data. Prior to conducting a risk-free study, ethical approval from Faculty of Health Sciences Research Review Committee (FRRC) of MAHSA University will be sought and granted. To evaluate the postural stability errors, the Modified Balance Error Scoring System (mBESS) .The Y-Balance Test (YBT) (Figure E-2) has been chosen as the primary assessment tool to measures dynamic balance in single-leg stance, requiring a combination of balance, strength, flexibility, core control, and proprioception.

### 4. Results

The descriptive data has been analysed and the mean age for Group 1 (n=15) was 24.40  $\pm$  1.805, while Group 2 (n=15) shown 24.80  $\pm$  2.569. In Group 1, majority of participants were male, with limb length difference and BMI recorded at .63  $\pm$  1.316 and 22.71  $\pm$  2.231, respectively. Conversely, Group 2 had a higher proportion of male participants, with limb length difference of .00  $\pm$  .000 and BMI of 22.61  $\pm$  4.675.Group 1 YBT significant improvement in Pair 2 and Pair 3 with p<0.05, except for Pair 1 (p>0.05).Group 2 YBT significant improvement in Pair 2 with p<0.05, except for

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Pair 1 and Pair 3 (p>0.05).Group 2 YBT significant improvement in Pair 2 and Pair 3 with p<0.05, except for (p>0.05).Group 1 mBESS Pair 1 significant improvement in Pair 1 with p<0.05. Group 2 mBESS significant improvement in Pair 1 with p<0.05. Independent Sample t-test of YBT Left ANT between G1 and G2. revealed no significant difference between YBT ANT left and right among 2 groups, p>0.05.Independent Sample t-test of YBT right PL between G1 and G2. There is no significant difference between YBT PL left and right among 2 groups, p>0.05. Independent Sample t-test of YBT right PM between G1 and G2. There is no significant difference between YBT PM left and right among 2 groups, p>0.05.Independent Sample t-test of mBESS between G1 and G2.revealed no significant difference between mBESS among 2 groups, p>0.05.

#### 5. Discussion

The main objective of this research was to compare the effects of two distinct surfaces for balance training on the dynamic balance skills and postural stability during single-leg stance among hill hikers from Malaysia. Dynamic balance encompasses a multifaceted interplay of sensory, musculoskeletal, and nervous system components (Roshni et al., 2021. According to the findings of the current study, engaging in SSSE led to noteworthy enhancements in the dynamic balance of both the left and right legs and for the left PM component, the observed improvement did not reach statistical significance. Sports-related activities frequently give rise to ankle sprains, which are frequently linked to diminished sensorimotor control involving factors like proprioception, muscle strength, and balance (Lizardo, et al., 2017).Consequently, it is recommended to incorporate the BOSU device to enhance the variety of prevention and rehabilitation programs targeting lower limb injuries, particularly during the more advanced phases of these strategies (ibid). The above findings concluded by Lizardo, F. et al. (2017) reinforce that the use of instability training devices like the BOSU ball trainer challenges conventional training principles by introducing specific demands on the neuromuscular system. Nevertheless, the outcomes of the present study indicated the independent t-test of YBT and the mBESS demonstrated no notable distinction between the SSSE group and the SBBE group in terms of dynamic balance (p-value > 0.05). This observation can be attributed to the significant diversity in how individuals self-organize and execute movements for a specific task, which can vary considerably. As suggested by Cuğ et al. (2016) within the framework of dynamic systems theory, a progressive approach to balance training based on error analysis and consistent movement proficiency assessment enables the sensorimotor system to adapt itself to a specific range of task and environmental constraints. This adaptation occurs before facing heightened challenges at advanced difficulty levels, potentially leading to more substantial enhancements. Moreover, findings from Trajković et al. (2022) revealed that female athletes exhibited superior postural stability compared to male. This discrepancy was most notable in terms of Center of Pressure (CoP) and amplitude. The potential factors velocity contributing to enhanced postural stability among females encompass the maturation process, lower body weight, and improved proprioception and control, which could be attributed to a comparatively smaller absolute muscle mass and strength.

Additionally, the study conducted by Roshni et al. (2021) demonstrated noteworthy advancements in dynamic balance after six weeks of BOSU ball balance training. The training led to a statistically significant enhancement of 24.44% in dynamic balance by the end of the sixth week, as compared to the control group. This improvement was attributed to the training's impact on reflex control of muscle activity when performing exercises that involve a closely linked kinematic chain, with p-value <0.05. Hence, due to the comparatively shorter duration of the present study, spanning only four weeks, a longer timeframe would likely be necessary to observe more substantial effects. It is important to note that the inclusion of downhill running in the hiking training regimen can trigger repetitive eccentric contractions and vibrations within the tissues. This phenomenon can result in muscle damage, subsequent tissue inflammation, delayed onset muscle soreness (DOMS), and heightened perceived fatigue (Dupuy, O., et al., 2018). Consequently, participants in this study who engaged in training a few days before the post-data collection encountered exercise-induced disturbances that led to a temporary reduction in muscular force, an altered sense of joint position, and diminished physical performance. These factors collectively influence the precision of the research data (Wilke, J., and Behringer, M., 2021).

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