

The Immediate Effects of Dynamic Stretching and Static Stretching Using a Wedge Board on the Balance Ability and Jump Function of Healthy Adult

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Purpose: This study aims to measure the improvement of balanced ability and rapid response of 30 healthy adults by performing dynamic stretching, static stretching, and sargent jump.

Methods: The sample 30 peoples without any musculoskeletal disease who volunteered to be the subject of the study. We measured all subjects on following metrics to evaluate the function and stability under the normal condition, with dynamic stretching (DS) group, static stretching (SS) group: vertical jump height and reaching distance Anterior, Posteromedial, Posterolateral and NO (Normal eye open), NC (Normal eye close), PO (Pillow with eye open), and PC (Pillow with close eye) were evaluated. All measures were analyzed using independent t-test and One-way repeated Anova.

Results: There was a significant increase in SJH (Sargent jump) in both groups ($p < 0.05$). In Y-balance test, there was a significant increase in both groups except for the ANT (Anterior) direction, and there was a significant increase only in the SS group in the ANT (Anterior) direction ($p < 0.05$). There was no significant difference between the DS group and the SS group ($p > 0.05$). There was no significant improvement in ST (Stability Index) and WDI (Weight Distribution Index) in both groups ($p > 0.05$).

Conclusion: Both DS and SS showed significant improvement in SJH and Y-balance tests, which are dynamic functions, but had no significant effect on static balance ability.

Keywords: Static stretching, Dynamic stretching, Postural balance, Sargent jump

INTRODUCTION

Human bipedal standing is inherently unstable due to the high center of the body on a relatively narrow base, and since most functional activities performed by humans are performed in a standing position, interest in maintaining balance in a standing position has long been high. Humans need an ankle strategy and a hip strategy to stabilize the body during standing, and it is known that the ankle joint especially contributes a lot in studies on balance.¹

Balance is one of the important factors in human life, as previous studies have shown.² Balance refers to the ability to maintain or control the center of the body with minimal postural sway to a stationary or moving basal plane.² In addition, the balance that is important for maintaining daily life is the function of maintaining the stability of the body and is

used in the sense of the ability to maintain posture. Such balance is an important ability in daily life and sports scenes.³ Balance refers to the ability to maintain the center of gravity on the basal plane and maintain equilibrium when moving the body and occupies an important part in maintaining posture and performing motor skills.⁴

There are many types of stretching, but static stretching is the most common stretching technique that can be easily done at home, while ballistic stretching is a risk of tissue damage. It is known that neurophysiologic stretching can safely and efficiently build muscle but has the disadvantage of requiring the help of others.¹ Static stretching is a traditional method of maintaining the same movement for about 15-60 seconds without moving for a period of time. Dynamic stretching, on the other hand, is a method of repeatedly stimulating a region with dynamic joint movements. Widens the range of motion of joints due to twisting and pulling.

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Stretching prevents the risk of injury due to muscle shortening and improves chronically stiff range of motion (ROM), it is known to help prevent injuries.^{5,6}

Vertical jumping is one of the exercises that can improve agility. The instantaneous force refers to the force that occurs when the muscle contracts explosively due to the concentration of nerve impulses. In other words, it is the ability to run, jump, and throw with instantaneous power. It is the ability to apply force with strong muscle strength and agility and is a fundamental ability in various sports.⁷ The main muscles used in vertical jumping are hamstring and gluteus maximus, which extend the hip joint, quadriceps femoris, which extends the knee joint, and gastrocnemius and soleus, which cause plantar flexion of the foot. It is reported that it is necessary to enhance the coordination of the nervous system as well as these muscles in order to improve the ability to jump vertically. In particular, strength and jumping performance show a moderately constant correlation.⁸

Stretching is time and place agnostic and not very strong, so it can be applied to all age groups.⁶ Stretching enables balanced development and increased flexibility by allowing modern people with biased physical activity as a temple exercise to move evenly.⁸ In addition, stretching is used for maintaining the condition of daily life and preparing and organizing before and after exercise, and is indispensable in the field of performing exercise such as sports and health management.⁶ This positive effect of stretching has already been clarified in previous papers, so if stretching is also closely related to improving balance and instantaneous power, it can occur if it is damaged. It will also help solve some secondary problems. However, since there have not been many studies that have revealed the relationship between balance and jump ability improvement through stretching, we intend to conduct a study with the purpose of revealing the correlation between them. Therefore, the purpose of this study is to investigate the effects of dynamic stretching and static stretching on balance and jumping ability in healthy adults.

METHODS

1. Participants

This study was conducted on 30 healthy adult men and women at A City (Table 1). Before participating in the study, all the subjects were given a thorough explanation of the purpose and method of conducting the study, and the subjects in this study were tested in advance. Subjects who could do everything in their daily lives independently, without any dis-

Table 1. General characteristics of participants (N = 30)

	DS group (n = 15)	SS group (n = 15)
Age (yr)	21.9 ± 0.6	20.8 ± 0.3
Height (cm)	168.8 ± 2.9	165.5 ± 2.0
Weight (kg)	65.0 ± 4.4	60.3 ± 3.2

Values indicate mean ± standard deviation.

ability due to foot surgery or trauma, without past history such as pre-political, nervous system and musculoskeletal disorders, participated in the study. After familiarization with all the content of the experimental process, all targets who provided prior consent to this participated in the study. The study design is pre, post and follow-up test control group design (randomized) up to pre, post and follow-up comparisons between the two groups.

This study was approved by the S University IRB (Institutional Review Board) (SM-202104-021-1). All participants agreed to the written notice, explained the purpose of the experiment and the method to the study subjects, and before starting the experiment, autonomous BMI measuring stadiometer (BSM 370, Korea, 2011).

2. Measurement Equipment

The instruments used in the experiment were the sargent jump (Vertical jump) Test, Y-balance Kit, and Tetrax. These mechanisms measured the subject's instantaneous force, static balance ability and dynamic balance ability.

1) Vertical jump (Sargent jump)

Vertical jump is a test that records the height of a subject's vertical jump and evaluates the function of instantaneous force. Jump vertically as fast as possible to the maximum height, touch the wall, and after placing chalk on the wall, the uppermost part of the marked area was measured.

2) Y-balance test

The dynamic balance ability was evaluated using the Y-Balance Kit. Three variants are measured by Anterior (ANT), Posteromedial (PM), and Posterolateral (PL) three times, and the dynamic balance ability is evaluated using the normalized numerical value converted to the reach distance as a percentage (Figure 1).

3) Tetrax—a system for analyzing balance

The posture to evaluate the static balance of the subject using Tetrax (Sunlight Medical Ltd., Ramat Gan, Israel) (Figure 2). Tetrax is a device that evalu-

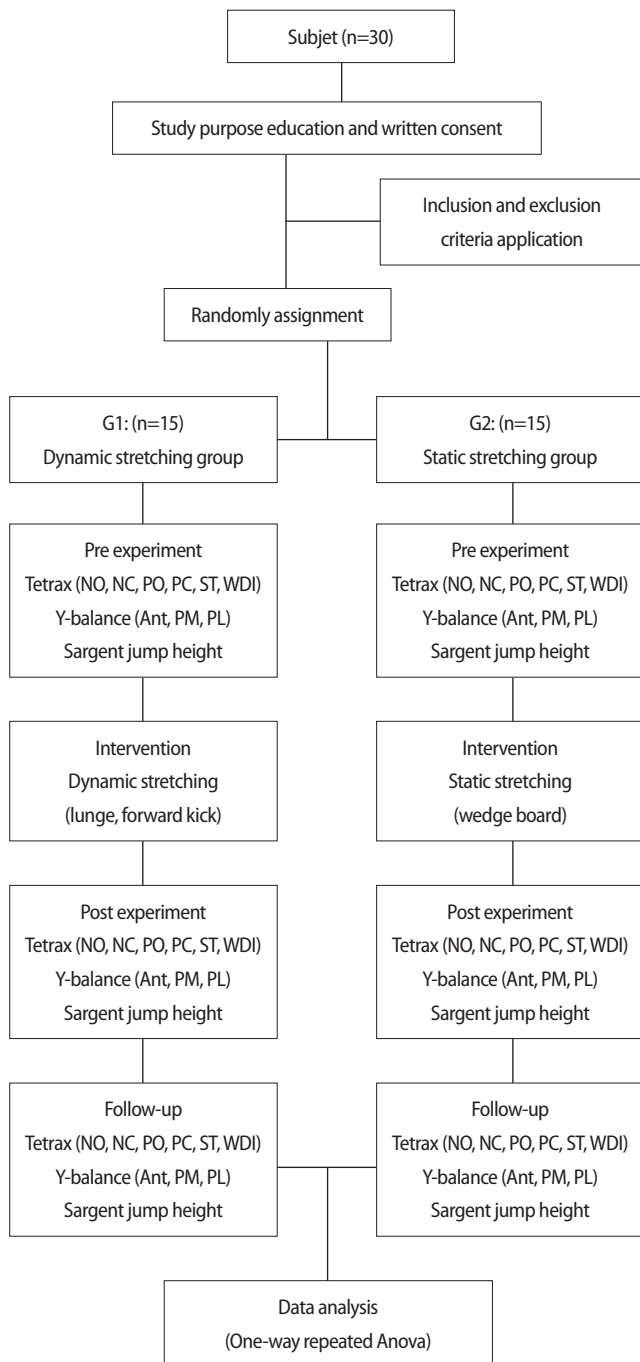


Figure 3. Study flow chart.

ates the static balance control ability by detecting the postural sway on the force plate. Tetrax with eyes open and stable support surface (NO, Normal eye open), eyes closed and stable support surface (NC, Normal eye close), eyes open and unstable support surface (PO, Pillow with eye open). Eyes closed and measurements were taken on an unstable support surface (PC, Pillow with close eye). Each measurement method was measured before and after the experiment, all for 32 seconds. The stability index (ST) and

weight distribution index (WDI) were used for evaluation. The lower the ST and WDI, the higher the balance ability.

3. Experiment procedures

In the process of research, it is the same as Figure 3. The target is divided into a group to which dynamic stretch is applied and a group to which static stretch is applied. Prior to the experiment, all subjects measured their height and weight. The subject measures the static (Tetrax) balance ability and the instantaneous jump (Sargent jump) in the order of follow-up after death in advance. Measure three times for a total of two weeks to provide adequate rest to participants during the measurement and to minimize fatigue. Participants will also perform one stretch and preparatory exercise for 3 minutes to prevent symptoms such as muscle mass and cramps and provide sufficient rest time during the measurement.

4. Statistical analysis

Statistical analysis was performed by using SPSS Statistics software version 23.0 (IBM Co., Armonk, NY, USA). A normality test was performed, and a parametric tests were performed by satisfying normality. One-way repeated ANOVA was used to confirm the difference between before and after intervention and follow-up, and Fisher's LSD (Last Significant Difference) was used for post hoc analysis. Independent t-test was used to compare the differences between groups. Statistical significance was accepted for p values < 0.05.

RESULTS

There was a significant increase in SJH (Sargent jump) in both groups ($p < 0.05$). In Y-balance test, there was a significant increase in both groups except for the ANT direction, and there was a significant increase only in the SS (static stretching) group in the ANT direction ($p < 0.05$). There was no significant difference between the DS (dynamic stretching) group and the SS group ($p > 0.05$). There was no significant improvement in ST and WDI in both groups ($p > 0.05$) (Table 2).

DISCUSSION

In this study, after performing static stretching and dynamic stretching, changes were investigated to improve static balance ability, dynamic balance ability, and instantaneous force. Static stretching was performed by

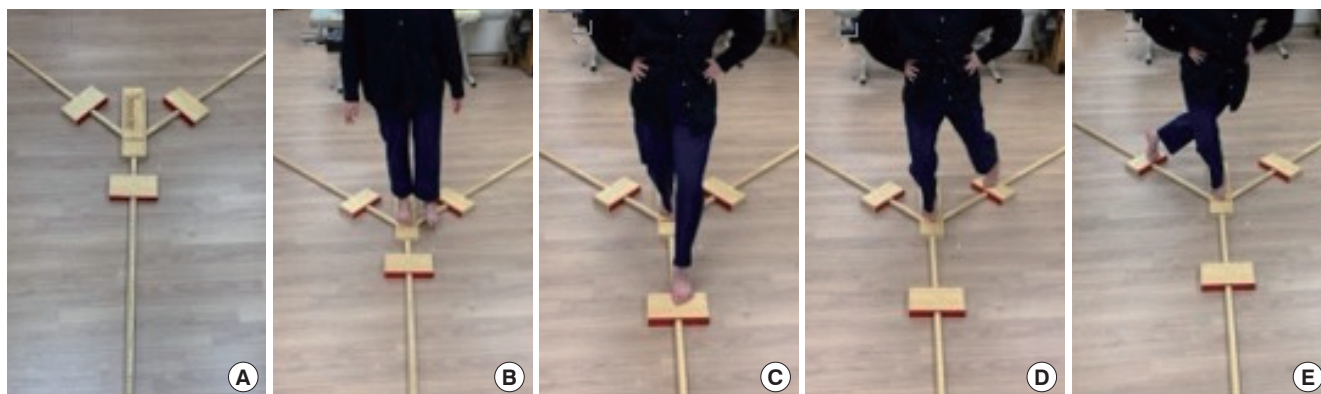


Figure 1. Y-balance. (A) Y- Balance Test Kit, (B) Starting position, (C) Anterior reach using the Y-Balance Test Kit, (D) Posteromedial reach using the Y-Balance Test Kit, (E) Posterolateral reach using the Y-Balance Test Kit.

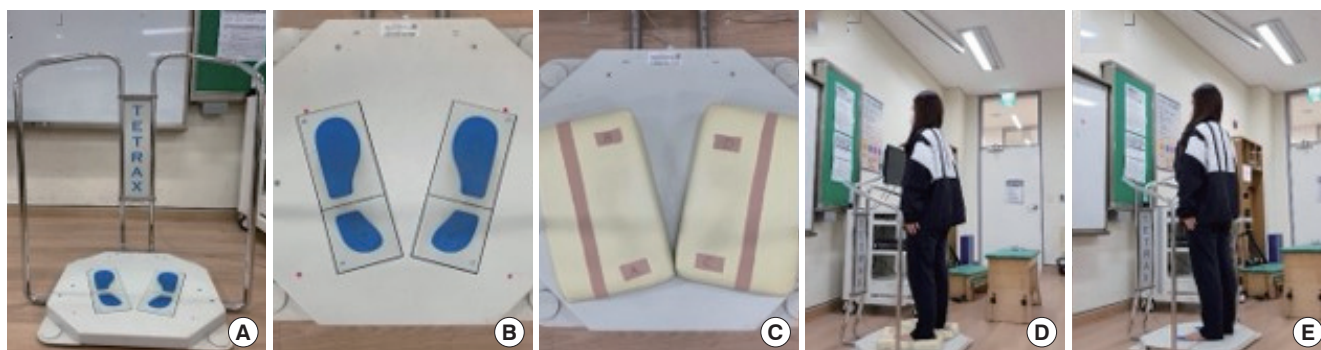


Figure 2. Static balance. (A) Tetrax, (B) Force plate, (C) Tetrax Pillow, (D) Static balance test, (E) Static balance test with pillow.

standing on a wedge board for 9 minutes, dynamic stretching was measured by forward kick and lunge, and instantaneous force was measured by sargent jump. When we looked at and compared previous studies that investigated the improvement of balance and reflexes during static and dynamic stretching, there were some high or low values in young and healthy subjects like our study, but there was no significant difference.

In a study by Yang and Jeong conducted on healthy men in their twenties,⁹ the change in jump height by the stretching method was 44.94 ± 3.58 cm in the dynamic stretch group and 53.32 ± 4.20 cm in the dynamic stretch group. The pattern of results in which the static stretch group woke up and showed a change in height at 46.10 ± 3.02 cm and 49.65 ± 3.57 cm was similar to our study.⁹ The pattern of results showing that stretching in a study by Annino et al. was useful in maintaining muscle performance when making dynamic movements was similar to our study.¹⁰ That is, in this study, the sargent jump value showed a significant difference in both groups after stretching and was maintained even in follow-up. Therefore, the application of static stretch and dynamic stretch seems to have contributed to the improvement of SJH value.

In the study of Suk et al.,¹¹ Functional movement and dynamic balance

ability (Y-balance) ANT, PM, PL values after all exercises are similarly from all directions when compared to our study. However, the pattern of improved PM and PL values after exercise compared to before exercise is similar to our study results.¹¹ In addition, in the study of Smith et al.,¹² the dynamic balance ability was found to be reliable in all directions of ANT, PM, and PL, but in our study, the Ant value showed a significant difference only in the SST group. After stretching in studies such as Oba et al.,¹³ tilting forward as much as possible showed a significant increase in both center of press (COP) position and velocity compared to before stretching. It increased not only ROM but also the forward limit of stability, inducing faster COP movement than before stretching. These results show that static stretching can also improve dynamic postural control, similar to our study.¹³ According to a study by Leblebici et al.,¹⁴ stretching exercise for less than 30 seconds did not have a negative effect on dynamic balance, but stretching exercise for more than 30 seconds had a negative effect on dynamic balance. These results are similar to our study. Therefore, the insignificant ANT value of the DS group in the dynamic balance ability measurement did not provide sufficient rest time and was performed beyond the time during which the stretching effect could be maximized.

Table 2. Comparison of variable values according to intervention

Variable	Group	pre	post	follow-up	F	p
SJH (cm)	DS	30.27±8.43 ^{bc}	36.47±8.75 ^a	35.07±9.04 ^a	6.36	<0.01*
	SS	31.87±11.75 ^{bc}	34.73±10.84 ^a	36.60±13.28 ^a	6.49	<0.01*
ANT (cm)	DS	69.39±11.25	69.91±5.49	70.67±7.65	0.23	0.79
	SS	66.82±6.69 ^{bc}	70.09±6.11 ^a	69.39±5.37 ^a	10.6	<0.01*
PM (cm)	DS	94.46±13.41 ^c	99.20±10.25	103.54±12.31 ^a	5.38	0.01*
	SS	94.60±12.77 ^{bc}	101.88±13.59 ^a	100.59±12.69 ^a	6.54	<0.01*
PL (cm)	DS	101.55±10.64 ^{bc}	107.55±10.33 ^a	109.46±12.10 ^a	6.45	<0.01*
	SS	99.70±9.82 ^b	104.73±11.11 ^a	104.67±10.58 ^a	3.75	0.03*
ST-NO	DS	16.16±12.26	18.89±14.74	14.29±10.00	2.57	0.11
	SS	13.47±5.91	13.54±3.60	12.72±4.86	0.19	0.82
ST-NC	DS	19.17±10.69	19.33±13.56	17.75±5.74	0.18	0.83
	SS	16.68±4.39	17.08±5.21	16.78±4.21	0.06	0.94
ST-PO	DS	18.86±10.97	16.82±6.71	14.92±3.72	1.44	0.27
	SS	15.82±4.44	15.09±4.00	14.39±3.24	1.02	0.37
ST-PC	DS	25.58±10.28	25.98±7.80	27.94±12.16	0.65	0.53
	SS	26.09±5.07	26.09±7.37	26.12±5.05	0.00	1.00
WDI-NO	DS	5.87±3.46	5.84±2.78	6.90±2.28	0.97	0.39
	SS	6.88±2.49	6.23±2.46	5.84±3.75	1.01	0.37
WDI-NC	DS	5.28±2.54	6.42±2.85	5.75±2.74	0.12	0.23
	SS	6.41±2.28	5.44±2.84	5.51±2.80	1.40	0.26
WDI-PO	DS	5.72±2.66	5.81±2.87	5.51±2.76	0.06	0.93
	SS	5.69±2.56	5.43±2.91	4.76±2.85	0.79	0.46
WDI-PC	DS	5.11±2.41	4.65±2.83	4.40±2.06	0.77	0.47
	SS	6.59±2.99	5.39±3.21	4.88±3.07	0.22	0.80

Mean ± SD.

DS: dynamic stretching group, SS: static stretching group, SJH: sargent jump height, ST: Stability Index, WDI: Weight Distribution Index, ANT: Anterior, PM: Posteromedial, PL: Posterolateral, NO: Normal eye open, NC: Normal eye close, PO: Pillow with eye open, PC: Pillow with close eye.

^aStatistically different from pre, ^bStatistically different from post, ^cStatistically different from follow-up.

*p < 0.05.

However, in studies such as Oba et al.,¹³ the improvement in ANT value seems to be more appropriate in the SS group. However, when static stretching was performed, the forward SS group showed a significant difference in PM and PL value in both groups, which seems to be the reason why it is maintained even in follow-up. In conclusion, the degree of improvement in balance ability and instantaneous power after static stretching and dynamic stretching from healthy adults in their twenties was that of ANT, PM, and PL excluding the ANT value of the DS group within the group. Stretching was applied by value, and a significant effect of the result due to the change could be confirmed. In addition, the SJH value was also confirmed to have a significant effect in both the DS and SS groups after applying the stretch. However, after applying the stretch, the static balance ability was not significantly affected by the improvement of the balance ability.

A study by Yuk,¹ who studied healthy adults aged 20 and 30, found that sway distance was more significant than our study when performing a

1-minute standing posture after performing a 15-minute static stretch. However, it showed a 44.78% increase in body sway and reduced static orthostatic stability, similar to our study.¹ Also, in previous studies, before stretching, immediately after stretching, 10 minutes after stretching, 20 minutes after stretching, 30 minutes after stretching, and after applying another break time, muscle activity depended on the break time. It showed a correlation with the flow of time.¹² If this does not provide enough rest time, it seems to be the basis for not seeing significant results in the static balance test. In a study by Alexander and LaPier,¹⁵ patients with low back pain showed reduced limits of stability (LOS) and increased sway in the anterior-posterior, medial, and center of gravity with their anterior-posterior center widened and eyes open compared to healthy individuals. The results form the basis of our research results. In a study by Ruhe et al.,¹⁶ patients with NSLBP (nonspecific low back pain) showed an average rate of COP and increased agitation before and after compared to healthy adults, which underpins our findings. When compared to healthy

individuals in studies such as Oyarzo,¹⁷ patients with low back pain used much more energy to maintain balance and had a greater displacement of the center of pressure. Healthy adults had different results before and after arbitration to maintain balance, but healthy subjects showed significant effects after arbitration to maintain balance only in patients. It is the basis for our research results, which were recruited only by those who were recruited.

In conclusion, both DS and SS showed significant improvement in SJH and Y-balance tests, which are dynamic functions, but had no significant effect on static balance ability. The results of this study can be used as basic data for studies related to dynamic balance control abilities (Sargent jump and Y-balance test) and static balance control abilities.

There are some limitations in this study. First, it is considered that the arbitration period of this study was shorter than that of the previous study and did not bring about a change in the body's balance ability that affected the balance. Secondly, it seems that the activity of muscles that did not provide sufficient rest time was not restored after stretching compared to the previous study. Third, when recruiting subjects, the physical variables of the subjects could not be predicted, and many values exceeded the average of the ST index and WDI values. Fourth, subjects did not follow the tester's instructions correctly and did not significantly affect Tetrax test results. Fifth, when selecting the subjects, we targeted healthy adults, so we could not observe any noticeable improvement in balance. The need for additional research emerges, as there are not many previous papers studying these limitations of balance.

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