Indian Journal of Science and Technology, Vol 9(43), DOI: 10.17485/ijst/2016/v9i43/105033, November 2016
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

The Effects of Circuit Weight Training and Weight Training on Foot Pressure in Healthy Adults

Sumin Lee[1], Jemyung Shim[2]*, Sungjoong Kim[2], Seung Namkoong[2] and Hyolyun Roh[2]

[1]Department of Physical Therapy, Emergency Medical Rehabilitation, Kangwon National University, 346 Hwangjo-ri Dogye-eup Samcheok-si Kangwon-Do, KS007, Republic of Korea; gonyei@nate.com
[2]Department of Physical Therapy, College of Health and Science, Kangwon National University, 346 Hwangjo-ri Dogye-eup Samcheok-si Kangwon-Do, KS007, Republic of Korea; sjm7897@hanmail.net, lymphkim@kangwon.ac.kr, seungnk@kangwon.ac.kr, withtry@kangwon.ac.kr

Abstract

Objectives: This study aims to identify the effects of circuit weight training and weight training on foot pressure. **Methods/Statistical Analysis**: The 20 young participants were divided into a Circuit Weight Training Group (CWTG) and a Weight Training Group (WTC) with ten participants in each group. A gait analyzer was utilized to assess on plantar pressure of subjects. The plantar pressure of ten spots was measured and analyzed. A paired samples t-test was used before and after the exercise in the CWTG and the WTG. **Findings**: This study shows the two groups' changes in plantar pressure after the exercise as compared to before the exercise. The CWTG saw a significant increase in plantar pressure in two of the ten areas (F6, R1) and the WTG saw a significant increase in five of the ten areas (F4, F5, F6, R3, R4). After the four-week exercise program, the WTG's plantar pressure significantly increased in five of the ten areas of the sole, with a significant increase in the middle foot. The CWTG's plantar pressure significantly increased in two of the ten areas of the sole, the great toes and the outer areas of the heels. This means that the CWTG's plantar pressure is closest to the normal movement of plantar pressure. **Improvements/Applications**: The CWTG exercise method resulted in a normal gait pattern, which had a more positive effect on gait than weight exercise.

Keywords: Circuit Weight Training, Foot Pressure, Healthy Adults, Normal Gait Pattern, Weight Training

1. Introduction

Circuit weight training was devised by British researchers Morgan and Adamson. As a training method for improvement in all functions of the body, aerobic and anaerobic exercises are conducted together aimed at improvement of muscle strength and muscle endurance. In addition, circuit weight training is used for overall improvement in physical strength, including musculoskeletal system and cardiopulmonary system. Circuit[1] weight training utilizes small intensity loads and does not include resting between exercises. It is effective for the whole body, including the muscular system, the cardiopulmonary system and the neurological system[2–4].

Weight training is a representative resistance exercise method with short exercise times and high loads. For weight training, resistance exercise tools, such as barbells and dumbbells, are used. This exercise method is used for body building, physical training, muscle strength training and recovery from injuries. Most[5] weight training programs consist of high intensity and low repetition times for enhancing muscle strength[6,7].

Body alignment and muscular balance are important for humans to walk erect. In[5] general, yoga, pilates and weight training, as well as exercises including aerobic elements, such as dance sports, may improve body alignment. And[8–11] improper body alignment may trigger a number of obstacles to ordinary life as well as a bad

*Author for correspondence

appearance; therefore, appropriate treatment and prevention are important[12].

Gait leads to sole pressure distribution according to the structural and functional conditions of the feet and the functions and balance of the human body affect this pressure distribution. Data[13] obtained by measuring plantar pressure are used for evaluation and management of gait as well as foot and lower limb disabilities. They[14] are also utilized to evaluate the overall balance of the body. Accordingly, this study intends to examine the effects of circuit weight training and weight training on plantar pressure and assess how effective such trainings are for improvement in body alignment.

2. Subjects and Methods

2.1 Subjects

The 20 young adults were voluntarily consented to participate in this study and had no problem for congenital deformities, orthopedic disorders and any problems with walking. Before beginning the study, the researchers followed the Declaration of Helsinki guidelines. All test protocols were approved by the institutional review of the physical therapy faculty at Kangwon National University.

The subjects were divided into a Circuit Weight Training Group (CWTG) and a Weight Training Group (WTC) with ten participants in each group. The average age, height and weight of the CWTG were 20.22 years, 167.22 cm and 63 kg, respectively. The average age, height and weight of the WTG were 20.55 years, 162.88 cm and 58.33 kg, respectively (Table 1).

Table 1. General characteristics of subjects

Units	CWTG M±SD	WTG M±SD
Age (yr)	20.22±0.66	20.55±1.01
Sex (M/F)	4/5	4/5
Height (cm)	167.22±9.28	162.88±8.29
Weight (kg)	63±9.98	58.33±7.69

M : Mean, SD : Standard Deviation

2.2 Instrument and Intervention

A gait analyzer was utilized to assess the plantar pressure of the subjects (Tech Storm Inc., Korea). While the subjects walked naturally on a film-type plate (384 mm x 1152 mm), the plantar pressure of ten spots was measured and analyzed. For collection of data on plantar pressure distribution, a software 3.1 version interoperated with a gait analyzer and three measurements were averaged. The exercise program was applied in the exercise treatment and cancer rehabilitation practice room of the Kangwon National University physical therapy department. The exercise was conducted for a total of 35 to 40 minutes per day and stretching was carried out as a warm-up exercise and a cool-down exercise. Before the subjects received training, they were given an explanation and instructions about the exercise events. The program was composed of three days of exercise per week, for a total of four weeks. For circuit weight training, a total of ten events were conducted in the following order: Walking lunges, jumping jacks, stiff dead lifts, air cycles, wide squats, mountain climbers, bridge exercises, running in place and side squat back lunges. For one event, the subjects conducted exercise for 30 seconds and took a rest for 30 seconds before the next event. When one circuit ended among the three circuits the subjects took a dynamic rest for one minute. For weight training, the subjects conducted a total of six events: Lunges, squats, stiff dead lifts, leg presses, leg curls and side lying hip abductions. The exercise load was a 40% intensity of a one-repetition maximum (the maximum weight one individual can raise once). Each subject repeated 12 times per event. Each event was composed of three sets and one minute of rest was given between each set. (Tables 2 and 3).

Table 2. Circuit Weight Training Program

Exercise	Method
Walking lunge	Walk going forward as the front knee bent 90 degrees at the waist in the back of the knee is straightened state makes a body feel touch the ground.
Jumping jack	Doing Jump to the open arms.
Stiff dead lift	During waist and back straightened state Bend forward the body
Air cycle	in the supine position look like by the bike on the air
Wide squat	Spread your legs wider than shoulder width apart and knees bent.
Mountain climber	Prone state in the sense of the knee touches turns to the left or right side of the chest in a bend.

Bridge exercise	In the supine position the hip and knee joint is flexion
Running in place	Doing place running.
Side squat	Spread your legs wider than shoulder width apart and bend one leg by the knee from side to side.
Back lunge	Going to walk back as the front knee bent at 90 degrees at the waist, straighten state falls back knee touches the floor, the body feels.

Table 3. Circuit weight training program

Exercise	Method
Lunge	Bend your front knee to 90 degrees as the waist in the back of the knee is straightened state makes a body feel touch the ground.
Squat	Spread your legs shoulder width apart bend your knees enough.
Stiff deadlift	During waist and back straightened state Bend forward the body
Leg press	Sit on the leg press machine and knee extension.
Leg curl	Sit on the leg cur machine and knee flexion.
Side lying hip abduction.	In the side lying position bind the band on the ankle joint and hip abduction.

2.3 Data Analysis

The SPSS v20 statistical program was used for statistical analysis of this study and the average and standard deviation of each item was calculated. A paired samples t-test was conducted in order to comparatively analyze differences between prior to the exercise and after the exercise in the CWTG and the WTG. A significance level was set at $p < .05$.

3. Results

Table 1 shows the two groups' changes in plantar pressure after the exercise as compared to before the exercise. The CWTG saw a significant increase in plantar pressure in two of the ten areas (F6, 27.81±8.79 Kpa to 36.81±10.93 Kpa; R1, 34.81±12.04 Kpa to 48.63±13.96 Kpa) and the WTG saw a significant increase in five of the ten areas (F4, 20.71±6.16 Kpa to 29.34±9.78 Kpa; F5, 47.14±9.95 Kpa to 57.63±10.19 Kpa; F6, 21.16±9.54 Kpa to 30.01±8.37 Kpa; R3, 18.04±8.96 Kpa to 38.19±13.27 Kpa; R4, 0.80±0.87 Kpa to 4.91±5.87 Kpa). (Table 4).

Table 4. Comparison of foot pressure distribution between pre-test and post-test in each group (Unit: % N/cm^2)

Region	Group	Pre-test	Post-test	
F1	CWTG	1.80±1.79	1.84±2.24	
	WTG	1.93±1.92	1.34±1.32	
F2	CWTG	11.67±3.99	11.36±3.99	
	WTG	11.26±5.53	13.50±5.69	
F3	CWTG	15.96±6.50	17.48±5.71	
	WTG	14.41±8.58	11.83±4.26	
F4	CWTG	20.12±11.51	25.43±4.04	
	WTG	20.71±6.16	29.34±9.78	*
F5	CWTG	55.78±16.44	60.23±9.20	
	WTG	47.14±9.95	57.63±10.19	*
F6	CWTG	27.81±8.79	36.81±10.93	*
	WTG	21.16±9.54	30.01±8.37	*
R3	CWTG	25.82±18.74	29.21±12.64	
	WTG	18.04±8.96	38.19±13.27	*
R4	CWTG	0.69±0.70	2.91±3.62	
	WTG	0.80±0.87	4.91±5.87	*
R1	CWTG	34.81±12.04	48.63±13.96	*
	WTG	25.28±16.13	40.61±23.12	
R2	CWTG	64.98±30.32	95.69±34.69	
	WTG	78.52±55.39	102.19±30.79	

CWTG: Circuit Weight Training Group, WTG: Weight Training Group

4. Conclusion

Circuit weight training and weight training are exercise methods anyone can conduct economically. Prior research on their effects has focused on exercise performance ability, muscle strength, vital capacity, body fat rate, body composition and physical constitution and physical strength, but[15–17] there has been no research on plantar pressure by body alignment.

After the four-week exercise program, the WTG's plantar pressure significantly increased in five of the ten areas of the sole, with a significant increase in the middle foot. The CWTG's plantar pressure significantly increased in two of the ten areas of the sole, the great toes and the

outer areas of the heels. In general, ideal movement of plantar pressure during gait is from the outer area of the heels to the great toes. This means that the CWTG's plantar pressure is closest to the normal movement of plantar pressure.

In[18] healthy subjects conducted deep trunk muscle exercises and then their plantar pressure was comparatively analyzed. The result was that plantar pressure of the great toe areas and outer heels significantly increased. Their result is similar to the CWTG's plantar pressure movement pattern found in the present study. The CWTG exercise method resulted in a normal gait pattern, which had a more positive effect on gait than weight exercise.

This study involved male and female adults in their 20s and therefore has limitations with regard to generalizing its results. However, it is expected that based on the results of this study, circuit weight training including aerobic elements may be utilized as an exercise program for improvement in body alignment.

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