

# EMG Comparison of Selected Thigh Muscles and Gluteus Maximus Using the Arc Trainer, Stairstepper, and Treadmill

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## Abstract

**Background:** The ArcTrainer (AT), stairstepper (SS), and treadmill (TM) are commonly used in both the rehabilitative and fitness industry to increase lower body strength and improve cardiovascular function. No research was found comparing muscle activity while using the AT to the SS and TM.

**Purpose:** The purpose of this study was to compare peak muscle activity of the rectus femoris (RF), vastus lateralis (VL), vastus medialis (VM), biceps femoris (BF), and gluteus maximus (GM) when using the AT, SS, and TM

**Methods:** The subjects consisted of 20 young and apparently healthy individuals (males n=10, 26.6±3.1 yrs, 183.3±6.1 cm, 92.6±11.1 kg) and (females n=10, 24.6±1.8 yrs, 165.3±5.5 cm, 65.5±13.6) reporting no current pain or any lower extremity injury occurring in the past year. Surface electrodes were placed on the right lower extremity over the muscle bellies of the RF, VL, VM, BF, and GM using topographical location. An electrical goniometer was placed over the lateral aspect of the subject's right knee. Using a hand held dynamometer (HHD), subjects performed two maximum voluntary isometric contractions (MVIC) for three seconds while EMG was recorded. The highest HHD value was used for data analysis. Subjects were given a demonstration and received instruction on proper use of each exercise device. The order of performance on the exercise devices were determined by random drawing. After subjects demonstrated proper technique on each exercise device for one minute, EMG activity was recorded for 30 seconds. Subjects received a three minute rest break after each exercise device. Comparisons were made using repeated measures ANOVAs.

**RESULTS:** There were no statistically significant differences in the RF (SS=47.7%, TM=53.5%, AT=74.7%) among the three exercise devices. The TM provided significantly lower activity in the VM (TM=50.99%, SS=122.45%, AT=127.98%) and VL (TM=34.65%, AT=109.53%, SS=133.82%). The SS provided significantly lower activity in the BF (SS=39.9%, TM=102.2%, AT=156.94%) and GM (SS=32.13%, TM=50.0%, AT=62.99%).

**CONCLUSION:** The GM did not have sufficient load to cause a strengthening effect. The SS and AT could provide a strengthening effect for the VM and VL. The TM and AT could provide a strengthening effect for the BF. The AT could provide a strengthening effect for the RF.

## Background

The Cybex Arc Trainer (AT), stair stepper (SS), and treadmill (TM) are commonly used to improve cardiovascular performance. However, these devices may utilize the muscles of the thigh differently. They may provide sufficient resistance to affect the strength of lower limb muscles.

We performed an EMG study to determine the different contraction amplitudes of five thigh muscles while exercising on the three devices. Studies have determined that strengthening effects can occur when muscle activity reaches at least seventy percent of the MVIC (1, 2)

Twenty young and apparently healthy males (10) and females (10) exercised on the AT, SS, and TM. We placed surface electrodes on the rectus femoris (RF), vastus lateralis (VL), vastus medialis (VM), biceps femoris (BF), and gluteus maximus (GM) to determine the electrical activity produced by these muscles while using the 3 devices.

Resistance settings on each device were determined by having each subject exercise at a level within a target heart rate range and subjective rating of perceived exertion. A metronome was used to set the pace for each exercise device. Prior to testing, each subject was assigned an order in which to use each exercise device by random drawing.

### Instrumentation:

A Telemyo 2400T electromyography (EMG) system was used to collect, amplify, and process the electrical signals. Ag-AgCl surface electrodes were applied to the bulk of each muscle. An electrogoniometer was placed on the lateral aspect of the knee to measure joint position during the activity. A Microfet dynamometer was used to determine the maximum voluntary isometric contraction (MVIC). The MVIC value provided a standard for comparison among the muscles.



Arc Trainer



Stepper



Treadmill

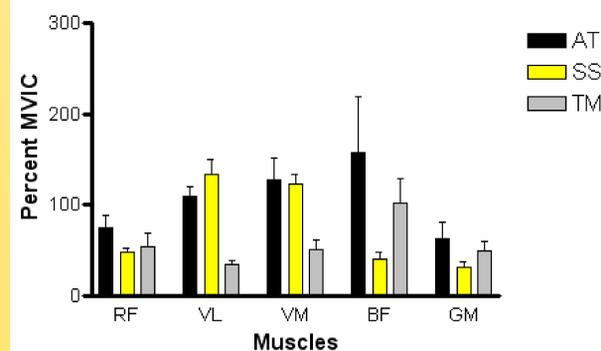
## Results

### Mean % of MVIC and standard deviation of five thigh muscles using the three exercise devices

	n	AT X ± sd	SS X ± sd	TM X ± sd
RF	20	74.7 ± 63.6	47.7 ± 24.6	53.5 ± 67.6
VL	20	109.5 ± 51.0	133.8 ± 75.1	34.6 ± 22.3
VM	20	127.9 ± 107.8	122.4 ± 48.5	50.9 ± 50.7
BF	20	156.9 ± 275.4	39.9 ± 34.3	102.2 ± 120.3
GM	20	62.9 ± 78.3	32.1 ± 23.8	50.0 ± 43.1

MVIC- Maximum Voluntary Isometric Contraction  
AT-Arc Trainer; SS-Stair stepper; TM- Treadmill;  
RF- Rectus femoris; VL- Vastus lateralis; VM- Vastus medialis;  
BF-Biceps femoris; GM- Gluteus maximus

### Percent MVIC for EMG of Five Muscles on Three Exercise Devices



The exercise devices provided different muscle activity levels for four of the thigh muscles studied. No significant difference among the exercise devices was found for the RF (AT=74.7 ± 63.6 %, SS=47.7 ± 24.6%, TM=53.5 ± 67.6%). The VM and VL produced similar electrical activity during the AT and SS exercises (VM: AT=127.98 ± 107.8% and SS=122.4 ± 48.5%; VL: AT=109.5 ± 51.0%, SS=133.8 ± 75.1%), but significantly less electrical activity during the TM exercise (VM =50.99 ± 50.7%; VL =34.6 ± 22.3%). The BF produced the greatest electrical activity during the AT (156.9 ± 275.4%), less electrical activity during the TM (102.2 ± 120.3%), and the least electrical activity during the SS (39.9 ± 34.3%). Similarly, the GM had the greatest electrical activity during the AT exercise (62.99 ± 78.3%), less during the TM exercise (50.0 ± 43.1%) and least during the SS exercise (32.1 ± 23.8%).

## Conclusion

At the settings used for this study, the SS and AT could provide a strengthening effect for the VM and VL. The TM and AT could provide a strengthening effect for the BF. The strengthening effect is greater with use of the AT than that of the TM. The AT appears to be the only device able to provide a strengthening effect for the RF. The GM did not have sufficient load to result in a strengthening effect with any of the devices used.

## References

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