

The effects of multisensory exercise on foot pressure sensitivity, balance for the elderly

*Ji-Eun Kang, *Kyung-Ock Yi
**Teoh Jee Chin, **Taeyong Lee

**Division of Human Movement Studies, Ewha Womans University, Seoul, Korea*
***National University of Singapore, Division of Bioengineering Faculty of Engineering,
Singapore*

jieunkang@ewha.ac.kr

ABSTRACT

The purpose of this study is to investigate the effects of multisensory exercise on foot plantar pressure sensitivity and balance. 17 women from an elderly residence program in Seoul served as subjects for this study. 11 women served as the exercise treatment group, 6 women were the control group, and they did not exercise at all. Independent variable was multisensory exercise with multidirectional exercise equipment. Multisensory exercise program developed include proprioceptive, vision, and vestibular system. Dependent variables were Plantar Pressure Sensitivity (The sub-Metatarsal Pad Elasticity Acquisition Instrument, MPEAI) and balance test (MFT S3 Balance Test). Pre and post test results for the 12 week period were compared using the independent, paired t-test with repeated measures via PASW 18.0. There appears to be a correlation between plantar pressure sensitivity and balance. Multisensory exercise can help prevent falls while increasing the capability for daily life activity amongst the elderly.

1. PURPOSE

The purpose of this study is to investigate the effects of multisensory exercise on foot plantar pressure sensitivity, balance.

2. METHODS

2.1. Subjects

17 women from an elderly residence program in Seoul served as subjects for this study. 11 women served as the exercise treatment group, 6 women were the control group, and they did not exercise at all.

Table 1. Subjects

| | | 1. Ages(yr) | 2. Weights(kg) |
|----------|------|-------------|----------------|
| Exercise | Mean | 82.91 | 49.88 |
| (n=11) | ±SD | ±4.09 | ±4.64 |

| | | | |
|---------|------|-------|--------|
| Control | Mean | 83.33 | 54.17 |
| (n=6) | ±SD | ±6.38 | ±11.97 |

2.2. Variables

Table 2. variables

| variable | item | contents |
|----------------------|--|---|
| Independent variable | Multisensory exercise program | 1. Proprioceptive 2. Visual 3. Vestibular |
| Dependent variables | Plantar pressure sensitivity (Soft Tissue) (Chen et al., 2011), | Foot positioned on the MPEAI system 1. Hallux: 0° 2.(2 nd MTH): 0°,20°,40° 3.Heel: 0° |
| | Balance test | MFT Balance test V1.7 1. Back and Forth, 2. Right and Left |

2.3. Multisensory exercise program

2.3.1. Proprioceptive system

- A. Upper body (water bag and ball)
- B. Lower body (surfaces, and ball)
- C. Tung exercise

2.3.2. Vestibular system

- A. Lower body (Surfaces)
- B. Change direction
- C. Change head
- D. Closed eyes on ky boulder
- E. Contents and principles of a multisensory balance exercise program

2.3.3. Visual system

- A. Close & open eye
- B. Eye tracking

2.3.4. Steps for Multisensory exercise (Yi,2010)

This study used variations of three different exercises to stimulate the somatosensory, visual, and vestibular systems. The first exercise involved walking and moving with a 500 ml water-filled weight. The second exercise involved seated self-massage with a knobbed, air-filled ball. The last exercise was visual tracking from a variety of positions.

2.3.5. Developing exercise program

-From easy to moderate & advanced gradually-

- A. Body segments
 - From one to more.

- B. Center of gravity
 - from lower to higher
 - from proximal to distal
- C. Base of support
 - from wider to narrower
- D. Direction
 - from sideward to upward, backward, and etc.
- E. Velocity
 - from slower to faster
- F. Blindfold
 - from eyes open to eyes closed
- G. Load
 - from light to heavy

3. RESULTS

Table 3. Paired t-test analysis for plantar pressure sensitivity for control group

| | Mean | ±SD | t | df | P |
|-------------------------------------|---------|---------|-------|----|------|
| Hallux_0 -12weeks | 82.03 | ±264.96 | .76 | 5 | .482 |
| Heel_0-12weeks | -209.56 | ±463.78 | -.78 | 2 | .516 |
| 2 nd MTH 0°-12weeks | 21.11 | ±34.59 | 1.06 | 2 | .401 |
| 2 nd MTH 20°_0 -12weeks | 61.83 | ±87.45 | 1.00 | 1 | .500 |
| 2 nd MTH 40°_0 - 12weeks | -123.67 | ±187.81 | -1.32 | 3 | .279 |
| Hallux_0 - 6weeks | 5.83 | ±101.77 | .15 | 6 | .885 |
| Heel_0-6weeks | -69.47 | ±139.35 | -.86 | 2 | .479 |
| 2 nd MTH 0°_0 - 6weeks | -20.20 | ±22.22 | -1.82 | 3 | .167 |
| 2 nd MTH 20°_0 - 6weeks | -84.65 | ±233.11 | -.73 | 3 | .520 |
| 2 nd MTH 40°_0-6weeks | -41.91 | ±220.66 | -.38 | 3 | .729 |

*p<.05, **p<.01

Table 4. Paired t-test analysis for plantar pressure sensitivity for exercise group

| | Mean | ±SD | t | df | P |
|------------------------------------|--------|---------|------|----|--------------|
| Hallux_0 -12weeks | 176.00 | ±157.89 | 3.15 | 7 | .016* |
| Heel_0-12weeks | 226.24 | ±186.40 | 2.71 | 4 | .053 |
| 2 nd MTH 0°-12weeks | 16.59 | ±230.88 | .14 | 3 | .895 |
| 2 nd MTH 20°_0 -12weeks | 180.94 | ±249.04 | 1.62 | 4 | .180 |

| | | | | | |
|-------------------------------------|---------|---------|------|---|---------------|
| 2 nd MTH 40°_0 - 12weeks | -100.00 | ±575.00 | -.35 | 3 | .751 |
| Hallux_0 - 6weeks | 124.71 | ±137.23 | 2.87 | 9 | .018* |
| Heel_0-6weeks | 186.84 | ±92.56 | 5.71 | 7 | .001** |
| 2 nd MTH 0°_0 - 6weeks | 66.07 | ±74.11 | 2.36 | 6 | .056 |
| 2 nd MTH 20°_0 - 6weeks | 161.85 | ±254.87 | 1.80 | 7 | .116 |
| 2 nd MTH 40°_0-6weeks | 204.64 | ±159.13 | 3.15 | 5 | .025* |

*p<.05,**p<.01

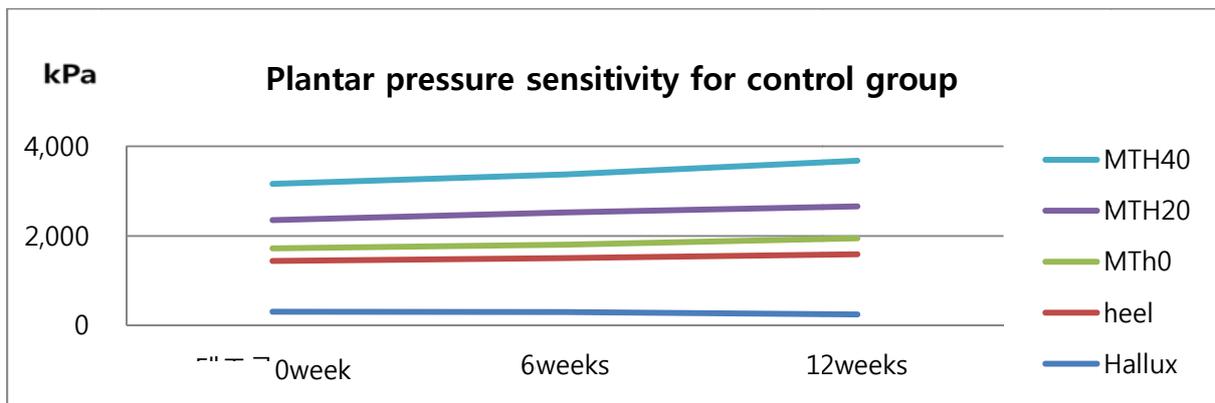


Fig 1. Plantar pressure sensitivity for control group

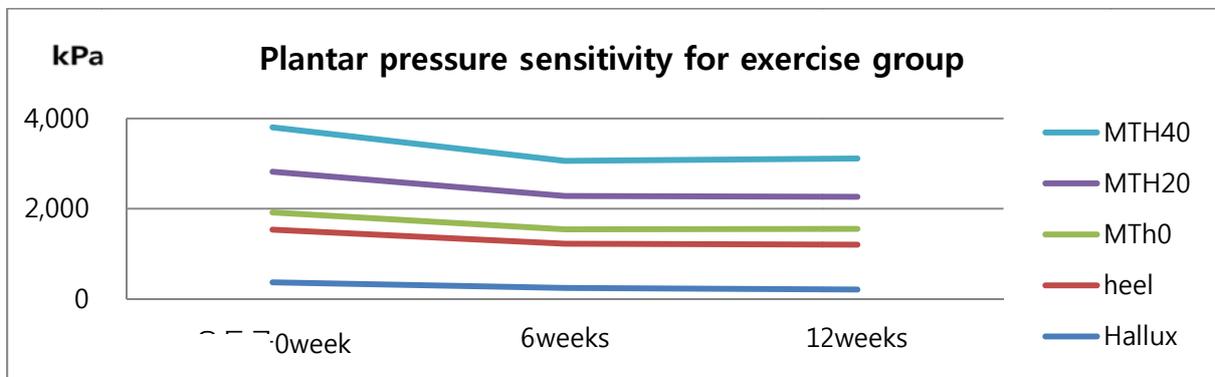


Fig 2. Plantar pressure sensitivity for exercise group

Table 5. Paired t-test analysis for MFT Balance test for control group

| | Mean | ±SD | t | df | P |
|-----------------------|---------|---------|--------|----|------|
| Balance RL pre - post | .16667 | ±.57155 | .714 | 5 | .507 |
| Balance FB pre - post | -.83333 | ±.85946 | -2.375 | 5 | .064 |

*p<.05,**p<.01

Table 6. Paired t-test analysis for MFT Balance test for exercise group

| | Mean | ±SD | t | df | P |
|-----------------------|--------|---------|-------|----|------|
| Balance RL pre - post | .32727 | ±.68715 | 1.580 | 10 | .145 |
| Balance FB pre - post | .00909 | ±.63789 | .047 | 10 | .963 |

*p<.05,**p<.01

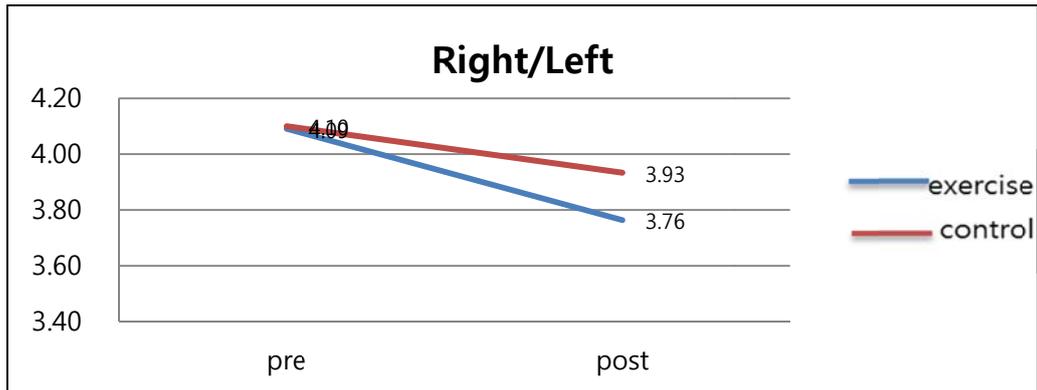


Fig 3. MFT Balance test of Right and Left

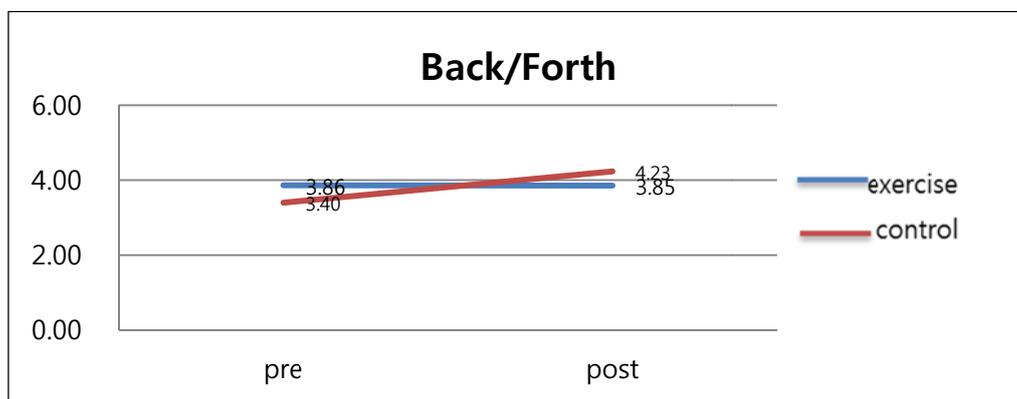


Fig 4. MFT Balance test of Back and Forth

4. CONCLUSIONS

There appears to be a correlation between plantar pressure sensitivity and balance. Multisensory exercise can help prevent falls while increasing the capability for daily life activity amongst the elderly.

REFERENCES

- Kyung Ok Yi.(2009), "The effect of the five-toed shoe on foot pressure distribution." *Korean Physical Education Association for Girl and Women*, **23**(4), 35-44.
- Kyung Ok Yi.(2010), "The effects of shoe type on plantar pressure distributions." 2010 NACK: Northeast Asia Conference on Kinesiology. KACEP 11th Annual Meeting. Seoul. Korea.
- Wen-Ming Chen, Victor Phyu-WuiShim, Seung-BumPark, TaeyongLee (2011), "An instrumented tissue tester for measuring soft tissue property under the metatarsal heads in relation to metatarsophalangeal joint angle." *Journal of Biomechanics* **44** (2011) 1801–1804.