KJSB

Korean Journal of Sport Biomechanics 2016; 26(2): 213-220
http://dx.doi.org/10.5103/KJSB.2016.26.2.213
http://e-kjsb.org eISSN 2093-9752

ORIGINAL

Effects of ProBody Massage on Body Alignment and Plantar Pressure Balance in Middle-aged Men with Musculoskeletal Diseases

Se-Jin Oh[1], Joong-Sook Lee[2]

[1]Department of Physical Education, Graduate School of Education, Silla University, Busan, South Korea
[2]Department of Kinesiology, College of Health and Welfare, Silla University, Busan, South Korea

Received : 06 January 2016
Revised : 05 February 2016
Accepted : 06 April 2016

Corresponding Author
Joong-Sook Lee
Department of Kinesiology, College of Health and Welfare, Silla University, 140, Baekyang-daero 700beon-gil, Sasang-gu, Busan, 46958, South Korea
Tel : +82-51-999-5064
Fax : +82-51-999-5576
Email : jslee@silla.ac.kr

Objective: The purpose of this study was to investigate the effect of an 8-week ProBody massage program on body alignment and plantar pressure balance in middle-aged men with musculoskeletal diseases.

Method: The subjects of this study were 20 middle-aged men with musculoskeletal diseases in B Metropolitan City who participated in an 8-week ProBody massage program conducted twice a week. Physical characteristics (height, weight, and body mass index), body alignment, and plantar pressure were assessed before and after the experiment.

Results: The 20 middle-aged men with musculoskeletal diseases who underwent the ProBody massage program showed positive changes in physiological characteristics, body alignment, and plantar pressure balance.

Conclusion: Consequently, the 8-week ProBody massage program was suggested to be effective for improving and preventing postural imbalance in middle-aged men with musculoskeletal diseases. The ProBody massage program could also be utilized to improve the body alignment and plantar pressure balance in middle-aged women with musculoskeletal diseases.

Keywords: ProBody massage program, Musculoskeletal diseases, Physical characteristics, Body alignment, Plantar pressure

INTRODUCTION

In this era, the middle-aged can be considered central to the overall advancement of society, as they provide a driving force for society as a whole (Jung, 2013). Inspection of recent demographics in South Korea revealed a gradual increase in the proportion of middle-aged men within the total population. According to data from Statistics Korea, the middle-aged population of 40- to 59-year-olds in 2010 was 14.76 million, which was about 30% of the total population, and the number of middle-aged men was 7.36 million, which was approximately 15% of the total population (Statistics Korea, 2013).

Recently, the incidence of factors threatening the health of middle-aged men, such as overwork, stress, smoking, and excessive alcohol consumption, has increased. These factors elevate the risk of hypertension, diabetes, and musculoskeletal diseases. In particular, office workers are known to develop more musculoskeletal diseases if they sit at a computer for long periods with incorrect posture (Lee, 2007; Ong, Chia, Jeysratnam, & Tan, 1995). Since musculoskeletal diseases became recognized as work-related disease in 1996, their incidence has steadily increased (Jeong, 2010), as has the proportion of total work-related diseases accounted for by musculoskeletal diseases. Consequently, systems to prevent musculoskeletal disease were introduced in 2003 for the benefit of business owners and workers alike (Seo, 2012). In 2009, musculoskeletal diseases accounted for 2,915 (33.4%) of 8,721 cases of work-related disease (Kim, Hwang, & Suk, 2013).

Musculoskeletal diseases occur when the body is maintained in an unbalanced state, such as when sitting with poor posture in a chair for long periods (Hwang, 2012). Habitual poor posture causes deformity of the spine and gradual development of pain, eventually causing difficulties in activities of daily living (Im, 2003). Owing to a lack of awareness about the importance of posture, the number of people with low back pain (LBP) and other spinal diseases is increasing. In particular, LBP, as the most common spinal disease in South Korea, has grown beyond a personal health issue to become a societal issue as a whole. In 2000, the Ministry of Health and Welfare reported that the production loss due to LBP was 1.3072 trillion KRW (Ministry of Health and Welfare, 2000). With the spine at the center, our bodies should be balanced with left-right symmetry of the shoulders, pelvis, and lower limbs. When the proper posture is not maintained, this leads to a state of physical imbalance.

Physical imbalance can generate pain and imbalance of the lower limbs, causing problems in the position of the feet or legs, or can cause

Copyright © 2016 Korean Journal of Sport Biomechanics
This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (http://creativecommons.org/licenses/by-nc/3.0/) which permits unrestricted noncommercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

the body to lean to one side or twisting of the pelvis (Cho, 2010). A stable posture impacts coordination, gait, and various joints, and musculoskeletal structure in the upper and lower limbs. Balance of the feet has a direct influence on walking, so it is particularly emphasized when increasing gait stability (Choi & No, 2011). Hence, balance of the feet is closely related to balance of the body (Eric, 2005). Plantar pressure measures the balance of the feet via the pressure applied by the foot as a whole or by specific parts of the foot (Dowling, 2001), making it possible to also examine postural balance and gait state (Jahss, 1982).

Various studies have been conducted in order to improve postural and plantar pressure imbalance statuses. Choi (2012) reported that proprioceptive neuromuscular facilitation (PNF) stretching has a positive effect on postural change, trunk lean, and lateral deviation, whereas balance exercise programs were reported to improve posture, physical balance, and gait ability (Moon, Jeong, Park, Kim, & Park, 2014). In a report by Son, Lee, and Kim (2014), the upright body-type exercise program was effective for improving sense of balance, while Park, Song, and Lee (2015) reported that passive body alignment exercise is effective for improving plantar pressure balance. In addition, Park (1999) reported that massage, rather than exercise, reduced pain, increased muscular endurance, and was effective for restoring proper posture and flexibility. Nevertheless, research is lacking on using diverse methods, including massage, to improve postural balance in middle-aged men with musculoskeletal disease.

Massage in general began as a means of resolving physical pain and discomfort in a specific area (Kim, 2013). Massage is not only effective for reducing pain, improving muscular endurance, and restoring proper posture and flexibility (Park, 1999) but also has proven efficacy at improving joint range of motion (ROM) and motor function (Hermandez-Rief et al., 2005), enhancing basic motor control, and relieving chronic pain (Mckearnan & Kimberly, 2004). As the application of massage has become more widespread, forms of scientific, therapeutic massage are being developed for the whole body, including not only the nervous system, but also the skeletal, muscular, vascular, and circulatory systems (Lim, No, & Kim, 2004). ProBody massage can be considered one type of therapeutic massage. It is a rehabilitative massage developed by Kim (2015) by applying the upright body type exercise program (Kim, 2013), which was designed to maintain an upright body posture through spinal and skeletal alignment. ProBody massage is effective for musculoskeletal alignment and activating circulatory function. According to a study by Kim (2015), in children with a grade 1 neurological disorder, ProBody massage aligned the spine and joints, and aided traction and relaxation of stiff muscles, and thereby improved large movements and joint ROM.

In this study, a ProBody massage program was implemented in middle-aged men with musculoskeletal disease who were residing in B Metropolitan City. The Shisei Innovation System and Foot Checker System were used to investigate the impact of the intervention on postural alignment and plantar pressure balance, with the aim of providing basic data for improving plantar pressure balance and body type in middle-aged men.

RESEARCH METHODS

1. Selection of the subjects

This study evaluated 20 middle-aged men (30~49 years old) with musculoskeletal disease who were residing in B Metropolitan City. The subjects were men with no prior experience with the ProBody Massage Program who had musculoskeletal disorders, who had a score of at least 5 on a subjective pain scale (visual analogue scale [VAS]), and who had given willful written consent to participate in the experiment after hearing a thorough explanation of its objectives and procedures (Table 1).

Table 1. Physical characteristics of the subjects

Subjects	Age (yr)	Height (cm)	Weight (kg)	BMI (kg/m^2)	VAS
n = 20 (mean ± SD)	38.10 ± 6.88	173.07 ± 6.39	76.56 ± 11.38	25.45 ± 3.10	6.70 ± 1.81

2. Measured variables and methods of analysis

In order to investigate the effect of ProBody massage on postural alignment and plantar pressure in middle-aged men with musculoskeletal disease, a ProBody massage program was implemented for 60 minutes per session, 2 sessions per week, for 8 weeks (a total of 16 sessions). Prior to measurements and the ProBody massage, all the subjects were made to wear identical cotton T-shirts and training pants. Height, weight, body mass index (BMI), posture, and plantar pressure were measured in a stationary standing position before and after the intervention.

1) Physical characteristics

An automated height and weight scale (DS-102, Dong Sahn Jenix, Seoul, South Korea) was used to measure height and weight. BMI was calculated from these measurements. BMI was calculated by dividing weight by the square of height (weight [kg]/height squared [m^2]).

2) Measuring postural alignment

Posture was measured by using a whole-body posture analysis system (Shisei Innovation System PA200). This system is used to collect data from plantar pressure sensors and to analyze body weight distribution and whether body weight distribution and balanced physical alignment are being maintained. In addition, it allows measurement of posture from 4 directions and analysis of angles of tilt at the neck and pelvis, height differences in the pelvis and shoulders (mm), genu varum and genu valgum, and rotation of the upper and lower body. Furthermore, the device can be used for examining three-dimensional posture and body type, for making comparisons after body type correction, and for planning postural correction therapy.

A physical alignment measurement closer to 0 indicates that the center of gravity and center of postural alignment are in the correct positions. Hence, a value closer to 0 for anterior-superior iliac spine-posterior-superior iliac spine can be interpreted as better postural alignment.

The method for measuring body type is shown in Table 2, and the Shisei Innovation System is shown in Figure 1.

Table 2. Body alignment measurement

	Measuring items	Measurement point
Pelvis	Anterior-superior iliac spine (ASIS)	Front body projection of the iliac bone
Knee	Front lower body	Center of the patella

Figure 1. Shisei innovation system PA200

3) Measuring plantar pressure

Plantar pressure was measured by using a plantar pressure measurement device (GHF-550, G.Hi. Well, South Korea). Assessment was made relative to a standard of 50:50, with plantar pressure and foot balance located over the center. The measurement variables and methods are displayed in Table 3, and Figures 1~3.

Table 3. Plantar pressure

Subjects	Measurement
Plantar balance	Standing up over the whole-foot pressure measurement sensors
Right foot pressure	Standing up over the right foot pressure measurement sensors
Left foot pressure	Standing up over the left foot pressure measurement sensors

3. ProBody massage program

The ProBody massage program used in this study is a rehabilitative massage program developed by Kim (2015) by applying the upright body-type exercise program (Kim, 2013), which was designed to maintain an upright posture through spinal and skeletal alignment. The massage was conducted by a professional upright-body exercise instructor with a ProBody massage certificate, and a single practitioner implemented directly the ProBody massage to all the subjects. The subjects wore cotton training outfits during the massage. The massage was applied by using the method of Jeong (2009). The massage intensity was sufficient to induce a pain intensity of 1~7 (mild-moderate) in weeks 1~4 and 7~9 (mild-severe) in weeks 5~8. The subject's condition and subjective pain index were checked prior to each massage session, and the massage intensity was adjusted according to the extent of

Figure 2. Foot checker

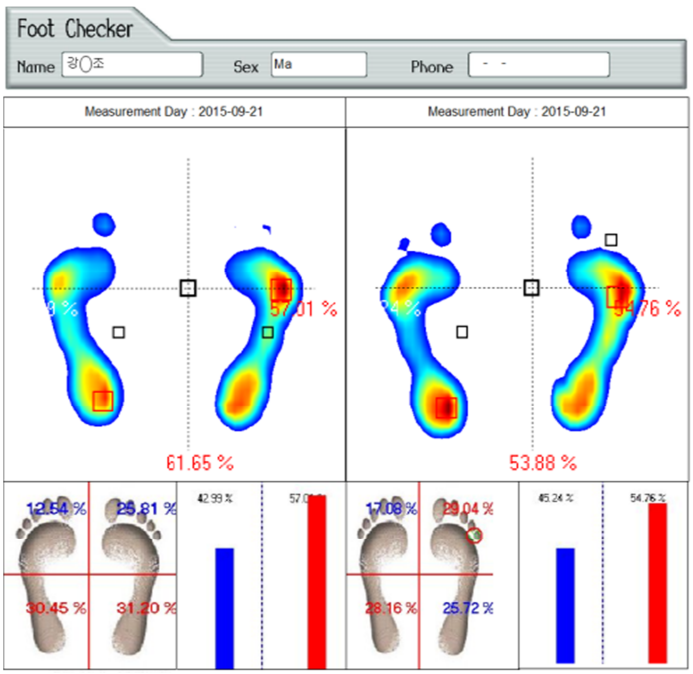

Figure 3. Plantar pressure

Table 4. ProBody massage program (1~4 weeks/5~8 weeks)

Subject position	Massage contents	Massage frequency	Massage strength	Duration
1- to 4-week program/5- to 8-week program				
Supine position	Cervical portion massage 1	3 points, 3 times, 1 set/2 sets	1~4 weeks Pain Stimulation Strength 1~7 (weak–middle) / 5~8 weeks Pain Stimulation Strength 7~9 (middle-strong)	60 min
	Laryngeal muscle massage	2 points, 3 times, 1 set/2 sets		
	Trapezius muscle massage 1	3 points, 3 times, 1 set		
	Hip joint massage 1	3 points, 3 times, 1 set		
	Quadriceps muscle of the thigh	4 points, 3 times, 1 set		
	Knee joint massage	3 points, 3 times, 1 set		
	Hip joint massage 2	3 points, 3 times, 1 set		
	Front crural muscle massage 1	3 points, 3 times, 1 set		
	Front crural muscle massage 2	2 points, 3 times, 1 set		
Prone position	Back massage 1	3 points, 3 times, 1 set		
	Back massage 2	3 points, 3 times, 1 set		
	Scapula massage	3 points, 3 times, 1 set		
	Back massage 1	3 points, 3 times, 1 set		
	Back massage 2	3 points, 3 times, 1 set		
	Hip massage	1 points, 3 times, 1 set		
	Biceps muscle of the thigh	3 points, 3 times, 1 set		
	Back crural muscle massage	3 points, 3 times, 1 set		
	Ankle massage 1	1 point, 3 times, 1 set		
	Ankle massage 2	3 points, 3 times, 1 set		
	Ankle massage 3	1 point, 3 times, 1 set		
Supine position	Chest massage	1 point, 3 times, 1 set		
	Cervical portion massage 2	1 point, 3 times, 1 set/2 sets		
	Cervical portion massage 1	3 points, 3 times, 1 set/2 sets		
	Laryngeal muscle massage	2 points, 3 times, 1 set		
	Arms massage	3 points, 3 times, 1 set		
Sitting position	Spine muscle 1	3 points, 3 times, 1 set/2 sets		
	Spine muscle 2	3 points, 3times, 1 set/2 sets		
	Shoulder joint massage	1 point, 3 times, 1 set		
	Trapezius muscle massage 2	3 points, 3 times, 1 set		

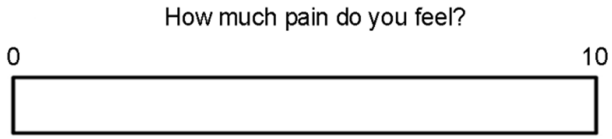

Figure 4. Massage Intensities of Stimulation (Jeong, 2009)

pain. For the subjective pain index, the VAS score was determined by using a single item ("How much pain do you feel?") from the 15-item pain questionnaire developed by Wang and Kim (1995), which was scored on a scale from 0 ("no pain at all") to 10 ("very painful"). The massage stimulus intensity in this study was measured with the massage stimulus intensity index developed by Jeong (2009) by using the VAS while applying a stimulus to the skin. The massage program and VAS are displayed in Table 4 and Figure 4, respectively.

4. Data processing

Windows SPSS Version 23.0 was used to process all data collected in this study to analyze the subjects' general characteristics and other data. The mean and standard deviation were calculated, and a paired *t* test was performed to verify changes in the measured variables after implementation of the ProBody massage. All the measured variables were evaluated by using a significance level of $\alpha = .05$.

RESULTS

1. Changes in postural alignment after implementation of the ProBody massage program

Changes in postural alignment after implementation of the ProBody massage program are displayed in Table 5.

Prior to the ProBody massage program, pelvic alignment was 11.00 ± 5.65 mm, and this showed a statistically significant decrease of 8.15 mm to 2.85 ± 3.22 mm after the program ($p = .001$).

Left knee alignment was 117.70 ± 7.57 mm before the program, and this decreased significantly by 8.8 mm to 108.90 ± 11.50 mm after the program ($p = .001$). Right knee alignment also decreased significantly by 12.20 mm, from 86.25 ± 12.94 mm before the program to 74.05 ±

11.07 mm after the program (p = .022).

Table 5. Changes in body alignment (unit; mm)

Subjects		Before (Mean ± SD)	After (Mean ± SD)	t	p
Pelvis		11.00 ± 5.65	2.85 ± 3.22	7.28	.001**
Knee	Left	117.70 ± 7.57	108.90 ± 11.50	4.69	.001**
	Right	86.25 ± 12.94	74.05 ± 11.07	2.50	.022*

*p < .05, **p < .005

2. Changes in plantar pressure balance after implementation of the ProBody massage program

The changes in plantar pressure balance after implementation of the ProBody massage program are displayed in Table 6.

Left foot plantar pressure balance statistically significantly increased from 47.170 ± 6.12 mm to 48.74 ± 2.85 mm after implementation of the ProBody massage program (p = .048).

Right foot plantar pressure balance statistically significantly decreased from 52.83 ± 6.12 mm to 51.26 ± 2.84 mm after implementation of the ProBody massage program (p = .048).

Table 6. Changes in plantar pressure balance (unit; mm)

Subjects	Before (mean ± SD)	After (mean ± SD)	t	p
Left foot	47.17 ± 6.12	48.74 ± 2.85	1.28	.048*
Right foot	52.83 ± 6.12	51.26 ± 2.84	1.28	.048*
Difference	11.23 ± 7.14	4.51 ± 4.20	3.615	.002**

*p < .05, **p < .005

DISCUSSION

1. Changes in postural alignment

Since incorrect posture not only leads to musculoskeletal deformities but also causes physical health problems, attention is being given to the importance of postural alignment and physical correction to maintain a correct posture (Lee, 2009).

In this study, when we examined changes in postural alignment after implementing the ProBody massage program, pelvic alignment decreased significantly by 8.15 mm, from 11.00 ± 5.65 mm before the intervention to 2.85 ± 3.22 mm after the intervention (p = .001). Left knee alignment decreased significantly by 8.8 mm, from 117.70 ± 7.57 mm before the intervention to 108.90 ± 11.50 mm after the intervention (p = .001). Right knee alignment decreased significantly by 12.20 mm, from 86.25 ± 12.94 mm before the intervention to 74.05 ± 11.07 mm after the intervention (p = .022). Hence, the ProBody massage program was effective for postural alignment.

Kim (2015) reported that ProBody massage is an effective rehabilitative intervention for improving skeletal alignment and maximizing joint ROM, relaxing stiff muscles by promoting flexibility and activity, and enhancing the blood circulation and cardiopulmonary function by stabilizing the balance of the spine and pelvis. Specifically, the ProBody massage was reported to have positive effects on shoulder and spine ROM, and large movements in children with a grade 1 neurological disorder. In that study, an 8-week ProBody massage program had a positive effect on shoulder joint ROM after 4 and 8 weeks, and was effective for increasing upper limb ROM during sitting and crawling in children with cerebral palsy. Meanwhile, Han (2009) reported that traditional Korean manipulation was effective for alleviating diseases related to poor lifestyle habits, work, or the environment, correcting physical structures, restoring healthy circulation, and providing the body with symmetry and balance through physical alignment. Lim (2011) reported that deep tissue massage reduced musculoskeletal pain and improved balance in patients with musculoskeletal disease accompanied by shoulder pain and tension headache. Choi (2009) reported that stationary balance ability improved after foot reflexology therapy. Park (2002) reported that chiropractic and sports massage improved displacement of the cervical spine, scapula, lumbar spine, and pelvis in patients with sacroiliac joint dysfunction. Sin (2011) reported that manual therapy produced changes in the angle and left-right symmetry maintenance of the upper and lower shoulder.

Studies have used various methods other than just massage to improve physical alignment. Kim (2013) and Son (2014) reported that upright body-type exercise, which was developed as an exercise in groups of 2 by applying physical alignment techniques, was greatly effective for improving spinal scoliosis and postural imbalance in youths. When 12 weeks of upright body-type exercise was implemented in 20 female middle-school students with scoliosis with a Cobb's angle of at least 10°, scoliosis and LBP indexes decreased significantly (Kim, 2013). Moreover, when an upright body-type exercise program was implemented in female high-school students with body imbalance, it had a significant effect on balance of the head, shoulders, and pelvis, and sense of balance of the feet (Son, 2014). Woo (2014) reported that upright body-type exercise produced significant results on stationary and dynamic balance in female middle-school students. Niedziolski and Zwierzchowski (1993) suggested the need for stabilization exercises that could improve postural imbalance. Yang (2004) stated that for the improvement of physical imbalance, maintaining a correct posture was important for maintaining spinal mobility and stability. Lee and Kim (1999) reported that strengthening exercises for the muscles around the spine and pelvis prevented not only scoliosis but also 70% of scoliosis progression in youths and improved spinal scoliosis in 50% of cases. Im, Kim, Yoon, and Park (2003) also reported that corrective aerobics helps to improve spinal scoliosis by strengthening the spinal erectors, and the muscles in the back, abdomen, and lumbar regions.

Looking at previous research, most studies to improve postural alignment have been reported in relation to dynamic exercise. Thus, studies on passive massage programs or manipulation therapy are still lacking.

When we examined changes in postural alignment induced by the ProBody massage, pelvic tilt and knee alignment decreased significantly, demonstrating that the ProBody massage had a positive effect on postural alignment. This is similar to the results of studies by Han (2009), Lim (2011), Park (2002), and Son (2014), and indicates the efficacy of the ProBody massage for pelvic postural alignment.

Combining the results of this study and previous studies, the ProBody massage program showed significant results in pelvic alignment and knee alignment. Even though the ProBody massage was only implemented in the short term, the fact that it showed identical results to long-term exercise therapy indicates that it is a highly effective means of improving posture. A study by Cho (2010) showed that physical imbalance caused physical pain through lower limb and pelvic imbalance. Hence, the positive change in pelvic and knee alignment in this study is expected to have a positive effect on improving postural imbalance and physical asymmetry that have been degraded by musculoskeletal disease.

2. Changes in plantar pressure balance

Physical misalignment and spinal imbalance cause foot deformities, resulting in asymmetrical feet and abnormal gait. In order to prevent or alleviate such issues, correct posture and gait should be maintained (Kwon, 2013).

In this study, plantar pressure balance of the left foot increased significantly from 47.170 ± 6.12 mm to 48.74 ± 2.85 mm after the ProBody massage program (p = .048), while right foot plantar pressure balance decreased significantly from 52.83 ± 6.12 mm to 51.26 ± 2.84 mm (p = .048). Hence, the subjects became closer to the ideal ratio of 50:50. These results are similar to those of several previous studies that reported an effect of massage and manipulation therapy on plantar pressure balance. Yu (2013) reported that foot reflexology and venous relaxation therapies had positive effects on plantar pressure balance and psychological stability in elderly female individuals and significantly reduced the anteroposterior discrepancy in plantar pressure distribution in stationary and dynamic postures. Kim (2004) implemented foot reflexology and venous relaxation therapies in patients undergoing hemodialysis and found a significant increase in lower limb muscle strength. Kim (2010) reported a statistically significant improvement in lower limb muscle strength after implementing foot reflexology and venous relaxation therapies in elderly individuals. Finally, Kim, Kim, and Chang (2009) performed ideal body and meridian pathway massage on middle-aged women with lower limb deformities and found that it had an effect on lower limb, hip, and pelvic deformities, making it effective for correcting joints of the lower limb.

Conversely, when Kwon (2013) performed 8 weeks of foot reflexology therapy, they found no improvement in pes planus or pes cavus, and no change in plantar pressure distribution. Choi (2014) performed mani pulation in 20 college students to compare the changes in plantar pressure, and the mean plantar pressure of the left foot decreased by 0.4%, from 48.9% to 48.5%, which was not a statistically significant change. The mean plantar pressure of the right foot increased by 0.5%, from 51.1% to 51.6%, which was also not statistically significant change.

When previous studies on massage and manipulative therapy were analyzed, most of the studies reported a positive effect on plantar pressure, but other studies reported little difference in plantar pressure.

This study implemented a ProBody massage program in middle-aged men with musculoskeletal disease and found that plantar pressure distribution became closer to the ideal ratio of 50:50 and that this change was statistically significant.

Therefore, the combined results of this study and those of previous studies demonstrate that the ProBody massage had a significant positive effect on plantar pressure balance. This is consistent with the result of the study of Lim (2014), who reported that physical alignment brought about a healthy distribution of plantar pressure, and the study of Son, Lee, and Kim (2014), who found a close relationship between plantar pressure balance and physical alignment. Thus, the improvement in plantar pressure from the ProBody massage in this study is thought to have occurred as a result of improved physical alignment, specifically from improved pelvic and knee alignment.

CONCLUSION

This study implemented a ProBody massage program in 20 middle-aged (30- to 49-year-old) male subjects with musculoskeletal disease, with the aim of investigating its effects on postural alignment and plantar pressure. The massage was administered for 60 minutes per session, 2 sessions per week, for 8 weeks, and the following conclusions were obtained.

First, the ProBody massage program had positive effects on pelvic asymmetry and lower limb misalignment in the middle-aged men with musculoskeletal disease. Further research should be conducted in different age groups that require treatment of musculoskeletal disease, as this could be expected to not only prevent musculoskeletal disease and improve postural alignment but also promote overall physical health.

Second, the ProBody massage program influenced positive changes in planter pressure balance in the middle-aged men with musculoskeletal disease. Further research should be conducted in different age groups that require improved plantar pressure balance because of postural imbalance or physical misalignment. Such research could be expected to help not only improve plantar pressure imbalance but also stabilize gait and improve physical alignment.

REFERENCES

Cho, D. S. J. (2010). *Analysis of basic fitness, body composition and foot balance of women in their twenties according to pilates mate exercise*. Unpublished Master's Thesis, Wonkwang University.

Choi, J. W. & No, H. J. (2011). The influence of trunk rotation exercise and PNF exercise on gait in the individuals with malalignment syndrome. *Journal of the Korean Proprioceptive Neuromuscular Facilitation Association*, 9(4), 49-55.

Choi, J. W. (2012). The effect of combined PNF patterns of upper and lower extremities on 20's generation with malalignment syndrome. *Journal of the Korean Proprioceptive Neuromuscular Facilitation*

Association, 10(4), 65-69.

Choi, M. J. (2009). *The effect of using both myofascial release technique and foot reflexology on static body balance*. Unpublished Master's Thesis, Konkuk University.

Choi, Y. J. (2014). *Effects of manual therapy and customized functional insole on neck pain, neck disability, spinal curvature and plantar foot pressure balance of smartphone addict*. Unpublished Doctor's Thesis, Hanseo University.

Dowling, A. M. (2001). *Does obesity affect foot structure and function, foot sensation and plantar pressure distribution in children*. Unpublished Master of Science (honours) Thesis. NSW Australia: Department of Biomedical Science, University of Wollongong.

Eric, F. B. (2005). *Conditioning for dance*, seoul: Gunja.

Han, K. J. (2009). *Study on the recovering way of physical imbalance through traditional korean manipulation. department of oriental medicine*. Unpublished Master's Thesis, Sangji University.

Hermandez-Rief, M., Field, T., Largie, S., Diego, M., Manigat, N. & Seoanes, M. & Bornstein, J. (2005). Cerebral palsy symptoms in children decreased following massage therapy. *Early Child Development and Care*, 175(5), 445-456.

Hwang, S. K. (2012). *The effects of pilates mat exercises on physical posture and foot balance in male adults.* Unpublished Master's Thesis, Myongji University.

Im, Y. T., Kim, S. S., Yun, S. J. & Park, H. Y. (2003). A study of the corrective exercise program on change in curve in girls with mild scoliosis. *Journal of Sport and Leisure Studies*, 20(2), 1341-1347.

Jahss, M. H. (1982). *Disorder of the foot*. WB Saunders Company, Philadelphia.

Jeong, B. Y. (2010). Ergonomics' role for preventing musculoskeletal disorders. *Journal of the Ergonomics Society of Korea*, 29(4), 393-404.

Jeong, S. H. (2009). *Effects of massage as different intensities of stimulation*. Unpublished Master's Thesis, Keimyung University.

Jung, S. H. (2013). *A study on the effects of a sense of psychological crisis and self-reflection perceived by middle-aged men on psychological equilibrium*. Unpublished Master's Thesis, Kyungsung University.

Kim, T. S. (2013). *Impact of chronic shoulder pain and improvement of motion range through therapeutic, Healing Massage Program*. Unpublished Master's Thesis, Mokwon University.

Kim, E. J. (2010). *The effect of foot reflex-massage on physiological index and function of musculoskeletal system of the elderly.* Unpublished Doctor's Thesis, Chungnam National University.

Kim, E. S. (2013). *Effects of the upright body type exercise program on scoliosis, muscle function and vas in female middle school students*. Unpublished Master's Thesis, Silla University.

Kim, E. S. (2015). *Effects of the probody massage on the physiological variables, gross motor function and rom in youth with cerebral palsy, case study.* Unpublished Doctor's Thesis, Silla University.

Kim, K. H., Hwang, R. I. & Suk, M. H. (2013). The trends and status of work-related musculoskeletal diseases under korean worker's compensation system. *Korean Journal of Occupational Health Nursing*, 22(2), 102-111.

Kim, S. J., Kim, W. W. & Jang, W. S. (2009). Effects of Jung-Che meridian pathways on lower limbs deformation with correction in genu varus & genu valgus. *Journal of Ideal Body & Meridian Pathways*, 1(1), 1-12.

Kim, Y. S. (2004). *Effect of foot reflexology on fatigue and lower leg muscle strength among hemodialysis patients*. Unpublished Master's Thesis, Eulji University.

Kwon, T. I. (2013). *Effect of foot reflexology on the body compositions and foot pressure distribution*. Unpublished Doctor's Thesis, Kosin University.

Lee, K. S. (2007). *Effect of pain reduction and flexibility on regular stretching exercise for frequent computer user with musculoskeletal disorder*. Unpublished Master's Thesis, Kookmin University.

Lee, S. D. (2009). *A study of the influence on lumbago on sports massage and integrated group treatment of physical correction*. Unpublished Doctor's Thesis, Seonam University.

Lee, S. H. & Kim, J. H. (1999). A study on the actual conditions of scoliosis in fifth and sixth grade school children. *Journal of the Korean Society of Health*, 12(1),143-148.

Lim, D. H. (2011). *The effect of the whole body deep-tissue massage in shoulder ache and tension headache*. Unpublished Master's Thesis, Chosun University

Lim, E. J. (2014). *The effect of lower limb strengthening exercise and gait training on body balance, foot pressure and cobb's angle in high school female scoliosis patients with pelvic malignment syndrome*. Unpublished Master's Thesis, Korea National Sport University.

Lim, J. I., No, D. S. & Kim, J. H. (2004). *Theory of health sport massage*: Publishing Hong Kyoung.

McKearnan, K. A., Kieckhefer, G. M., Engel, J. M., Jensen, M. P. & Labyak, S. (2004). Pain in children with Cerebral Palsy: A Review. *Journal of Neuroscience Nursing*, 36(5), 252-259.

Ministry of Health and Welfare (2000). *Public health and nutrition survey. Seoul*; Ministry of Health and Welfare.

Moon, K. H., Jeong, S. Y., Park, S. S., Kim, B. K. & Park, Y. J. (2014). The effect of corrective exercise on Cobb's angle, static and dynamic foot pressure of patients with kyphosis. *Korea Journal of Sport Biomechanics*, 24(2), 103-109.

Niedziolski, K. & Zwierzchowski, H. (1993). *Evaluation of the effect of therapeutic exercise and supination shoe insert on static flatfoot in children*. Chirugia Narzadow Ruchu I Ortopdia Polska, 58, 46-51.

Ong, C. N., Chia, S. E., Jeyaratnam, J. & Tan, K. C. (1995). Musculoskeletal disorders among operators of visual display terminals. *Scandinavian Journal of Work, Environment & Health*, 60-64.

Park, C. H. (2002). *Effect of chiropractic and sports massage in sacroiliac joint subluxation patients*. Unpublished Master's Thesis, Mok-Won University.

Park, J. E. (1999). *A study on the effects of sports massage to waist softness, muscular strength and muscular endurance in high school students*. Unpublished Master's Thesis, Cheong Ju University.

Park, J. S., Song, S. H. & Lee, H. S. (2015). Effects of passive body alignment exercise on regional malalignment and foot pressure in male adolescents. *Journal of Korean Society of Dance Science*, 32(3), 143-154.

Seo, S. C. (2012). *Prevention of musculoskeletal diseases impact analysis*

system research. Korea Occupational Safety & Health Agency, 138.

Sin, M. S. (2011). *The effects of manual therapy on the body balance and biochemical index of women*. Unpublished Master's Thesis, Wonkwang University.

Son, N. Y. (2014). *Effects of the upright body type exercise program on postures and foot balance in female high school students*. Unpublished Master's Thesis, Silla University.

Son, N. Y., Lee, J. S. & Kim, J. H. (2014). Effects of the upright body type exercise program on postures and foot balance in female high school students. *Korean Journal of Sport Biomechanics*, 24(1), 75-83.

Statistics Korea (2013). *National statistical office, life expectancy and health life progression*. Seoul; National Statistics Korea.

Wang, J. M. & Kim, D. J.(1995). Assessment of the spinal pain using visual analogue scale (VAS). *Journal of Korean Society of Spine Surgery*, 2(2), 177-184.

Yang, S. H. (2003). *Effects of lumbar stabilization exercise for spinal function in patients with low back pain*. Unpublished Master's Thesis, Yongin University.

Yu, S. J. (2014). *The effects of foot reflexology and venous relaxation massage on female elderly persons' plantar pressure, balance, and psychological stability*. Unpublished Doctor's Thesis, Daegu University.