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ORIGINAL ARTICLE

The Effects of Compound Exercise on Pain and Musculoskeletal Disorders in Office Workers

[1]Hee-Do Ryu, [1]Na-Young Yoon, [1]J-Hun Lee*, [2]Soon-Gi Baek*

[1]Korea Institute for Applied Anatomy, College of Sports Science, Korea National Sport University, Seoul, Korea. [2]Department of Beauty Care, Jungwon University, Goesan, Korea.

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ABSTRACT

Background. Modern office workers are exposed to cardiovascular and metabolic disorders and musculoskeletal disorders due to a long-term sedentary working environment, so it is important to prevent musculoskeletal disorders. As a preventive method for musculoskeletal pain in office workers, flexibility exercise, core exercise, and compound exercise programs can reduce body composition, functional movement, and pain, and effectively improve reduced physical ability and lack of physical activity. **Objectives.** The purpose of this study was to investigate the effects of 12-week exercise for the prevention of musculoskeletal disorders in office workers on body composition, FMS, and SF-MPQ pain scores. **Methods.** The subjects of the study divided 30 office workers into flexibility exercise groups (n=10), core exercise group (n=10), and compound exercise group (n=10) and proceeded for 12 weeks. The flexibility exercise group consisted of self-myofascial release using a foam roller, static stretching, and dynamic stretching. The core exercise group was a core exercise program to improve the stability and movement of the torso and strengthen the torso, improving balance. It consisted of an accompanying core stabilization exercise. **Results.** The results of this study are as follows; 1) Body weight, body fat mass, body mass index, and body fat percentage were reduced in core exercise and compound exercise. 2) The amount of skeletal muscle increased in core exercise. 3) FMS scores increased in flexibility exercise, core exercise, and compound exercise, but the score increased in the order of compound exercise>core exercise>flexibility exercise. **Conclusion.** Summarizing the body composition results of the office workers who participated in this study, there were significant differences in body weight, body fat mass, body mass index, and body fat percentage according to the degree of exercise in the core exercise group and the combined exercise group. FMS, SF-MPQ score, and VAS results showed improvement in all three groups, and among them, the combined exercise group had the best score. The complex application of flexibility exercises that promote muscle contraction and relaxation and core exercises consisting of major muscle groups is thought to help reduce body fat and pain in office workers.

KEYWORDS: ***Musculoskeletal Disorder, Office Worker, Body Composition, Functional Movement Screen, Pain.***

INTRODUCTION

Modern office workers are exposed to cardiovascular and metabolic disorders and musculoskeletal pain (MSP) due to the work environment in which video display terminals (VDT) are used while sitting in the wrong posture for a long time (1). Working on a VDT in an incorrect posture for a long time puts strain on the neck and shoulders, causing turtle neck syndrome, forward head posture, etc., and 1/3 of office workers with these disorders experienced

*. Corresponding Authors:
J-Hun Lee, Ph.D.
E-mail: leejehun@knsu.ac.kr
Soon-Gi Baek, Ph.D.
E-mail: bsg@jwu.ac.kr

back pain (2-4). The posture of a VDT operator causes weakness in the abdominal and spine, hip muscles, transversus abdominis, and pelvic floor muscles called core muscles, making the body unstable (5-7). For workers who are forced to sit for long periods, rest along with exercise can be a good solution to prevent cardiovascular and metabolic disorders and plays an important role in the treatment of MSPs (6).

Flexibility exercises, a form of physical activity in which specific skeletal muscle masses are intentionally stretched have benefits including increased flexibility, increased range of motion within a joint, improved circulation, improved posture, and reduced stress. Flexibility exercises are effective in relieving pain caused by MSP by workers (8, 9).

Additionally, 75% of office workers experiencing acute/chronic back pain found that the application of core stability exercises was more effective than regular exercise in reducing back pain and increasing core activation (10, 11). Humans want physical activities that require stability, and core stability in the central part of the spine, which is important in the body, is the activity of the abdominal muscles, waist, and hip joints (12, 13). Therefore, to prevent musculoskeletal disorders, it is effective to increase the stability of the core by applying whole-body exercises that improve muscle function (14, 15).

Functional Movement Screen (FMS), a test method that can simultaneously evaluate joint stability and mobility based on joint and muscle flexibility, can check the probability of injury as a score. Numerical FMS tests ranging from 0-21 have shown that scores below 14 are highly sensitive and specific to injury probability (16-21).

In addition, as a result of using the Short Form-McGill Pain Questionnaire (SF-MPQ), a pain evaluation index for back stabilization exercise and pain in patients with back pain, among previous studies related to complex including core exercise and flexibility was confirmed (22).

Therefore, the purpose of this study is to identify the most significant exercise method for preventing musculoskeletal disorders by body composition and FMS after performing flexibility exercise and core exercise twice a week for VDT office workers for 12 weeks.

MATERIALS AND METHODS

Participants. This study included 30 participants (Table 1). Subjects were those who were able to perform glycolytic exercise according to orthopedic findings and had no inflammation or injury. All research participants research process by fully explaining the research procedure, purpose, advantages, and effects, and obtain research consent from the participants (Figure 1).

Table 1. Physical characteristics of study subjects (Mean±SD)

Group (n=30)	Age (years)	Height (cm)	Weight (kg)	B.M.I(%)
FG (n=10)	32.6±4.71	165±5.46	59±8.15	21.6±2.57
CG (n=10)	33.6±5.99	165±8.44	61.9±13.13	22.3±3.64
CBG (n=10)	29.0±4.69	166.3±5.55	66.4±16.53	24.3±6.39

Values: Mean ± Standard Deviation, FG: flexibility exercise group, CG: core exercise group, CBG: compound exercise group, n: number, B.M.I: body mass index

Exercise programs. The exercise methods applied in this study were flexibility exercise and core exercise, and the flexibility exercise group (FEG) consisted of self-myofascial release, static stretching, and dynamic stretching using a foam roller (Table 2). The core exercise group (CEG) is a group that applies a core exercise program to improve trunk stability and movement and strengthen the trunk, and consists of core stabilization exercises accompanied by balance (Table 3). The compound exercise group (CbEG) is a group in which core exercise and flexibility exercise are compounds (Table 4).

Variables and Tools. In this study, a body composition measuring instrument (Inbody 120, Biospace, Seoul, Korea) was used to measure body composition such as body weight, lean mass, body fat mass, body fat percentage, and body mass index. Eight tactile electrodes (thumb and fingers of the hand, ball, and heel of the foot) with frequency (20/100 kHz) bioimpedance analysis in a standing position. The data obtained were then processed by the software Lookin'Body120 (Biospace Co. Ltd, Korea). The following body composition parameters were evaluated: weight (kg) and body mass index

(BMI, kg/m2) calculated as weight (kg) divided by height (m) squared, waist circumference (WC, cm). BSA = $\sqrt{h \times w/3600}$, Where h is height in cm and w is weight in kg (23) (Figure 2).

Table 2. Flexibility exercise program

Period	Classification	Exercise program	Duration/repetition/set
1 - 4week	Self-myofascial release	Release compartment Calf /hamstring/tibialis anterior Quadratus/tensor fasciae latae/gluteus Lower back/thoracic/latissimus dorsi Posterior neck/mountain position & cobra	10 repetitions /1 set /30 seconds or more and less than 60 seconds
5 - 8week	Static stretching	Sitting & Stretch Neck/triceps/deltoid/quadratus lumborum Wrist/ankle/iliopsoas/back-word rocking Adductor/hamstring/piriformis Pectoralis major/bretzel Mountain position & cobra	10sec/2set /30 seconds or more and less than 60 seconds
9 - 12week	Dynamic stretching	Ankle circle Quadruped weight shift Dynamic opposite arm leg lift Quadruped thoracic rotation Quadruped kneeling thoracic rotation Low lunge weight shift Knee extension & hamstring stretch Hip hinge /knee hug High lunge – elbow to toe Hand walking/mountain position & cobra	10repeitition /1set /30 seconds or more and less than 60 seconds

Sec: second

Table 3. Core exercise program

Period	Classification	Exercise program	Duration/repetition/set
1 - 4week	Core stability exercise	Wide squat	10 repetitions /2sets
		Marching	10 repetitions /2sets
		Bridge	10 repetitions /2sets
		Dead-bug	10 repetitions /2sets
		Bird dog	10 repetitions /2sets
		Quadruped knee lift	30sec/2sets
		Plank	30sec/2sets
		Side plank	15sec/2sets
5 - 8week	Core strength exercises	Lunge Crunch Side crunch Alternate heel touchers Sit-up with rotation Reverse crunch Leg raise Seated knee-up Russian twist	10 repetitions /2sets 30sec/
9 - 12week	Core balance exercise	Ball squat	10 repetitions /2sets
		Ball lunge	10 repetitions /2sets
		Ball bridge	30sec/2sets
		Ball high plank	15sec/2sets
		Ball roll-out	10 repetitions /2sets
		Ball back extension	10 repetitions /2sets
		Ball hip extension	10 repetitions /2sets
		Ball dead-bug	10 repetitions /2sets
		Ball pass	10 repetitions /2sets

Sec: second

Table 4. Combined exercise program

Period	Classification	Exercise program	Duration/repetition/set
1 - 4week	Core stability Exercise & Self-myofascial release	Wide squat/bridge Dead-bug/birddog Plank/calf /tibialis anterior Quadratus/gluteus Latissimus dorsi Mountain position & cobra	10 repetitions /1set 30sec/2sets
5 - 8week	Core strength exercise & Static stretching	Lunge, crunch Alternate heel touchers Sit-up with rotation/seated knee-up Deltoid stretch/ankle stretch(soleus) Iliopsoas/ hamstring stretch Backward rocking Piriformis stretch Bretzel Mountain position & cobra	10 repetitions /2sets 10sec/1set
9 - 12week	Core balance exercise & Dynamic stretching	Ball squat Ball lunge Ball high plank Ball pass Ball dead-bug Dynamic opposite arm leg lift Quadruped thoracic rotation Low lunge weight shift Hip hinge High lunge – elbow to toe Hand walking Mountain position & cobra	10 repetitions /2sets 10 repetitions /2sets 30sec/2sets 10 repetitions /2sets 10 repetitions /2sets 10 repetitions /2sets 10sec/1set 10sec/1set 10sec/1set 10sec/1set 10sec/1set 10sec/1set

Sec: second

The FMS is a test to check for uncontrollable movements or imbalances in the body (24). Seven Deep Squats (DS), Hurdle Step (HS), In-line consists of Lunge (ILL), Shoulder Mobility (SM), Straight Leg Raise (SLR), Trunk Stability Push-up (TSP), and Rotary Stability (RS) (Figure 3). A score of 4 levels from 0 to 3 was used, and in the evaluation criteria, 3 points are given when functional movements can be performed without compensatory action, and 2 points are given when it is possible to perform movements accompanied by compensatory actions. If the performance of the motion was not performed according to the standard, a score of 0 was given when the pain occurred when the correct motion was performed (8, 25). The range of the FMS total score is 0 to 21 points, and among the 7 items on the test, 5 items (HS, ILL, SM, LSLR, RS) used the lowest scores among the scores on the left and right sides The FMS was shown to have an excellent reliability coefficient (ICC = 0.98). Also, it has good to excellent intertester reliability for all of the 12 variables: ILLl, w = 0.87; ILLr and ASLRr, w = 0.93; the other 9 variables, w = 1.0, or perfect (8, 26, 27) (Figure 3).

The SF-MPQ consists of three parts, the largest part of which is composed of 15 adjectives representing the state of pain, and consists of 11 sensory domain items and 4 emotional domain items (28). Each item is scored on a rating scale of 0 (no pain), 1 (mild pain), 2 (moderate pain), and 3 (severe pain) (29). The second part is represented by the Visual Analogue Scale (VAS), a visual pain rating score, the third is Present Pain Intensity (PPI), which is a visual pain rating score and is composed of 0-5 points. It consists of items that allow you to fill in your subjective thoughts about whether there is pain when you take a motion. The VAS and PPI have proven high validity of 0.90 and were developed to rapidly assess subjects (30). The SF-MPQ was developed in English and French and has been translated and used in a wide variety of languages (31).

Procedures. The FMS consisted of seven component tests used to assess various basic movement patterns. 3-5 participants completed the component tests in a balanced order. These included deep squats, hurdle steps, inline lunges, shoulder mobility, active straight leg lifts, trunk stability push-ups, and quadrupedal rotational stability tests (Figure 3). Five of the seven component tests evaluate asymmetry by measuring both tests. If there is a discrepancy between the left and right sides, the asymmetry is recorded for that component test and the lower of the two scores is included in the FMS composite score. For flexibility exercise and core exercise, different protocols were applied for 1-4 weeks, 5-8 weeks, and 9-12 weeks, which are described in (Tables 2-4).

Statistical Analysis

Measurement. In this study, descriptive statistics for each group were calculated using the SPSS Version 22.0 program for Windows. For statistical analysis, two-way repeated measures ANOVA was conducted to evaluate the interaction and main effect of the difference between groups for the change by the exercise program applied to the three groups and to evaluate the temporal change. Confidence intervals were adjusted with Bonferroni correction. As an analysis method for variables with significant interaction effects and temporal changes, one-way ANOVA was performed post hoc tests were performed, and the significance level was set at $p<0.05$.

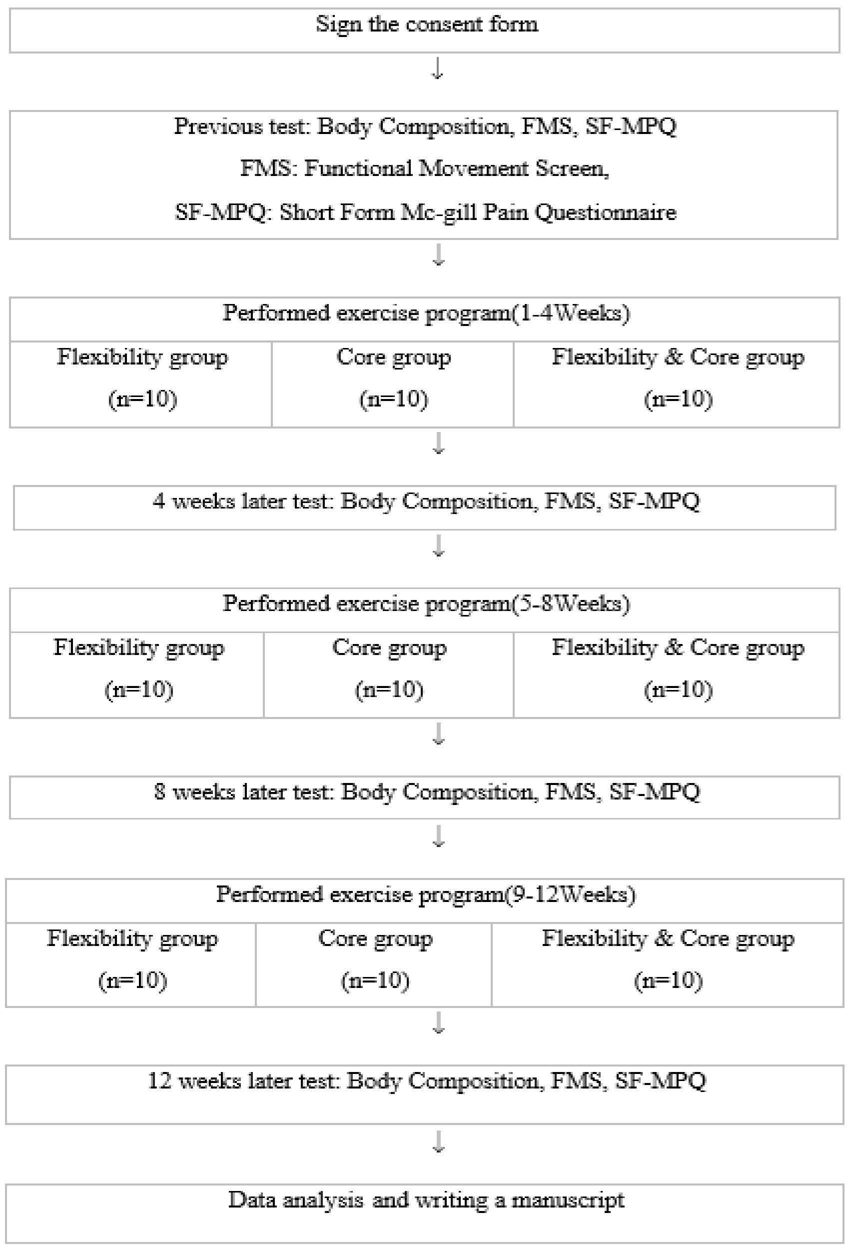

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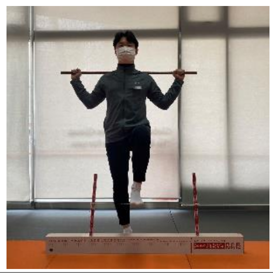
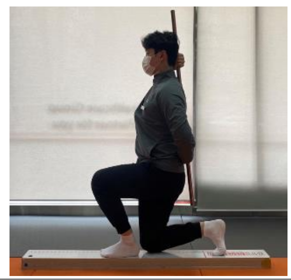
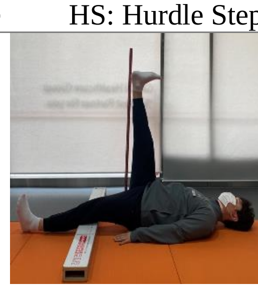
Figure 1. The research design.

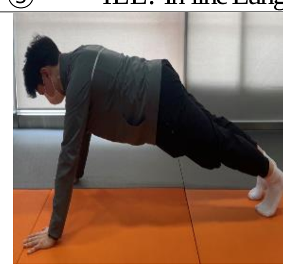
Figure 2. Body Composition Test (Inbody, 120).



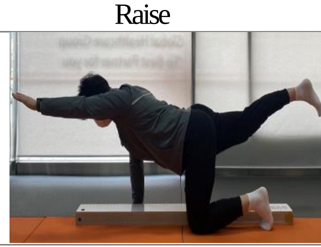


① DS: Deep Squat ② HS: Hurdle Step ③ ILL: In-line Lunge





④ SM: Shoulder Mobility ⑤ SLR: Straight Leg Raise ⑥ TSP: Trunk Stability Push-up



⑦ RS: Rotary Stability

Figure 3. Functional movement screen motions.

RESULTS

Body composition. There was no difference in body weight between groups, p=0.391, and the average difference according to the measurement period was p=0.011, showing a significant difference based on p<0.05. The interaction effect between group and repeated measures was p=0.329, showing no statistically significant difference. There was no difference in skeletal muscle mass as the average difference between groups (p=0.869), and the average difference according to the measurement period was p=0.006, showing a significant difference at the p<0.01 level. The interaction effect between the group and repeated measures was p=0.214, confirming that there was no statistically significant difference.

There was no difference in body fat mass as the average difference between groups was p=0.220, and the average difference according to the measurement period was p=0.962, and there was no difference. The interaction effect between group and repeated measures showed a statistically significant difference at the p<0.001 level with p=0.000. There was no difference in body mass index as the average difference between groups was p=0.320, and the average difference according to the measurement period was p=0.018, showing a significant difference at the p<0.05 level. The interaction effect between the group and repeated measures was p=0.298, confirming that there was no statistically significant difference. There was no difference in body fat percentage between groups, p=0.151, and there was no difference in average difference according to measurement period, p=0.444. The interaction effect between the group and repeated measures showed a statistically significant difference at p=0.001 level with p=0.000. (Table 5).

Table 5. Statistical Analysis for Body Composition (Mean±SD)

Group	Pre	4week	8week	12week	Within-Subject	Group *Time	Between -Subject
FG(n=10)	57.38 ±8.10	57.65 ±8.16	57.58 ±8.11	57.46 ±8.25			
CG(n=10)	61.89 ±13.84	62.11 ±13.73	61.55 ±13.82	61.54 ±14.23	F=3.969 *p*=0.011*	F=1.172 *p*=0.329	F=0.971 *p*=0.391
CBG(n=10)	66.35 ±17.42	66.48 ±17.06	65.75 ±17.28	65.42 ±17.15			
Skeletal muscle mass							
FG(n=10)	23.86 ±2.62	23.76 ±2.55	23.28 ±2.54	23.19 ±2.47			
CG(n=10)	24.41 ±6.56	24.68 ±6.59	24.46 ±6.43	24.42 ±6.40	F=4.479 *p*=0.006**	F=1.429 *p*=0.214	F=0.141 *p*=0.869
CBG(n=10)	24.79 ±6.20	24.78 ±6.02	24.71 ±5.85	24.50 ±5.76			
Body fat mass							
FG(n=10)	13.80 ±5.65	14.20 ±5.67	14.93 ±6.04	14.96 ±5.88			
CG(n=10)	17.50 ±6.07	17.17 ±6.02	17.04 ±6.04	17.12 ±6.41	F=0.096 *p*=0.962	F=4.779 *p*=0.000***	F=1.600 *p*=0.220
CBG(n=10)	21.32 ±11.65	21.45 ±12.01	20.84 ±11.95	20.82 ±11.39			
Mass Index							
FG(n=10)	20.89 ±2.76	21.00 ±2.78	20.98 ±2.79	20.94 ±2.81			
CG(n=10)	22.3 ±3.83	22.39 ±3.68	22.20 ±3.73	22.19 ±3.87	F=3.556 *p*=0.018*	F=1.233 *p*=0.298	F=1.188 *p*=0.320
CBG(n=10)	24.32 ±6.74	24.35 ±6.61	24.10 ±6.74	23.97 ±6.68			
Body fat percentage							
FG(n=10)	23.46 ±6.46	24.02 ±6.48	25.30 ±6.79	25.43 ±6.36			
CG(n=10)	28.18 ±7.00	27.60 ±6.98	27.54 ±6.64	27.64 ±6.77	F=0.902 *p*=0.444	F=.444 *p*=0.000***	F=2.031 *p*=0.151
CBG(n=10)	31.27 ±8.22	31.31 ±8.71	30.80 ±8.60	30.87 ±7.73			

Unit: kg, n: number, Values: Mean ± Standard Deviation, FG: flexibility exercise group, CG: core exercise group, CBG: combined exercise group, Pre: Pre-exercise, *: p<0.05, **: p<0.01, ***: p<0.001

FMS After the exercise program for 12 weeks, the average difference between groups was p=0.333, and there was no significant difference, The average difference according to the measurement period was p=0.000, and there was a significant difference at the p<0.001 level. The interaction effect between groups and repeated measures was p=0.032, showing a statistically significant difference at the p<0.05 level (Table 6).

Short-Form McGill Pain Questionnaire (SF-MPQ) After the exercise program for 12 weeks, the average difference between groups was p=0.620, and there was no difference, and the average difference according to the measurement period was p=0.000, showing a significant difference at the p<0.001 level. The interaction effect between groups and repeated measures was p=0.191, confirming that there was no statistically significant difference (Table 7).

Table 6. Statistical Analysis for Functional Movement Screen (Mean±SD)

Group	Pre	4week	8week	12week	Within-Subject	Group *Time
FG(n=10)	10.00 ±1.94	12.30 ±1.70	13.70 ±1.57	15.60 ±1.17	F=161.059 *p*=0.000***	F=3.912 *p*=0.032*
CG(n=10)	10.20 ±2.20	12.10 ±2.13	14.40 ±1.58	15.70 ±1.57		
CBG(n=10)	8.20 ±1.14	11.40 ±1.07	13.60 ±1.26	15.70 ±1.34		
Between -Subject	F=1.144 *p*=0.333					

Unit: score, n: number, Values: Mean ± Standard Deviation, FG: flexibility exercise group, CG: core exercise group, CBG: combined exercise group, Pre: Pre-exercise, *: p<0.05, **: p<0.01, ***: p<0.001

Table 7. Statistical Analysis for Short-Form Mcgill Pain Questionnaire (Mean±SD)

Group	Pre	4week	8week	12week	Within -Subject	Group *Time
FG(n=10)	0.76±0.43	0.52±0.30	0.35±0.20	0.21±0.12	F=49.936 *p*=0.000***	F=1.494 *p*=0.191
CG(n=10)	0.53±0.35	0.35±0.33	0.33±0.30	0.19±0.21		
CBG(n=10)	0.67±0.30	0.50±0.28	0.34±0.32	0.15±0.16		
Between -Subject	F=0.486 *p*=0.620					

Unit: score, n: number, Values: Mean ± Standard Deviation**,** FG: flexibility exercise group, CG: core exercise group, CBG: combined exercise group, Pre: Pre-exercise**,** *: p<0.05, **: p<0.01, ***: p<0.001

DISCUSSION

As we enter the 4th industrial revolution society, office workers spend more time sitting in chairs and looking at monitors in the digital economy, and their movement in the work environment is rapidly decreasing (32). Summarizing the body composition results of office workers who participated in this study, there were significant differences in body weight, body fat mass, body mass index, and body fat percentage according to the degree of exercise in the core exercise group and the combined exercise group. These results may support a previous paper that core exercise has a significant effect on reducing body fat percentage and increasing skeletal muscle mass (33). However, the fact that there was no change in body composition in the flexibility exercise group contradicts previous studies that showed that flexibility exercise and strength exercise programs affect weight, body fat mass, and body mass index reduction in the elderly. All physical activities consume energy in the exercise itself to increase the metabolic rate and consume energy even during rest, but it is difficult to say that flexibility exercise unconditionally reduces body weight and body fat percentage (22, 34).

The FMS results of this study showed that the FMS score improved in all three groups, which is the result of the study that walking and core exercise had a significant effect on the improvement of trunk stability and function in patients with chronic low back pain, and the application of core exercise helped the stability of the pelvic complex. It shows a similar pattern to the research result that increases the balance of muscles and muscles (35). The increase in the FMS score in the flexibility exercise group is thought to be due to the exercise method using back thigh muscle stretching and eccentric contraction receiving high scores in the flexibility evaluation (22, 35).

As a result of the study, it was found that the combined exercise group had the best FMS score, which is contrary to the previous study that the core exercise group had the best FMS score. In a previous study that flexibility exercise increases trunk stability, it was found that applying Pilates as a combination exercise of flexibility exercise and core exercise is effective in increasing muscle activity and improving flexibility of trunk muscles, supporting the results of this study (36).

Summarizing the SF-MPQ results, all three groups were effective in the SF-MPQ score, VAS, and pain intensity. The PPI score worked best. This is consistent with previous research showing that local muscles such as the transversus abdominis and multifidus are activated during core exercises, helping to stabilize the torso and reduce discomfort. Proper activation of the core muscles restores normal lordosis of the back and kyphosis of the spine. These results are similar to previous studies showing that it is effective in preventing and managing skeletal muscle dysfunction (37, 38). Flexibility exercise that promotes muscle contraction and relaxation is thought to be effective in increasing muscle strength because it promotes neuromuscular transmission by increasing calcium influx into motor nerve terminals during flexibility exercise. In addition, the main purpose of flexibility exercise to increase muscle length and joint range of motion and help blood circulation is to recover from fatigue, lower muscle tone, prevent injury, and improve exercise capacity (4-8, 25, 35, 39). Therefore, in the flexibility exercise group, muscles such as the posterior femoris muscle, square muscle, levator scapula muscle, pectoralis minor muscle, iliopsoas muscle, and upper trapezius muscle, which are prone to stiffness in office workers, are relaxed to increase muscle strength. Improves joint range of motion and muscle tone. Pain reduction appears to be a mediator of pain reduction (40).

A limitation of this study is that the number of subjects was small and there was no control group other than the exercise group, so comparison between the control group and the exercise group was impossible. According to previous studies, pain occurs when there is little movement or activity due to the characteristics of office workers (41, 42). Therefore, a comparative study was conducted on the exercise group under the assumption that the non-exercise group did not affect body composition, functional movement, and pain. Combining the above information, if a more efficient exercise program is recommended for hard-working office workers with limited movement, a complex exercise program that properly combines core and flexibility can reduce body composition, functional movement, and pain.

CONCLUSION

In this study, flexibility exercise, core exercise, and compound exercise were applied to 30 office workers, and body composition, FMS, and SF-MPQ scores of the subjects were measured, and the following conclusions were obtained.

The application of core exercise and compound exercise had a significant effect on the reduction of body weight, body fat mass, body mass index, and body fat percentage, and the effect was seen after 8 weeks of exercise application.

A significant increase in skeletal muscle mass was found in the core exercise group, which was shown in the 4th week. It seems that the single application of core exercise should be continued for at least 4 weeks.

Flexibility exercise, core exercise, and compound exercise were all effective in increasing the FMS score, but the order of compound exercise > core exercise > flexibility exercise was effective. Flexibility exercise, core exercise, and compound exercise all reduced the SF-MPQ score, and flexibility exercise had the greatest effect. Flexibility exercise, core exercise, and compound exercise all reduced the VAS score, and the effect was greatest in the compound exercise group.

The PPI score decreased in all of the flexibility exercises, core exercises, and compound exercises, and the core exercise group was most effective in reducing the PPI score.

Core exercise and compound exercise had significant effects on body composition, and flexibility exercise, core exercise, and compound exercise all showed significant effects on functional movement and pain reduction. In terms of the average result, it was found that the compound exercise showed the most excellent effect. As a result, compound exercise is effective in preventing skeletal musculoskeletal disorders in office workers, and compound exercise programs using flexibility exercises and core exercises are judged to be effective in recovering functional movements and reducing pain caused by skeletal musculoskeletal disorders. Therefore, it is considered that office workers can be the basic data as an efficient exercise protocol for health on the line where they are not disturbed by their work. Looking at several previous papers, the probability of exposure to skeletal muscle disease in office workers is increasing. Office workers can exercise without being harmed by work during work, studies on clear exercise methods will help, and more specifically I think a lot of extensive research is needed.

APPLICABLE REMARKS

- This study is a method for preventing skeletal muscle diseases in office workers, and it can be said that the combined application of flexibility exercise and core exercise brings about a good prognosis.

- Changes by 4 weeks were measured for 12 weeks, and it was confirmed that changes appeared from 8 weeks and were maintained until 12 weeks.
- In the basic study setting, the exercise application of at least 8 to 12 weeks is considered to be a better study.

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AUTHORS' CONTRIBUTIONS

Study concept and design: J-Hun Lee, Soon-Gi Baek. Acquisition of data: Hee-Do Ryu, Na-Young Yoon. Analysis and interpretation of data: Hee-Do Ryu, J-Hun Lee, Soon-Gi Baek. Drafting the manuscript: J-Hun Lee, Soon-Gi Baek. Critical revision of the manuscript for important intellectual content: Hee-Do Ryu. Statistical analysis: Na-Young Yoon, J-Hun Lee. Administrative, technical, and material support: J-Hun Lee, Soon-Gi Baek. Study supervision: Hee-Do Ryu, Na-Young Yoon.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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