

# Effects of yoga exercise on maximum oxygen uptake, cortisol level, and creatine kinase myocardial bond activity in female patients with skeletal muscle pain syndrome

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**Abstract.** [Purpose] This study analyzed the effects of yoga exercise on maximum oxygen uptake, cortisol level, and creatine kinase myocardial bond activity in female patients with skeletal muscle pain syndrome. [Subjects] The subjects were 24 female patients with skeletal muscle pain syndrome. [Methods] The subjects were divided into 2 groups: a yoga exercise group ( $n = 12$ ) and a non-exercise control group ( $n = 12$ ). Body composition, maximum oxygen uptake, cortisol level, and creatine kinase myocardial bond activity were measured before and after a 12-week yoga exercise program. [Results] After the 12-week yoga exercise program, the exercise group exhibited slightly higher maximum oxygen uptake and creatine kinase myocardial bond activity than the control group, but the differences were not statistically significant. In addition, the exercise group exhibited a significant decrease in cortisol level. [Conclusion] Regular and continuous aerobic exercise such as yoga improves body composition, maximum oxygen uptake, cortisol level, and creatine kinase myocardial bond activity in female patients with skeletal muscle pain syndrome.

**Key words:** VO<sub>2</sub>max, Cortisol, Creatine kinase myocardial bond

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## INTRODUCTION

Exercise is well known to facilitate metabolic functions in the human body and benefit physical health by preventing disease, controlling weight, and maintaining homeostasis<sup>1)</sup>. One important physical change caused by regular exercise is an increase in red blood cells and consequently hemoglobin; this regulates the balance between the oxygen transfer system and requirements in the peripheral blood and improves homeostasis and the body's ability to remove wastes such as carbonic acid gas from tissues<sup>2)</sup>. The American Heart Association<sup>3)</sup> reports that a lack of exercise is one of the main factors of heart disease (along with high blood pressure, hyperlipidemia, and smoking) and recommends regular exercise to treat and prevent heart-related disease<sup>4)</sup>. Despite this emphasis on regular exercise for health promotion, contemporary society does not engage in sufficient exercise; moreover, because of inappropriate exercise methods, they

are vulnerable to health deterioration and disease<sup>5)</sup>.

In recent years, much attention has been given to preventing the reduction of women's physiologic motor ability. Thus, campaigns for effective exercise have been widely promoted, resulting in a clear trend of voluntary participation in exercise programs. In this regard, many attempts have been made to develop appropriate exercise programs to improve women's physiologic abilities<sup>1)</sup>. Previous studies on the effects of yoga have focused on social science research, targeting subjects such as the elderly or patients with some diseases; meanwhile, few studies have been conducted on its physiologic effects, i.e., functional improvement in women's physical bodies<sup>6–9)</sup>.

Through the relaxation and contraction of various body parts, yoga helps correct the positions of the skeleton and internal organs, reduce pain in patients with chronic back pain, increase aerobic capacity<sup>10–12)</sup>, and relieve stress<sup>9, 13–16)</sup>. In addition, it is conducive to functional improvement in blood pressure and muscles and joints in the elderly<sup>17, 18)</sup>. In particular, Kang<sup>19)</sup> reports that continuous yoga exercise for more than one year is effective for promoting health in women, improving heart disease, and managing obesity, which can develop into other diseases. In addition, yoga can minimize reactive oxygen species generation, because it improves aerobic capacity and positively influences stress hormones and inflammatory markers<sup>10)</sup>.

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**Table 1.** Demographic characteristics of the study subjects

	Age (years)	Height (cm)	Weight (kg)	% Body fat (%)
Yoga exercise (n = 12)	22.1 ± 2.9	159.4 ± 14.6	50.9 ± 3.9	19.3 ± 1.2
Control (n = 12)	22.6 ± 0.9	161.5 ± 4.3	49.2 ± 4.5	19.2 ± 1.1

However, although yoga has been classified as an aerobic exercise that improves aerobic capability, its intensity is physiologically lower than the lactate threshold; thus, it can be classified as a low-intensity exercise. Accordingly, high-intensity exercise over the lactate threshold should be conducted to improve maximum oxygen uptake ( $VO_2\max$ ). However, it is doubtful that yoga can improve aerobic capability, because it is considered a low-intensity exercise.

In addition, as patients with musculoskeletal disease are characterized by a high reaction rate with respect to muscle fatigue, inflammatory marker activity, and stress, they have difficulties performing exercise as they experience more oxidative stress during exercise<sup>20, 21</sup>). The main effects of yoga are thought to be pain reduction in patients with musculoskeletal disease, functional improvement in muscles/joints, and stress relief.

Accordingly, this study evaluated the effects of yoga exercise 3 times per week for 12 weeks on cardiovascular endurance capability, cortisol level, and inflammatory markers (i.e., creatine kinase myocardial bond [CK-MB]) in women in their twenties with shoulder pain.

## SUBJECTS AND METHODS

This study involved 24 women in their twenties with shoulder pain. The subjects were divided into 2 equal groups to ensure biologic homogeneity: the exercise group ( $n = 12$ ) and non-exercise control group ( $n = 12$ ). All subjects provided written informed consent prior to participation, and ethical approval was granted by our Institutional Human Research Committee.

Body composition was measured prior to the experiment by using Inbody 720 (Biospace, Korea). The subjects subsequently engaged in preliminary exercise for one week to adapt to the yoga program application. The exercise consisted of a 5-min warm-up, 40 min of exercise, and a 5-min cool-down for a total of 50 min. The subjects engaged in this yoga program 3 times per week for 12 weeks.  $VO_2\max$  (Cpet-Cosmed, Italy), cortisol level (Kodak, USA), and CK-MB (Kodak, USA) were measured 6 times prior to the experiment and throughout the 12-week yoga program in all subjects.

The yoga exercise group was taught and practiced modified hatha yoga 40 minutes per session 3 times per week on nonconsecutive days for 12 weeks. The yoga exercise program offers the greatest health benefits by enabling each subject to improve their strength, flexibility, and balance. All sessions emphasized the proper use of aligned postures and breathing techniques through the use of large muscle movements.

All data are presented as mean ± SD. All statistical analyses were completed using SPSS version 21.0 for Windows (SPSS Inc., Chicago, IL, USA). All statistical tests used an  $\alpha$

**Table 2.** Changes in maximum oxygen uptake after 12 weeks

	Pre-test	Post-test
Yoga exercise (n = 12)	48.14 ± 7.06	48.71 ± 6.47
Control (n = 12)	44.86 ± 7.15	45.57 ± 6.60

**Table 3.** Changes in cortisol hormone after 12 weeks

	Pre-test	Post-test
Yoga exercise (n = 12)	8.90 ± 0.69	8.11 ± 0.55*
Control (n = 12)	8.38 ± 1.02	9.17 ± 1.15*

\* $p < 0.05$

**Table 4.** Changes in CK-MB after 12 weeks

	Pre-intervention	Post-intervention
Yoga exercise (n = 12)	0.63 ± 0.14	0.71 ± 0.20
Control (n = 12)	0.57 ± 0.17	0.92 ± 0.41

level set at  $p < 0.05$ . This intervention trial was designed to compare pre- and post-intervention variables. Changes from baseline to the end of the intervention within and between groups were determined using paired t-tests and independent t-tests, respectively.

## RESULTS

The demographic characteristics of the study subjects are shown Table 1. Changes in  $VO_2\max$  in both groups after the 12-week yoga program are shown in Table 2. Mean  $VO_2\max$  in the control group increased from 44.86  $mL \cdot kg^{-1} \cdot min^{-1}$  before the intervention to 45.57  $mL \cdot kg^{-1} \cdot min^{-1}$  after the intervention; this change was not statistically significant. Mean  $VO_2\max$  in the exercise group increased from 48.14  $mL \cdot kg^{-1} \cdot min^{-1}$  before the intervention to 48.71  $mL \cdot kg^{-1} \cdot min^{-1}$  after the intervention; this change also was not statistically significant.

The control group had higher cortisol levels at all stages (i.e., prior to exercise, immediately after exercise, and after a 30-min rest), while the exercise group had lower cortisol levels at all stages (Table 3). The control group had higher CK-MB activity at all stages, while the exercise group had lower CK-MB activity at all stages (Table 4).

## DISCUSSION

In the present study, women in their twenties with musculoskeletal disease were divided into an exercise group and a non-exercise control group in order to identify the effects of yoga exercise on aerobic exercise capability, cortisol level,

inflammatory markers (i.e., CK-MB).

The results show that the yoga program had no significant effect on subjects'  $\text{VO}_2\text{max}$ . Cardiac output ( $Q = \text{stroke volume} \times \text{heart rate}$ ) and arteriovenous oxygen difference must be increased in order to improve  $\text{VO}_2\text{max}$ . However, the subjects had musculoskeletal disease and no prior experience with yoga, which made it difficult for them to learn the yoga positions quickly. Therefore, they had limited ability to increase their cardiac output at the beginning of the program. Moreover, the intensity and period of the yoga program did not significantly impact subjects' arteriovenous oxygen difference.

Cortisol, a stress hormone, can facilitate decomposition of free fatty acids from adipose tissue to activate the use of fat, thereby helping the body cope with stress, such as intense exercise; it is also used as a marker of immune function inhibition. The blood concentration of cortisol increases when performing moderate-intensity exercise. The normal blood concentration of cortisol can play a role in helping the body cope with stress. However, high blood concentrations can damage tissue, negatively affecting nitrogen equilibrium in the body and leading to diminished immunity<sup>22</sup>).

In this study, there was no significant difference in the blood concentration of cortisol between groups. However, in the control group, the cortisol level increased significantly ( $p < 0.05$ ) after the program, whereas in the exercise group, it decreased significantly ( $p < 0.05$ ). Furthermore, the control group showed the highest concentration during rest time, whereas the exercise group showed the highest concentration immediately after exercise. This result is consistent with a previous study; it can be attributed to a reaction mechanism against small-muscle damage caused by stress and an increase in stress caused by exercise in patients with musculoskeletal disease<sup>22, 23</sup>).

It is important to note that cortisol concentration decreased after the yoga program in the exercise group in this study; this was due to the subjects' adaptation to the program and is concordant the results of a previous study in which the increase in cortisol in response to stress in the training group was small<sup>22, 23</sup>).

CK-MB activity can increase as a result of damage to muscle fiber membranes, which is useful for the early diagnosis and treatment of acute myocardial infarction. The increase in CK-MB activity is characterized by sensitive reactions to even minimal damage to the heart<sup>24</sup>).

There was no significant difference in CK-MB activity between groups. However, in the control group, CK-MB activity was slightly higher in the control group than in the exercise group after the intervention.

This result is consistent with that of a previous study in which adaptation to exercise was shown to reduce the increase in CK-MB activity. This result indicates the yoga program effectively decreased inflammatory markers. In particular, the yoga program effectively lowered stress caused by exercise.

Therefore, although the yoga exercise did not significantly influence  $\text{VO}_2\text{max}$ , it improved flexibility and muscle/joint function, reduced pain, decreased stress hormone level, and mitigated muscle damage.

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