

Effect of regular swimming exercise on the physical composition, strength, and blood lipid of middle-aged women

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The purpose of this study is to define the effects of regular swimming exercise on the physical composition, physical strength, and blood lipids of middle-aged women. The subjects of this study are a total of 24 middle-aged women in the swimming group and the control group, with 12 women for each group. The swimming group performed swimming exercise for 60 min every time for 3 times a week, for a total of 12 weeks. For data processing, SPSS 21.0 statistics program was used to calculate the mean and standard deviation. For the difference verification on the change in mean for each group and between the groups, paired and independent *t*-tests were respectively used. As a result, for physical composition, the body fat rate decreased in the swimming group. Moreover, the difference verification result showed a statistically significant difference between the groups. For physical strength, the difference verification result for each group showed that the swimming

group had a statistically significant difference in flexibility and cardiovascular endurance. Moreover, the difference verification result between the groups showed a statistically significant difference only for flexibility. For blood lipids, as a result of the difference verification for each group, T-C and TG showed a significant decrease, and HDL-C, a significant increase. However, in the difference verification result between the groups, only T-C and TG showed a statistically significant difference. With these results, it is considered that regular swimming exercise is effective for improving the physical composition, physical strength, and blood lipids of middle-aged women.

Keywords: Swimming, Middle-aged women, Physical composition, Strength, Blood lipid

INTRODUCTION

In the modern society, people become more disoriented doing physical activities because of the development of automation, thereby leading to a sedentary lifestyle that consequently causes them to suffer from various illnesses and diseases. Also, these symptoms increase the occurrence trend of obesity, hypertension, and cardiovascular disorders arising from lack of exercise. Most particularly, for those who are over the age of 50, preventing and treating cardiovascular disorders become even more challenging, and the occurrence, itself, can be fatal. The risk factors causing cardiovascular disorder include blood lipoprotein, hypertension, diabetes, obesity, and sedentary living habits (Burke et al., 2001).

These factors individually affect the health of a person, and in general, they act in combination to cause such an illness (Torremocha et al., 2001). In today's generation, the average life span of an individual can be more easily extended because of the development of modern medicine and technology. Aside from that, the aging population also increases quickly. To maintain a healthy body even when a person gets old, the importance of middle-age health management as a primary countermeasure is emphasized all the more. The middle-age period is the time when people pass through the highest then into the low point of physical development. Mostly observed in middle-aged women, the amount of muscles they have is reduced, and their basal metabolic rate is decreased because of hormone imbalance and lack of exercise. When the balance of

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this physical composition is broken, the muscular strength is reduced and causes sarcopenia. In addition to this, the increase in body fat results in obesity (Janssen et al., 2002; Toth et al., 2004).

Meanwhile, obesity increases the attack rate of secondary illnesses caused by various diseases in adults, and the World Health Organization announced that by 2025, the population of diabetic patients will reach 300 million (Kumanyika et al., 2002). For the prevention and treatment of these diseases in adults, multiple measures, such as dietary therapy, exercise therapy, and improvement in living habits, are required, and the effectivity of these countermeasures can be enhanced when they are deliberately selected and performed in combination based on the type and symptom of the disease being treated. Also, because it was revealed that the main cause of chronic degenerative illnesses is the lack of exercise, the necessity of it is emphasized even more as the effective method to prevent and treat adult diseases. In particular, to treat both physical and mental problems as well as the obese condition of middle-age women, doing aerobic exercise is generally recommended (Banz et al., 2003), with swimming as the main type suggested. Compared to other exercises, swimming does not cause too much pressure on the body, and it can be enjoyed by anyone regardless of his/her gender. Also, it is known to reduce the risk of cardiac diseases (Ussher et al., 2003). In the study conducted by Mcneal (1990), the four factors in swimming, including water, buoyancy, water pressure, resistance, and water temperature, were used to show that the effects and stability of this type of exercise can be maximized more than the effects of doing ground exercise. Also, it mentioned that the total cholesterol (T-C), neutral fat (TG), and low-density lipoprotein cholesterol (LDL-C) level that causes cardiovascular disorder can be reduced, and the high-density lipoprotein cholesterol (HDL-C) that play a positive role is increased, making it a very effective form of exercise that significantly treats blood lipids (Clapp and Kiess, 2000).

Considering this, swimming, as an exercise performed in water, reduces the stress in the joints, increases a person's physical strength, and reduces body fat. It also treats blood lipids that cause cardiovascular disorder. However, related studies that summarize and analyze these factors subjected to middle-aged women remain insufficient. Therefore, this study focuses in analyzing the effects of participating in swimming to the physical composition, strength, and blood lipid of middle-aged women in order to provide the basic data to prevent illnesses as well as to recognize the importance of sports activities. It also aims to generalize the possible actions for health enhancement in order to have a better life when a person gets older.

MATERIALS AND METHODS

Study subject

The subjects of this study include middle-aged women (aging from 40 to 60 yr old) who participate regularly in swimming in K-area. With the total of 24 subjects who understand the purpose and agreed to participate in this study, the group (n = 12) that agreed to swim for 60 min, thrice a week, for the span of 12 weeks, and another group that did not participate in swimming (n = 12) were composed. The physical characteristics of the study subject are shown in Table 1.

Measurement items

Physical composition

For physical composition, X-SCAN PLUS II was used for measurement. The subjects of this study were required to remove all metal accessories and their footwear as well as to wear light clothes. They were then asked to stand in an upright position on top of the electrode plate. After inputting their age and gender in the automatic input device, while holding the device, their arms were extended to approximately 30 cm for measurement.

Physical strength

For physical strength, muscular strength (gripping), flexibility (bending the upper body to the front), muscular endurance (sit-ups), and cardiovascular endurance (round-trip long-distance running) were measured.

Blood lipids

For blood collection, the subjects were required to abstain from food and water for more than 12 h, and to take a rest for 20-30 min between 10:00 a.m. and 12:00 p.m. A disposable syringe was used to collect approximately 15 mL of blood from the antecubital vein of a subject's arm for analysis.

Swimming program

The swimming program is a 12-week program to be conducted three times a week. The exercise time for one time is 60 min. The warm-up and cool-down exercises last for 10 min each, and the main exercise last for 40 min. The detailed swimming program is

Table 1. Physical characteristics of the subject

| Group/Factor | Age | Height | Weight (kg) | BMI (kg/m ²) |
|-----------------------|--------------|---------------|--------------|--------------------------|
| Swimming group (n=12) | 45.54 ± 1.65 | 159.24 ± 4.51 | 57.36 ± 3.31 | 22.34 ± 2.58 |
| Control group (n=12) | 47.25 ± 2.03 | 161.85 ± 3.51 | 59.13 ± 4.25 | 23.04 ± 3.42 |

shown in Table 2.

Data processing

To analyze all the data measured in this study, the SPSS Ver 21.0 statistics program was used to calculate the mean (M) and the standard deviation (SD) of all the factors, and the paired t-test was used for the difference verification on the change in mean within the group. The independent t-test was used for the difference verification between the groups. The significance level (α) on all statistics was set as 0.05.

RESULTS

With middle-aged women in K area serving as the subjects, 12 of them in the swimming group and another 12 of them in the control group were used to measure and compare their physical composition (body fat rate, fat-free amount), physical strength (cardiovascular endurance, muscular strength, muscular endurance, flexibility), and blood lipid (T-C, HDL-C, LDL-C, TG) by letting the swimming group perform a one-time, 60-min exercise thrice a week for 12 weeks. The results of the comparison and analysis on its change are shown in Table 3.

Table 2. Swimming program

| | Exercise | Week | Intensity | Frequency |
|------------------------|--|-------------|------------------------|--------------|
| Warm up (10 min) | Stretching | | RPE 79 | |
| Main exercise (40 min) | 1. Freestyle kick | 1 - 6 weeks | 60-70% HRR (RPE 11-13) | 3 times/week |
| | 2. Breathing motion practice | | | |
| | 3. Horizontal floating | | | |
| | 4. Kick while holding onto the kickboard | | | |
| | 5. Freestyle pull | | | |
| | 6. Freestyle combination | | | |
| | 7. Backstroke kick | 7-12 weeks | 70-80% HRR (RPE 13-15) | |
| | 8. Freestyle swim | | | |
| | 9. Backstroke pull | | | |
| | 10. Backstroke combination | | | |
| | 11. Backstroke swim | | | |
| Cool down (10 min) | Stretching | | RPE 79 | |

Table 3. Change in physical composition, strength, and blood lipid

| Factor | Group | Before | After | t | P* | P [#] |
|--------------------------|----------|--------------|--------------|--------|---------|----------------------|
| Body fat rate (%) | Swimming | 29.78±2.18 | 26.87±3.73 | 4.368 | 0.006** | 0.034 [#] |
| | Control | 30.80±4.47 | 32.34±2.87 | 2.918 | 0.365 | |
| Fat-free Amount (kg) | Swimming | 33.26±3.32 | 34.43±5.32 | 3.232 | 0.346 | 0.256 |
| | Control | 32.72±5.43 | 33.09±6.32 | -0.654 | 0.054 | |
| Cardiovascular Endurance | Swimming | 13.41±5.12 | 16.07±6.81 | 4.503 | 0.001** | 0.196 |
| | Control | 12.98±8.92 | 11.97±7.65 | -2.871 | 0.096 | |
| Muscular strength | Swimming | 40.15±5.63 | 41.93±4.80 | 3.873 | 0.518 | 0.132 |
| | Control | 41.87±5.43 | 42.31±4.53 | 1.431 | 0.063 | |
| Muscular endurance | Swimming | 17.05±7.85 | 18.87±6.01 | -1.636 | 0.211 | 0.342 |
| | Control | 16.03±8.54 | 16.87±9.76 | 3.204 | 0.142 | |
| Flexibility | Swimming | 13.43±3.93 | 15.66±5.97 | 2.973 | 0.038* | 0.000 ^{###} |
| | Control | 12.97±3.20 | 12.93±2.31 | 1.732 | 0.238 | |
| T-C (mg/dL) | Swimming | 185.62±28.35 | 173.21±25.17 | 5.988 | 0.003** | 0.000 ^{###} |
| | Control | 182.76±31.25 | 185.22±21.69 | -8.321 | 0.104 | |
| HDL-C (mg/dL) | Swimming | 53.27±11.54 | 58.43±10.32 | -0.987 | 0.013* | 0.132 |
| | Control | 51.25±12.35 | 50.41±9.52 | 1.732 | 0.159 | |
| LDL-C (mg/dL) | Swimming | 123.73±8.50 | 118.03±7.82 | 0.981 | 0.381 | 0.067 |
| | Control | 119.89±9.57 | 125.23±6.31 | -1.332 | 0.150 | |
| TG (mg/dL) | Swimming | 105.29±17.15 | 97.86±14.42 | 3.345 | 0.001** | 0.016 [#] |
| | Control | 109.32±12.39 | 116.11±11.89 | 0.832 | 0.212 | |

*, Difference verification on the change within the group. *P<0.05, **P<0.01. #, Difference verification on the change between the groups. #P<0.05, ###P<0.001.

Change in physical composition

For the fat-free amount, both for the swimming group and the control group, there was no statistically significant difference as a result of the difference verification on the change before and after within and between the groups, and for the body fat rate, the swimming group showed a significant difference as a result of the difference verification before and after the change within the group ($P < 0.01$). However, the control group showed to have no significant difference, but as a result of the difference verification between each group, there was statistically significant difference ($P < 0.05$).

Change on physical strength

For muscular strength and endurance, there was no statistically significant difference as the difference verification result before and after the change within and between the groups, but in flexibility, the result of the difference verification on the change between each group showed a significant increase in the swimming group ($P < 0.05$), and the control group had no significant difference. Meanwhile, as a result of the difference verification between each group, a statistically significant difference ($P < 0.001$) was shown. Also, in cardiovascular endurance, the swimming group showed a significant increase as a result of the difference verification before and after the change within each group ($P < 0.01$), and the control group showed to have no significant difference. Lastly, the difference verification result on the change between each group showed to have no significant difference.

Change in blood lipid

For the T-C, the difference verification result before and after the change between each group showed that the swimming group had a significant decrease ($P < 0.01$), and the control group had no significant difference. Also, as the difference verification result on the change between each group, there was a statistically significant difference ($P < 0.001$). For the HDL-C, the difference verification result before and after the change within each group showed that the swimming group had a significant increase ($P < 0.05$), and the control group showed to have no significant difference. Also, in the difference verification result on the change between each group, there was no statistically significant difference. For the LDL-C, as the difference verification result before and after the change within and between each group, both the swimming group and the control group did not show any significant difference. For the TG, the difference verification result before and after the change between each group showed that the swimming group has a significant decrease ($P < 0.01$), and the

control group had no significant difference. However, in the difference verification result on the change between each group, there was a statistically significant difference ($P < 0.05$).

DISCUSSION

The physical composition quantitatively measures the content of body component and its distribution, and the diagnosis on its rate is enabled by measuring the body composition. As an important element for the health and strength of an individual, it can be largely divided into body fat rate and fat-free amount. Therefore, in this study, as a result of performing 12 weeks of swimming subjected to middle-aged women, the swimming group and the control group all did not show statistically significant difference in the difference verification result before and after the change within and between each group. For the body fat rate, the swimming group showed significant decrease as the difference verification result before and after the change within the group. However, the control group showed to have no significant difference, but on the other hand, in the difference verification result between each group, there was a statistically significant difference. Abdominal fat due to the increase in body fat causes visceral fat, and the increase in this visceral fat is said to be the risk factor that causes many diseases such as metabolic diseases, cardiac disorders, and arthritis (Carr, 2003). As a result of performing aerobic exercise for 12 weeks to middle-aged obese women, it was reported that the body fat rate was reduced (Ito et al., 2001; Nindle et al., 2000). Also, in the study by Gappmaier et al. (2006), middle-aged women performed aerobic exercise in 70% exercise intensity of the maximum heartbeat for 40 min in one time, four times a week for 13 weeks. As a result, the body fat rate showed statistically significant difference, and this supports this study result. Meanwhile, the fat-free amount affects the increase in blood flow and on bone density through the muscular activity, and it is connected directly to exercise ability. However, this study showed to have no statistically significant difference, therefore, improvement is possible through regular and continuous exercise. Physical strength does not simply mean being strong or having no disease, but in other words, it refers to maintaining life and actively defending external stimulation. For this health-related physical fitness, it refers to the muscular strength, muscular endurance, flexibility, and cardiovascular endurance that are directly related to health such as sports injury and chronic illness.

Meanwhile, in this study, the muscular strength and endurance all showed no statistically significant difference as a result of the

difference verification before and after the change within and between each group. In terms of flexibility, the difference verification result on the change between groups showed a significant increase in the swimming group, but the control group showed no significant difference. However, in the difference verification result on the change between each group, there was a statistically significant difference. In cardiovascular endurance, the difference verification result before and after the change within each group showed that the swimming group had significant increase, and the control group showed no significant difference. Also, in the difference verification result before and after the change between each group, there was no statistically significant difference. Based on the study by Van Boxtel et al. (1997), the performing exercise on the body, physiological control is caused for the homeostasis, and as a result, the cardiopulmonary function is strengthened. In the study conducted by Vaitkevicius et al. (2002), it was reported that the middle-aged women who participated in the aerobic exercise program for six months improved in terms of cardiopulmonary strength. Also, in the studies by Fatouros (2002) and Miller et al. (1993), regular exercise improves flexibility and physical balance ability. Meanwhile, it was reported that the movement inside the water is the safest and the most effective exercise that increases the energy consumption to reduce the body weight and increase muscular strength (Belza et al., 2002). In this study, an opposite result was shown, because the subjects were beginners in swimming, and they required much time to adapt to water. In addition, two months of time was too short to complete the training amount of improving muscular strength and endurance.

The change in blood lipid also increases the occurrence rate of circulatory disorders such as coronary artery disease, hypertension, hyperlipidemia, and stroke. Most particularly, the lack of exercise and the increase in body fat of middle-aged women after menopause causes disorder in the lipoprotein metabolism in the blood to result in increase in the density of total cholesterol in the blood, low-density lipoprotein cholesterol, and decrease in the high-density lipoprotein cholesterol density for the biggest cause of cardiovascular disorder (Wallace et al., 1997). In this study, for the T-C, the difference verification result before and after the change within each group showed significant decrease in the swimming group, and the control group showed no significant difference. Meanwhile, the difference verification result on the change between each group showed to have a statistically significant difference. For the HDL-C, the difference verification result before and after the change within each group showed a significant increase in the swimming group, and the control group showed no signifi-

cant difference. Also, in the difference verification result on change between each group, it showed to have no statistically significant difference. For the LDL-C, the difference verification result on the before and after change within and between each group showed no statistically significant change in all swimming group and the control group. For the TG, the difference verification result before and after the change within each group showed a significant decrease in the swimming group, and the control group showed no significant change. Also, the difference verification result on the change between each group showed to have a statistically significant change. It was reported that regular aerobic exercise reduces the T-C, LDL-C, and TG density, and it increases HDL-C density (Motoyama et al., 1995). In the study by Maso et al. (2002), as a result of exercising for people with sedentary work, the TC level decreased significantly after 10 weeks. Also, it was reported that aerobic exercise has a positive effect on increasing the HDL-C density, which is one of the elements affecting the cardiovascular system. In the study conducted by Booth (2000), regular exercise is said to reduce the cholesterol related to the blood lipid metabolism.

Meanwhile, as a result of this study, LDL-C showed to have no statistically significant difference, and in the study conducted by Tanaka (1997), middle-aged women were divided into women skillful in swimming and women that were not skillful in swimming to test the effect to LDL-C, and the result showed to have no statistically significant difference, which matched the result of this study. However, because the increase in blood LDL-C level is deeply related to cardiovascular disorders, such as arteriosclerosis, the arteriosclerosis can begin or be stimulated if it is maintained highly (Stein, 2000). Therefore, it is considered that consistent and continuous exercise is required to reduce the level.

In this study, the effect of regular swimming exercise on the physical composition, strength, and blood lipid of middle-aged women were compared and analyzed to obtain the following results. First, for the physical composition, a significant decrease in body fat rate was enabled in the swimming group as a before and after result within each group. Also, in the difference verification result between each group, a statistically significant difference was shown. Second, for the physical strength, the result within each group before and after showed that the swimming group increased significantly in terms of flexibility and cardiovascular endurance. Also, in the difference verification result between each group, the flexibility and cardiovascular endurance showed a statistically significant difference. Lastly, for the blood lipid, the result within each group before and after showed that the swim-

ming group increased significantly in T-C and TG, and the HDL-C increased significantly. Also, in the difference verification result between each group, T-C and TG showed a statistically significant difference.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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