The purpose of this study was to develop a complex exercise program integrating Eastern and Western complex exercise rehabilitation programs in order to examine the effects of it on the human body with the subjects for women of the II period of mature age with metabolic syndrome. The subjects of this study are 60 II period of mature aged women with metabolic syndrome living in G City, and the experimental group conducted Taekwon-aerobic exercise, European rehabilitation gymnastics, gym ball exercise, and elastic band exercise while the control group performed European rehabilitation gymnastics, gym ball exercise, and elastic band exercise which is the rehabilitation program being presently conducted in Russia, for 90 min per day for three weeks. Two-way ANOVA with repeated measures was utilized to verify pre- and post-intergroup difference, and the significant level was set as P<0.05. Whereas body weight, % fat, WHR, SBP, DBP and blood glucose were significant decreased, muscle weight and pulse wave velocity were significant increased after complex exercise rehabilitation programs Both Eastern and Western complex exercise rehabilitation programs showed positive effects on the body of the II period of mature aged women with metabolic syndrome, and if various exercise programs are conducted, it will be more effective in improving II period of mature aged women's metabolic syndrome afterwards.

Keywords: Physical rehabilitation, Women of mature age, Metabolic syndrome

INTRODUCTION

Middle-aged women on average 45-55 yr old begin to undergo menopausal symptoms with the reduction of estrogen hormones. At this stage, the risk of heart disease and metabolic disorders to the women increase and muscle pain, joint pain, tachycardia, weight gain, fatigue, dizziness, attention deficit disorder, depression, anxiety, memory loss, insomnia, stress and others can be caused by physical and mental changes (Kulakov and Vikhlyrva, 2006).

Generally, many women like to take food and hate to move during this period. A scale of cholesterol causes high blood pressure in the blood vessels and cardiovascular disease and metabolic syndrome occur and become worse.

20-30% of the population in western developed countries already have metabolic syndrome, and it is predicted that metabolic syndrome patients over 50 million to 75 million may develop in these countries soon by doctors (Chazova and Meuchka, 2003). Metabolic syndrome is not directly associated with life, but it can be dangerous because other dangerous complications may be caused (Chirkin and Golubev, 2002; Druzhinin et al., 2005; Lifshitz et al., 2000). Korean women's average life expectancy is 82 yr (Male 79 yr), but the difference between patients and the normal average life expectancy is big and the quality of life shows a significant difference in health. There are each disease-specific drug therapy and exercise therapy for the treatment of metabolic syndrome.

Drug therapy alleviates disease quickly and easily, but it has side effects of medication. In contrast, exercise therapy provides the overall positive impact such as cardiovascular, metabolic function, musculoskeletal system, nervous system function and is effective in improving metabolic syndrome (Avdulina, 1986). Taekwon Aerobics among exercise programs can match the full body endurance exercise for middle-aged women because it's already
well-known worldwide by the benefits of Taekwondo and can increase the amount of aerobic exercise that is necessary for patients. In addition, this program can get rid of the boredom of exercise by performing with music and enjoy the effect of the exercise joyfully, so it is considered as a developing exercise program not only for Korea but for the whole world.

Complex exercise program that includes aerobic exercise decreases weight and promotes health of all organs, and it can have a positive influence on the prevention and treatment of metabolic syndrome and its complications. Complex exercise rehabilitation program combined Taekwon Aerobics of Korea and exercise rehabilitation program of Russia matches the benefits of exercise rehabilitation program of eastern and western society at the same time, and seems to be the distributing means of Korea’s exercise rehabilitation program to many people with fun and effective.

MATERIALS AND METHODS

Subjects

This study classified 60 middle-aged women into the experimental group 30 persons and the control group 30 persons, who had no symptom through medical history talking inspection and no special disease to perform exercise suffering with metabolic syndrome in G city. The physical characteristics of the subjects are shown in Table 1.

Design of experiments

Design of experiments conducted Taekwon-aerobics, therapeutic gymnastics, large rubber balls and elastic bands in the experimental group, and therapeutic gymnastics, large rubber balls and elastic bands in the control group for the women with obesity, high blood pressure and diabetes among women aged 45 to 55 yr in order to analyze the effect of complex exercise rehabilitation program combined Korea’s exercise program to middle-aged women suffering with metabolic syndrome. Body composition, blood pressure, blood glucose, waist and hip circumference and blood vessels elasticity advance were checked and compared for 3 times in advance, after months, after 6 months (post-experiments) to compare the efficiency by each group.

Experimental procedures and measuring methods

Body composition

Measuring the height using extensometer and weight, body fat percentage, body fat mass, lean body mass, abdominal fat rate and muscle mass using Inbody (Olympia 3.3: Jawon Medical, Gyeongsan, Korea).

Blood pressure, blood sugar

Measuring systolic blood pressure and diastolic blood pressure using sphygmomanometer (FT-500R: Jawon Medical, Gyeongsan, Korea) after stabilizing subjects for more than 10 min.

Measuring empty stomach blood sugar level using Blood Glucose Meter (ACCU-Chek, Model GC) with blood 1-2 μL sample.

Waist, hip circumference

Measuring waist circumference of the subjects, collecting arms on the side of the stand, the narrowest part of the torso of the subject, without pressing the skin to breath in the final stages of the tape measure horizontal 0.1 cm until measured.

Vessel elasticity

Measuring pulse wave velocity using Pulse Wave Velocity 3.0 (KM tec, Anyang, Korea), All metallic materials such as necklaces, rings, watches, etc. were removed before measurement. 2 EKG Electrodes on the left forearm and 1 on the right forearm in a supine position for stability, attaching pulse and sensor to the thumb for upper limbs measurement, and then, to the big toe for lower limbs measurement;

Making subjects do not move or say during measurement, calculating the average value from the selected confidence interval of 20 sec among the automatic measured data of 30 sec.

Exercise program

Complex exercise program used on this study is the complex exercise rehabilitation program combined Taekwon aerobics to the complex exercise rehabilitation program of Russia, and the procedure is 90 min a day, 3 days a week, for 6 months and the intensity of exercise is increased through 4 steps (adaptive stage 1-4 weeks, introduction stage 5-8 weeks, improving stage 9-20 weeks, maintenance stage 21-24 weeks).

Taekwondo aerobics is comprised of about 80% of default behavior, configure and competing based on the Taekwondo training.
courses presented at Kukkiwon, and the complex exercise is made up of European gymnastics, large rubber balls and elastic bands based on Astashenko (2009) conducted in Russia.

The first four weeks is the adaptive stage and conducting movement and behavior oriented learning and Taekwon Aerobics without music oriented learning the default behavior during this period. In next stage for 5-8 weeks, the load increases gradually by increasing the number of iterations of all the action and Taekwon aerobics of steps, kick, pierce and strike is conducted repeatedly with not fast music tempo for accuracy and learning.

In the improving stage, all of the exercise intensity and the number with the maximal load is increased and Taekwon aerobics increases the exercise intensity to 70% HRmax and the number of iterations with the fast music tempo, and the execution time gradually for more aerobic capacity. At the last 4 weeks, the program makes the body recover with gradual lowering of intensity and keep the precise movement behavior by conducting the exercise rehabilitation program alone after this experiment.

**Data processing**

The average and standard deviation to all variables of collected data was calculated using SPSS Statistics 19 program. The repeated measure ANOVA was executed to compare the interaction between the groups and the time interval according to 6 months' complex exercise rehabilitation program, and all statistical significance level was set to $P < 0.05$.

**RESULTS**

The results of this study on the effectiveness of the complex exercise rehabilitation program for the middle-aged women suffering with metabolic syndrome are as follows:

**Changes in body composition**

The result of Changes in body composition shows 1.7 kg loss of weight in the experimental group and 0.82 kg in the control group as shown in Table 2. There was no significant difference between two groups, but a significant difference appeared between the time interval ($P < 0.001$).

The percentage body fat showed the significant result in the comparisons between groups ($P < 0.001$) and the significant effect was shown as 0.61% loss of weight in the experimental group and 0.32% in the control group. The abdominal obesity rate showed 0.02% loss of weight in the experimental group and no changes in the control group, and there was a significant difference in the times ($P < 0.05$) and the difference in interaction ($P < 0.05$) between the groups and the time. Also, the muscle mass showed the significant differences in groups ($P < 0.001$) as 0.01 kg loss of weight in the experimental group and 0.08 kg gain of weight in the control group.

| Table 2. Changes in body composition |
|-------------------------------------|
| Variables               | Groups | In advance | After 3 mth | Post-experiment | F     | P    |
| Weight                  | Experi. | 64.02 ± 7.68 | 62.65 ± 7.36 | 62.65 ± 7.86 | Group: 0.000 | 0.993 |
|                        | Control | 63.7 ± 9.3   | 62.99 ± 9.25 | 62.88 ± 9.28 | Time: 14.872  | 0.000$^4$ |
|                        |        |             |             |                | Group*time: 0.941 | 0.393 |
| Body fat percentage    | Experi. | 36.62 ± 2.7  | 36.01 ± 2.81 | 36.01 ± 3   | Group: 0.399 | 0.000$^4$ |
|                        | Control | 35.98 ± 2.69 | 35.68 ± 2.94 | 35.66 ± 3.03 | Time: 2.765  | 0.067 |
|                        |        |             |             |                | Group*time: 0.329 | 0.72 |
| Body fat mass          | Experi. | 23.82 ± 4.97 | 23.7 ± 5.31  | 24.09 ± 5.77 | Group: 0.604 | 0.44  |
|                        | Control | 23.08 ± 5.11 | 22.9 ± 5.52  | 22.6 ± 5.11  | Time: 0.075  | 0.928 |
|                        |        |             |             |                | Group*time: 0.558 | 0.574 |
| Lean body              | Experi. | 40.23 ± 3.68 | 39.08 ± 7.52 | 40.05 ± 3.69 | Group: 0.024 | 0.879 |
|                        | Control | 40.12 ± 5.83 | 39.93 ± 5.87 | 39.93 ± 5.8  | Time: 1.725  | 0.187 |
|                        |        |             |             |                | Group*time: 0.512 | 0.602 |
| Abdominal fat rate     | Experi. | 0.95 ± 0.04  | 0.93 ± 0.04  | 0.93 ± 0.04  | Group: 0.034 | 0.85  |
|                        | Control | 0.94 ± 0.04  | 0.94 ± 0.05  | 0.94 ± 0.05  | Time: 5.457  | 0.005$^4$ |
|                        |        |             |             |                | Group*time: 3.186  | 0.045$^4$ |
| Muscle mass            | Experi. | 36.77 ± 3.33 | 36.68 ± 3.24 | 36.78 ± 3.27 | Group: 0.031 | 0.000$^4$ |
|                        | Control | 36.9 ± 4.17  | 36.86 ± 4.11 | 36.98 ± 4   | Time: 0.887  | 0.507 |
|                        |        |             |             |                | Group*time: 0.0.33 | 0.968 |

$^4$Represents $P<0.05$; $^3$Represents $P<0.01$; $^2$Represents $P<0.001$. 

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Changes in blood pressure and blood sugar

The result of Changes in Blood pressure and Blood sugar shows no significant difference in groups as 5.48 mmHg loss of systolic blood pressure in the experimental group and 17.44 mmHg loss in the control group, but the significant differences appeared in the time (P < 0.001) and the interaction (P < 0.05) between the groups and the time as shown in Table 3. At diastolic blood pressure, there was no significant difference in groups also as 0.27 mmHg loss of diastolic blood pressure in the experimental group and 7.24 mmHg loss in the control group, but the significant differences appeared in the time (P < 0.05) and the interaction (P < 0.05) between the groups and the time. In Blood sugar, there was no significant difference in groups as 29.33 mg/dL loss of blood sugar in the experimental group and 24.1 mg/dL loss in the control group, but the significant differences appeared in the time (P < 0.001).

Changes in waist and hip circumference

The result of Changes in waist and hip circumference shows no significant difference in groups as 1.65 cm loss of waist circumference in the experimental group and 1.32 cm loss in the control group, but the significant differences appeared in the time (P < 0.001) as shown in Table 4. In hip circumference, there was a significant difference as 1.04 cm loss of hip circumference in the experimental group and 0.75 cm loss in the control group, and the time (P < 0.001), too.

Change in vessel elasticity

The result pulse wave velocity shows a significant difference in groups (P < 0.01) as 27.5 ms gain of pulse wave velocity in the experimental group and 1.36 ms gain in the control group on the left hand of upper limbs as shown in Table 5. On the right hand, there were the significant differences in groups (P < 0.05) and the time (P < 0.01) as 26.28 ms gain in the experimental group and 3.12 ms gain in the control group. On the left foot, there was a significant difference in groups (P < 0.01) as 11.58 ms gain in the experimental group and 7.44 ms loss in the control group, and the interaction (P < 0.05) between the groups and the time, too. On the right foot, there were the significant differences in groups (P < 0.05) and the time (P < 0.05) as 12.47 ms gain in the experimental group and 9.58 ms gain in the control group. It seems that the program of the experimental group effects significantly to the change of pulse wave velocity according to the significant differences on both limbs in groups.

### Table 3. Changes in blood pressure and blood sugar

| Variables            | Groups   | In advance | After 3 mth | Post-experiment | F     | P     |
|----------------------|----------|------------|-------------|-----------------|-------|-------|
| Systolic blood pressure | Experi.  | 141.93±11.59 | 138.83±13.02 | 136.45±13.67 | Group  | 0.006 | 0.938 |
|                      | Control  | 147.17±17  | 139.57±20.08 | 129.73±15.45 | Time   | 15.367 | 0.00b |
|                      |          |            |             |                 | Group*time | 3.83  | 0.027a|
| Diastolic blood pressure | Experi.  | 78.6±8.52  | 78.27±9.35  | 78.33±9.25    | Group  | 41.08 | 0.622 |
|                      | Control  | 80.67±8.29 | 78.23±8.57  | 73.43±9.84    | Time   | 4.634 | 0.014a|
|                      |          |            |             |                 | Group*time | 3.949 | 0.025a|
| Blood sugar          | Experi.  | 154.9±40.42 | 130.47±23.44 | 125.57±23.3 | Group  | 0.171 | 0.681 |
|                      | Control  | 147.9±18.39 | 132.83±17.85 | 123.8±16.3   | Time   | 36.884 | 0.004a|
|                      |          |            |             |                 | Group*time | 1.058 | 0.351 |

*Represents P<0.05; †Represents P<0.001.

### Table 4. Result of changes in waist and hip circumference

| Variables          | Groups   | In advance | After 3 mth | Post-experiment | F     | P     |
|--------------------|----------|------------|-------------|-----------------|-------|-------|
| Waist circumference | Experi.  | 104.84±4.62 | 103.66±4.49 | 102.99±4.7     | Group  | 3.05  | 0.086 |
|                    | Control  | 102.26±5.67 | 101.36±5.3  | 100.94±5.24    | Time   | 35.379 | 0.00b |
|                    |          |            |             |                 | Group*time | 0.476 | 0.623 |
| Hip circumference  | Experi.  | 106.5±3.86  | 105.85±3.68 | 105.46±3.9     | Group  | 8.53  | 0.005a|
|                    | Control  | 103.53±3.96 | 102.94±3.76 | 102.78±3.82    | Time   | 38.993 | 0.00b |
|                    |          |            |             |                 | Group*time | 1.088 | 0.34  |

*Represents P<0.01; †Represents P<0.001.
DISCUSSION

Metabolic syndrome is the disease (Almazov, 1999; Chazova, 2011) increasing the amount of visceral fat and inducing the insulin sensitivity decrease and hyperinsulinemia causing the metabolic disorder of carbohydrate, lipid and purine metabolism and hypertension, so western industrialized countries as well as Korea have given more attention and research for it in recent years. This study tried to investigate the effects of the complex exercise rehabilitation program to the middle-aged women suffering with metabolic syndrome. The results of this study on changes in body composition show the significant results in weight and abdominal fat rate between the time interval, and the significant differences in body fat percentage and muscle mass at the groups, and a significant difference in abdominal fat rate at the interaction between the group and time.

The results were similar to the study of Lee et al. (2009) showed the significant decreases of body composition conducting the aerobic and strength complex exercise with the obese middle-aged women for 8 weeks, 5 times a week, and matched by the result of study of Jung and Kim (2003) conducted strength and aerobic complex exercise with obese middle-aged women for 12 weeks in terms of the giving valid impact to body composition.

The blood pressure on this study has been improved high blood pressure Phase 1 to normal levels of subjects. However, comparing with the study of Jung and Kim (1998) conducted the exercise management by middle-aged women diagnosed with metabolic syndrome separated in interval training group and aerobic exercise group for 12 weeks, 5 times a week, the results of this study is judged more effective, also with the study of Lee and Lee (2007) conducted the sports dance with abdominal obese women for 12 weeks, this study shows more significant effect in systolic blood pressure, so it’s considered that the complex exercise program is more effective for the blood pressure stabilization than the single exercise.

The risk of metabolic syndrome by Hormonal changes is more serious for middle-aged women in menopausal, especially, the risk of diabetes increases more by the disorder of carbohydrate metabolism (Chazova, 2011). In this study, the levels of blood sugar was improved to normal levels after the experiment and showed a significant difference at the time statistically, and this result was similar to the study of Lee et al. (2009) studied the effects of long-term aerobic exercise with middle-aged women according to the activity of the parasympathetic nervous system in showing a significant change of glucose, also shows more effective impact than the result of 13.24 mg/dL of decrease and no significant difference statistically at the study of An (2000) studied the impact of regular exercise to middle-aged women for 10 weeks, 4 times a week.

Thus, it’s considered that continuous long-term exercise is more effective than short-term one in the changes of blood glucose levels (Kustova, 2004). With the beginning of menopausal, the fat layer of waist and hips of middle-aged women become thicker and those circumferences increase. The problem is not only for appearance but for health (Zholondz, 1999). At the results of this

### Table 5. The result of vessel elasticity

| Variables                  | Groups   | In advance | After 3 mth | Post-experiment | F      | P  |
|----------------------------|----------|------------|-------------|-----------------|--------|----|
| Variables left hand of upper limb | Experi.  | 219.73 ± 69.58 | 214.87 ± 32.76 | 247.23 ± 84.57 | Group  | 7.766 | 0.007<sup>a</sup> |
|                           | Control  | 200.77 ± 25.5  | 209.93 ± 24.7 | 202.06 ± 25.53 | Time   | 2.704 | 0.076 |
|                           |          | Group*time   | 2.747       | 0.073           |
| Right hand of upper limb   | Experi.  | 210.23 ± 17.45 | 220.16 ± 23.41 | 236.52 ± 69.75 | Group  | 6.528 | 0.013<sup>a</sup> |
|                           | Control  | 202.52 ± 32.42 | 212.3 ± 22.24 | 205.64 ± 26.08 | Time   | 5.890 | 0.009<sup>a</sup> |
|                           |          | Group*time   | 1.269       | 0.289           |
| Left foot of lower limb    | Experi.  | 265 ± 19.06   | 266.04 ± 19.94 | 276.58 ± 44.62 | Group  | 8.956 | 0.004<sup>a</sup> |
|                           | Control  | 247.28 ± 43.3  | 261.32 ± 29.6 | 239.84 ± 66.32 | Time   | 1.723 | 1.187 |
|                           |          | Group*time   | 3.498       | 0.037<sup>a</sup> |
| Right foot of lower limb   | Experi.  | 263.94 ± 18.28 | 268.14 ± 17.54 | 276.36 ± 36.89 | Group  | 4.531 | 0.038<sup>a</sup> |
|                           | Control  | 250.41 ± 35.69 | 264.26 ± 29.01 | 259.99 ± 28.51 | Time   | 3.345 | 0.042<sup>a</sup> |
|                           |          | Group*time   | 1.656       | 0.2             |

<sup>a</sup>Represents P<0.05; <sup>b</sup>Represents P<0.01.
study on the circumferences of waist and hips, the circumferences of waist showed the significant differences at the time interval and that of hips showed the significant differences at both of the group and the time, but the decrease value was small compared to the study of Kim and An (2003) conducted diet, exercise, behavior modification therapy and aromatherapy abdominal massage to middle-aged women with abdominal obesity for 10 weeks.

Like the results of the study of Despres et al. (1985), only a regular aerobic exercise without dieting can reduce body fat and prevent the reduction of lean body mass. However, according to the study of Pavalou et al. (1985), exercise therapy is more effective when paired with diet for reducing fat, so it’s considered that the complex exercise rehabilitation program combined with the diet therapy produce more effective results.

Pulse wave velocity decreases with age, especially, seems a drastic decline after age of 45. Pulse wave velocity is measured by the pulse transit time and that time is changed by the length of the blood vessels, its diameter and thickness of the wall, and the pulse transit time becomes faster by the reduction of pulse wave velocity according to cardiovascular disease, diabetes, aging and others. The result of this study on pulse wave velocity showed the significant differences in left hand of upper limbs, right hand and left foot of lower limbs and right foot at all groups, and the significant differences in right hand of upper limbs and left foot of lower limbs at the time, and the pulse transit time increased significantly compared to not changed significantly in the control group mathematically. This result showed the effective impact compared to the study of Park and Choi (2010) conducted with middle-aged women classified in circuit resistance exercise group and aerobic exercise group and showed the significant differences only in left hand and left foot, at the study of Lee and Lee (2006) conducted the complex exercise with middle-aged obese women, the result showed the significant increase of pulse wave velocity similar to this study.

Like this, a complex exercise program is more effective for vascular elasticity than a single exercise such as resistance exercise or aerobic exercise and it’s considered that the complex exercise program is effective for cardiovascular diseases, diabetes and improving of vascular elasticity.

Likewise, this study shows that the complex exercise rehabilitation program is effective to improve metabolic syndrome of middle-aged women, especially, a effective result appeared in European complex exercise rehabilitation program of the control group, but the more effective result was shown in the complex exercise rehabilitation program of the experimental group, which was reinforced by Taekwon Aerobics to increase the intensity of aerobic exercise. Furthermore, it will provide the effects to depression and psychological impact on menopausal symptoms combining with music and it’s considered that this complex exercise rehabilitation program can be useful not only for Korea but also for any other countries in the world. Now the level of exercise rehabilitation program for metabolic syndrome is lagging behind the West, nevertheless, it’s needed to inform actively that the effect of the exercise program in Korea does not fall behind at all and strive continually to research and develop more efficient exercise rehabilitation program.

CONCLUSIONS

This study compared and analyzed the complex exercise rehabilitation program combined Taekwon Aerobics and the complex exercise rehabilitation program of Europe, 90 min a day, 3 days a week, for 6 months, and the results are as follows:

1) The weight of the body composition showed the significant difference in the time interval (\( P < 0.001 \)), and the percentage of body fat showed the significant difference in the groups (\( P < 0.001 \)). The rate of abdominal obesity showed the significant difference in the time interval (\( P < 0.01 \)) and also in the interaction effect (\( P < 0.05 \)). The muscle mass showed the significant difference in the groups (\( P < 0.001 \)).

2) The blood pressure showed the significant difference at the systolic blood pressure in the time interval (\( P < 0.001 \)), and the interaction effect between the groups and the time (\( P < 0.05 \)). The significant difference appeared at the diastolic blood pressure (\( P < 0.05 \)), and also in the interaction effect (\( P < 0.05 \)). The blood glucose levels showed the significant difference in the time interval (\( P < 0.001 \)).

3) The waist circumference showed the significant difference in the time interval (\( P < 0.001 \)), and the hip circumference showed the significant difference in the groups (\( P < 0.001 \)) and the time interval (\( P < 0.001 \)).

4) The pulse wave velocity showed the significant difference on the left hand of upper limbs in the groups (\( P < 0.01 \)), and on the right hand showed the significant difference in the groups (\( P < 0.05 \)) and the time interval (\( P < 0.01 \)). The left foot of lower limbs showed the significant difference in the groups (\( P < 0.05 \)) and the right foot showed the significant difference in the groups (\( P < 0.05 \)) and the time interval (\( P < 0.05 \)).

Based on these results, it’s considered that the complex exercise rehabilitation program can be applied effectively to improve the
metabolic syndrome.

CONFLICT OF INTEREST

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

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