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ORIGINAL PAPER

Effects of muscular and aqua aerobic combined exercise on metabolic indices in elderly women with metabolic syndrome

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ABSTRACT

The purpose of this study was to investigate the effects of muscle strengthening exercise using elastic thera-band and aquatic aerobic combined exercise on metabolic syndrome index in elderly with metabolic syndrome. Fifty-four were assigned to muscle strengthening exercise group (n = 19), aquatic aerobic exercise group (n = 19), and combined exercise group (n = 16). The muscle strength exercise, aquatic aerobic exercise and combined exercise were provided three times a week for 12 weeks. Metabolic syndrome indices[Fasting blood glucose, triglyceride, high density lipoprotein cholesterol (HDL-C), systolic blood pressure, diastolic blood pressure and waist circumference] were measured before and after the program. One-way ANOVA, paired t-test and two-way repeated ANOVA were used with the SPSS program for data analysis. There was a significant difference in triglyceride ($p < .001$), HDL-C ($p = .010$) and waist circumference ($p = .016$). Triglyceride and waist circumference was significantly decreased in combined group than muscle strength exercise group and aquatic exercise group. HDL-C was significantly increased in combined group than muscle strength exercise group. The results indicate that combined exercise was more effective in the improvement of dyslipidemia and abdominal obesity.

Keywords: elderly, metabolic syndrome, exercise

INTRODUCTION

According to the in-depth survey report on the 2005 Korea national Health and Nutrition Examination Survey, the overall prevalence rate of the metabolic syndrome tends to increase with older ages by comparison of the gender and ages, the male group with the age of 50-59 years old reaches the highest point of 44.7% of the assumed prevalence rate of the metabolic syndrome and the female group with older than 70 years old marks the highest point of 55.1% due to the increase in the prevalence rate of the metabolic syndrome with older ages. In particular, the prevalence rate of the metabolic syndrome for the female with the age of 60-69 and over 70 years old is significantly higher than the male group and it is indicated that it is required to manage the metabolic syndrome for the elderly female group [1]. In particular, the women in the menopause are exposed to the danger of the metabolic diseases due to various harmful side effects of the menopause and the prevalence rate is also high [2]. However, only 39.1% of the senior perform regular exercise (more than 150 minute per week) even though they should perform physical activities to manage such metabolic diseases [3].

The aerobics, one of the various exercises performed in the metabolic syndrome, is good to reduce the abdominal fat but it is reported that the resistance exercise increases the metabolic syndrome by upgrading the muscle quantity and the effect of the aerobics [4]. The effects of the combined exercise are proven by Kim *et al*. [5] who showed the improvement in the metabolic syndrome indicators, decrease in the blood sugar level and insulin level and increase in the physical fitness by performing the combined exercise of aerobic and resistance exercise for middle-aged women with the metabolic syndrome and Ban *et al*. [6] who showed effects in the body composition, metabolic syndrome indicator and

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physical fitness through the combined exercise for obese middle-aged women. In particular, the combined exercise is recommended as people claim burden and boredom in time due to aerobic and muscular strength exercise [7]. However, the aquatic exercise which may reduce the burden on the joints may be a useful alternative by utilizing physical features of the medium including static water pressure and temperature, buoyancy and muscular strength exercise using the elastic resistance for the senior due to injury or damage from excessive physical activities. Considering the elements of the physical fitness in the senior, the fitness using relatively safe elastic band is widely used and the aqua aerobic is used for certain disease groups with burden on the joints but it is confirmed effective in the physical fitness, physical composition and metabolic syndrome indicators [8].

Various exercise methods have been applied based on such positive effects of the exercise but in many cases, one exercise with aerobic or resistance exercise is performed or mainly based on the aerobic exercise on the ground or in the water. First, the studies on comparing the ground and underwater sports include Kim *et al*. [9] reporting that the aerobic on the ground and in the water is more effective than the ground aerobic in the metabolic syndrome indicators for metabolic syndrome patients and Kim [10] reports that the ground and underwater exercise shows significant difference in the CRP and Fibrinogen and the underwater exercise is more effective than the ground exercise. The positive effects in the ground and underwater exercise are different for the metabolic syndrome. The studies on walking on the ground and underwater improve the cardiovascular prediction indicators for healthy people [11]. There are rare prior studies on the ground and underwater exercise simultaneously but it is reported that the chronic hemiplegic patients with ground and underwater exercise show positive effect on the physical fitness for daily activities and range of motion than only with the underwater exercise [12].

Most prior studies cover the exercise program for 60 minutes with the warm-up, cool-down, aerobic and resistance exercise in a program. The study compares the effect of combined exercise with the ground band exercise (once a week) and aqua aerobic exercise (twice a week) on the metabolic syndrome indicators for female women with the metabolic syndrome to a single exercise and is used as the basic data to form effective health promotion program.

RESEARCH METHOD

Research subjects

The initial research subjects are 25 people in the muscular strength group using the elastic band (hereafter the muscle strengthening exercise using elastic thera-band), 25 people in the aqua aerobic exercise group and 25 people in the combined exercise group with the muscle strengthening exercise using elastic thera-band and the aqua aerobic exercise. However, the subjects without continuous participation or not in the post-test after the exercise program are removed and the final participants are 54 including 19 in the muscle strengthening exercise using elastic thera-band group, 19 in the aqua aerobic exercise group and 16 in the combined exercise group (dropout rate: 11.6%).

The sample number of the study is calculated based on the fact a total of 45 subjects are required to achieve effect size of 0.25, power of test .95 and alpha level of .05. in the ANOVA test of the G*power [13]. General characteristics of the subjects are in Table 1.

The selection criteria are 3 of 5 diagnosis criteria for the metabolic syndrome below and the subjects are women older than 65 years old, may communication with each other and have not done continuous exercise for 6 months prior to the program initiation. The diagnosis criteria for the metabolic syndrome is based on the National Cholesterol Education Program Adult Treatment Panel (NCEP ATP) III [14] and uses the waist circumference proposed by the Korean Society for the Study of Obesity [15] and the downward standard of the impaired fasting glucose proposed by the American Diabetes Association [16].

1) Higher than 100mg/dl of the fasting blood sugar, insulin injection or oral hypoglycaemic agent administration
2) Higher than 150mg/dl of the triglyceride
3) Less than 50mg/dl of the high density lipoprotein-Cholesterol; hereafter HDL-C)
4) Higher than 130mmHg of the systolic blood pressure or 85mmHg of the diastolic blood pressure, currently

Table 1. General characteristics of the subjects

Characteristics	Muscle	Aqua	Combined
Age (year)	71.20 ± 2.60	70.89 ± 3.32	71.14 ± 3.11
Height (cm)	153.68 ± 5.08	155.33 ± 3.75	154.94 ± 5.72
Weight (kg)	58.27 ± 5.70	63.24 ± 5.62	59.38 ± 6.46
Body mass index (kg/m^2)	24.72 ± 2.58	26.19 ± 1.90	24.75 ± 2.63

Muscle; Muscle strengthening exercise using elastic thera-band, Aqua; Aqua aerobic exercise, Combined; Muscle strengthening exercise using elastic thera-band and aqua aerobic exercise

under hypertension drugs
5) Longer than 85cm of the waist circumference

Data selection period and method

The data selection period is between March and July 2013 and is performed for each group of participants who agree to join the program prepared by the healthcare center. The metabolic syndrome indicators (fasting blood sugar, blood pressure, triglyceride, HDL-C and waist circumference) are measured prior to performing the muscle strengthening exercise using elastic thera-band, aqua aerobic exercise and combined exercise and measured again after completing the 12-week program.

Intervention

The combined exercise program with the muscle strengthening exercise using elastic thera-band and the aqua aerobic exercise is shown in Table 2.

Muscle strengthening exercise using elastic thera-band

The muscular strength exercise program goes for 60 minutes a day, 3 times a week with 10 minutes of warm-up, 10 minutes of cool-down and 40 minutes of main exercise using the thera-band with elasticity and the exercise strength uses the Rating of Perceived Exertion (hereafter, RPE). The study refers to the exercise material which provides elderly sports, youth and vigor [17,18] and the material is modified to the study. The first one week is the adaptation period with yellow and red bands with the strength of 11-12 (light), with the strength of 13-14 (somewhat Hard) and red and yellow bands with the strength of 15-16 (hard) to gradually increase the exercise strength. The strength of the elastic band (Thera-band; Hygenic Co., USA) consists of yellow (0.7/1.0/1.1 kg, 20/40/70 cm), red (0.9/1.6/2.0 kg, 20/40/70 cm) and green (1.1/1.9/2.3 kg, 20/40/70 cm) bands and the band is selected to perform an action more than 10 times.

Aqua aerobic exercise

The aqua aerobic exercise consists of a program of 60 minutes including 10 minutes of warm-up, 10 minutes of cool-down and 40 minutes of main exercise 3 times a week

Table 2. Exercise program

Order	Contents	Week/Intensity		BPM/Set	Time (min)
Warm-up	Stretching	Band Exercise	Combined Exercise		10
Muscle strength exercise	• Arm curl • Triceps extension • Bent over row • Good morning • Shoulder press • Up-right row • Squat • Lunge • Chest press • Crunch • Leg raise	1 weeks/ 11-12 RPE	1-2weeks/ 11-12 RPE	15/3,15/2	40
		2-6 weeks/ 13-14 RPE	3-7 weeks/ 13-14 RPE	20/2,15/3	
		7-12 weeks/ 15-16 RPE	8-12 weeks/ 15-16 RPE	20/3,20/2	
Aqua aerobic exercise	• Bounce-front, back, slide, side, twist • Knee jogging-narrow, wide • Jumping jack-front, back, side • Scissors & pendulum • Jazz kick & soccer kick • Rocking horse • Leaping- front, side • Heel cross, ankle reach • Kick & hold, mambo step, • Leg swing, kick swing • Frog jump, tuck jump • Touch bounce, jig, • Leg curl • Twist heel & toe • Kick-front, back, side • Side step, step & cross • Ankle inversion, eversion, dorsiflexion, plantar flexion	1-2 weeks/ 11-12 RPE		110~120	40
		3-7 weeks/ 13-14 RPE		120～140	
		8-12 weeks/ 15-16 RPE		120～140	
Cool-down	Stretching				10

RPE: Rating of perceived exertion

based on the manual used by the Korea Aquatic Exercise Association and the exercise strength uses the RPE.

The warm-up is for 10 minutes of standing jump to maintain the body temperature. The main exercise implements the gradual increase from the adaptation period of the first 1-2 weeks with the strength of 11-12 (light), 3-7 weeks with the strength of 13-14 (somewhat hard) and 8-12 weeks with the strength of 15-16 (hard). The cool-down is 10 minutes of the dynamic stretching. Also, the beat, important in the movement of the subject in the aquatic aerobic, is 110-140bpm, 110-120bpm for the cool-down and jogging, dance and flexible gymnastics are applied in the water to strengthen the cardiovascular endurance with 120-140bpm to increase the calorie consumption.

Combined exercise

The combined exercise consists of the muscle strengthening exercise using elastic thera-band once a week and the aqua aerobic exercise twice a week for 60 minutes each with 10 minutes of warm-up, 10 minutes of cool-down and 40 minutes of main exercise.

The aqua aerobic exercise is performed the same with the single exercise program and the resistance exercise uses the yellow and red bands with the strength of 11-12 for the first 1-2 weeks (light), yellow and red bands with the strength of 13-14 for 3-7 weeks (somewhat hard) and the red band with the strength of 15-16 (hard).

Instruments

Exsanguination and blood analysis

The smoking and drinking are prohibited 24 hours before the exsanguination and the exsanguination is performed with fasting for 12 hours. The blood of 5ml is exsanguinated from the antebrachial vein and the test is performed in the clinical pathology room. The items under the test are the fasting blood sugar, triglyceride and HDL-C.

Blood pressure

The blood pressure is measured by the mercury hemato-manometer (605p; Yamasu, Japan) after taking a rest for more than 30 minutes after the subject arrives the healthcare center

Waist circumference

The waist circumference is measured after the normal breath in parallel with the belly button using the tape measure. The measurement unit is cm.

Data analysis

The data analysis is performed by the statistics program, SPSS 18.0. General characteristics in the subjects are described with the average and the standard deviation and the ANOVA is performed for the homogeneity verification. The two-way repeated ANOVA is performed to investigate the difference in the groups and period for the metabolic syndrome indicators and the one-way ANOVA and Tukey methods are performed for significant difference. The period difference among the groups is analyzed by the paired t-test. The significance level (α) is configured to 0.05.

RESULTS

Fasting blood sugar changes

The difference in the groups of the subjects with the fasting blood sugar shows that the muscle strengthening exercise using elastic thera-band group significantly decreases from 94.32 mg/dl to 82.11mg/dl after the intervention ($p < .001$) and the aqua aerobic exercise group significantly decreases from 96.63 mg/dl to 80.74mg/dl after the intervention ($p < .001$). Also, the combined exercise shows significant decrease from 87.38 mg/dl to 74.38mg/dl after the intervention ($p < .001$).

The result of the two-way repeated ANOVA for the fasting blood sugar does not show significant difference in the group ($F = 2.36$, $p = .105$), time ($F = 100.25$, $p < .001$) and interaction according to the group and time ($F = 0.70$, $p = .504$) <Table 3>.

Table 3. Comparisons of fasting blood sugar among three groups

Index	Group	Before	After	t (p)	F (p)		
		Mean ± SD	Mean ± SD		Group	Time	Group-time
FBS	Muscle	94.32 ± 14.60	82.11 ± 13.38	-6.79 (< .001)	2.36 (.105)	100.25 (< .001)	0.70 (.504)
	Aquatic	96.63 ± 15.31	80.74 ± 11.66	-6.24 (< .001)			
	Combined	87.38 ± 10.31	74.38 ± 9.22	-4.67 (< .001)			

Muscle; Muscle strengthening exercise using elastic thera-band, Aqua; Aqua aerobic exercise, Combined; Muscle strengthening exercise using elastic thera-band and aqua aerobic exercise, FBS: Fasting blood sugar

Table 4. Comparisons of triglyceride among three groups

Index	Group	Before	After	t (p)	F (p)		
		Mean ± SD	Mean ± SD		Group	Time	Group-time
TG	Muscle[a]	152.63 ± 24.79	134.00 ± 22.75	-6.89 (< .001)	0.72 (.492)	91.28 (< .001)	8.67 (< .001)
	Aquatic[b]	145.05 ± 31.36	132.11 ± 30.29	-3.48 (.003)			a > c, b > c
	Combined[c]	167.06 ± 29.85	131.19 ± 22.60	-6.62 (< .001)			

Muscle; Muscle strengthening exercise using elastic thera-band, Aqua; Aqua aerobic exercise, Combined; Muscle strengthening exercise using elastic thera-band and aqua aerobic exercise, TG: Triglyceride

Table 5. Comparisons of high density lipoprotein cholesterol among three groups

Index	Group	Before	After	t (p)	F (p)		
		Mean ± SD	Mean ± SD		Group	Time	Group-time
HDL-C	Muscle[a]	54.05 ± 8.25	52.16 ± 7.44	-2.02 (.058)	1.39 (.257)	0.38 (.543)	5.06 (.010)
	Aquatic[b]	49.58 ± 6.61	49.53 ± 6.68	-0.10 (.920)			c > a
	Combined[c]	49.94 ± 6.19	51.38 ± 5.37	2.21 (.043)			

Muscle; Muscle strengthening exercise using elastic thera-band, Aqua; Aqua aerobic exercise, Combined; Muscle strengthening exercise using elastic thera-band and aqua aerobic exercise, HDL-C: High density lipoprotein cholesterol

Table 6. Comparisons of blood pressure among three groups

Index	Group	Before	After	t (p)	F (p)		
		Mean ± SD	Mean ± SD		Group	Time	Group-time
SBP	Muscle	138.74 ± 9.75	127.26 ± 10.36	-5.19 (< .001)	0.18 (.840)	74.44 (< .001)	0.91 (.408)
	Aquatic	138.84 ± 8.79	130.53 ± 11.42	-5.60 (< .001)			
	Combined	137.00 ± 14.39	128.56 ± 13.39	-4.38 (.001)			
DBP	Muscle	83.63 ± 4.37	80.16 ± 4.54	-3.81 (.001)	1.41 (.253)	34.99 (< .001)	0.10 (.901)
	Aquatic	85.05 ± 5.55	81.53 ± 5.12	-3.63 (.002)			
	Combined	82.13 ± 6.05	79.19 ± 4.72	-2.79 (.014)			

Muscle; Muscle strengthening exercise using elastic thera-band, Aqua; Aqua aerobic exercise, Combined; Muscle strengthening exercise using elastic thera-band and aqua aerobic exercise, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

Triglyceride changes

The difference in the triglyceride among the groups shows significant decrease from 152.63mg/dl to 134.00 mg/dl in the muscle strengthening exercise using elastic thera-band group after the intervention ($p < .001$) and from 145.05mg/dl to 132.11mg/dl after the intervention in the aqua aerobic exercise group ($p = .003$). Also, the combined exercise shows significant decrease from 167.06mg/dl to 131.19mg/dl after the intervention ($p < .001$).

The result of the two-way repeated ANOVA for the triglyceride level shows significant difference in the group ($F = 0.72$, $p = .492$), time ($F = 91.28$, $p < .001$) and interaction according to the group and time ($F = 8.67$, $p < .001$) and the triglyceride significantly decreases in the combined exercise group compared to the muscle strengthening exercise using elastic thera-band group and the aqua aerobic exercise group <Table 4>.

HDL-C changes

The difference in the group for the HDL-C does not show significant decrease from 54.05mg/dl to 52.16mg/dl after the intervention for the muscle strengthening exercise using elastic thera-band group and from 49.58mg/dl to 49.53mg/dl after the intervention for the aqua aerobic exercise group. Meanwhile, the combined exercise shows significant increase from 49.94mg/dl to 51.38mg/dl after the intervention ($p = .043$).

The result of the two-way repeated ANOVA for the HDL-C shows significant difference in the group ($F = 1.39$, $p = .257$), time ($F = 0.38$, $p = .543$) and interaction according to the group and time ($F = 5.06$, $p = .010$) and the combined exercise group shows significant increase in the HDL-C compared to the muscle strengthening exercise using elastic thera-band group <Table 5>.

Blood pressure changes

The difference in the systolic blood pressure among the

Table 7. Comparisons of waist circumference among three groups

Index	Group	Before	After	t (p)	F (p)		
		Mean ± SD	Mean ± SD		Group	Time	Group-time
Waist	Muscle[a]	85.37 ± 4.14	84.42 ± 3.67	-3.51 (.003)	2.37 (.104)	73.91 (< .001)	4.46 (.016)
	Aquatic[b]	88.76 ± 4.52	86.58 ± 3.66	-5.57 (< .001)			a > c, b > c
	Combined[c]	87.31 ± 4.17	85.00 ± 3.83	-5.57 (< .001)			

Muscle; Muscle strengthening exercise using elastic thera-band, Aqua; Aqua aerobic exercise, Combined; Muscle strengthening exercise using elastic thera-band and aqua aerobic exercise, Waist: Waist circumference

groups shows that the muscle strengthening exercise using elastic thera-band group significantly decrease from 138.74 mmHg to 127.26 mmHg after the intervention ($p < .001$) and the aqua aerobic exercise group significantly decreases from 138.84 mmHg to 130.53 mmHg after the intervention ($p < .001$). Also, the combined exercise group shows significant decrease from 137.00 mmHg before the intervention to 128.56 mmHg after the intervention ($p = .001$).

The result of the two-way repeated ANOVA for the systolic blood pressure does not show significant difference in the group ($F = 0.18$, $p = .840$), time ($F = 74.44$, $p < .001$) and interaction according to the group and time ($F = 0.91$, $p = .408$).

The difference in the diastolic blood pressure among the groups shows that the muscle strengthening exercise using elastic thera-band group significantly decrease from 83.63 mmHg to 80.16 mmHg after the intervention ($p = .001$) and the aqua aerobic exercise group significantly decreases from 85.05 mmHg to 81.53 mmHg after the intervention ($p < .002$). Also, the combined exercise group shows significant decrease from 82.13 mmHg before the intervention to 79.19 mmHg after the intervention ($p = .014$).

The result of the two-way repeated ANOVA for the diastolic blood pressure does not show significant difference in the group ($F = 1.41$, $p = .253$), time ($F = 34.99$, $p < .001$) and interaction according to the group and time ($F = 0.10$, $p = .901$) <Table 6>.

Waist circumference changes

The difference in the waist circumference among the groups shows that the muscle strengthening exercise using elastic thera-band group significantly decreases from 85.37 cm to 84.42 cm after the intervention ($p = .003$) and the aqua aerobic exercise group significantly decreases from 88.76 cm to 86.58 cm after the intervention ($p < .001$). Also, the combined exercise shows significant decrease from 87.31 cm before the intervention to 85.00 cm after the intervention ($p < .001$).

The result of the two-way repeated ANOVA for the waist circumference shows significant difference in the group ($F = 2.37$, $p = .104$), time ($F = 73.91$, $p < .001$) and interaction according to the group and time ($F = 4.46$, $p = .016$) and the waist circumference significantly decreases in the combined exercise group compared to the muscle strengthening exercise using elastic thera-band group and the aqua aerobic exercise group <Table 7>.

DISCUSSION

The study is performed to investigate the impact on the metabolic syndrome indicators after performing the muscle strengthening exercise using elastic thera-band, aqua aerobic exercise and combined exercise (muscular strength and aqua aerobic exercise) for 12 weeks for the elderly women with the metabolic syndrome.

The result of the metabolic syndrome indicators for the subject before the intervention shows that the prevalence rate for each risk factor is 25.9% of impaired fasting glucose, 57.4% of hyperlipidemia, 85.2% of hypertension and 92.6% of the abdominal obesity, covering almost all the elderly women except 4 for the abdominal obesity. 17 subjects (31.5%) show 4 risk factors 2 subjects (3.7%) show all the 5 factors. Compared to 18.95% for 4 risk factors and 2.35% for all the 5 factors in the study of Im *et al*. [19], the study shows the risk factors in the metabolic syndrome are higher, meaning that it is required to manage the health for the elderly women.

In particular, the ACSM [20] reports that the exercise program for the elderly women should include the muscular resistance exercise in the aerobic exercise due to weaker muscular strength and endurance than the elderly men, raising the requirement for the combined exercise. Laaksonen *et al*. [21] report that the people with weak physical fitness or sedentary lifestyle have high possibility for the metabolic syndrome and the exercise for more than 3 hours a week, rather than intensive exercise for 60 minutes a week reduces more risk factors in the metabolic syndrome. The authors focus on the lifestyle changes after the 12-week exercise program for the elderly women with the metabolic syndrome.

The study shows no significant difference between the fasting blood sugar, systolic blood pressure and diastolic blood pressure but each exercise group shows decrease. The metabolic syndrome indicators for the exercise type among obese youth shows interaction for all the indicators except the diastolic blood pressure in the aerobic exercise and resistance exercise in the study and the aerobic exercise and resistance exercise are effective compared to the control group [22] different from the study. It is judged that each group does not show significant difference considering the fact that no abrupt changes are found in the senior and the diabetic or hypertension patients well regulate their blood pressure by the medication based on the characteristics of the subjects. Also, the reason why no significant result is found out is that the current fasting blood sugar, systolic blood pressure and diastolic blood pressure levels are not included in the range of high blood sugar level and hypertension.

Meanwhile, the triglyceride and HDL-C show interaction according to the group and time and show the highest effect in the combined exercise group. This shows that the HDL-C increases by 4.6% and the triglyceride decreases by 3.7% for the exercise longer than 12 weeks, meaning that the continual exercise may decrease the blood lipid [23]. The HDL-C shows no difference in the muscular strength exercise and aquatic exercise among the groups except the combined exercise group, the triglyceride and HDL-C show interaction according to the groups and time and the combined exercise shows significant trend compared to other groups. It is remarkable in the study that the combined exercise group shows better achievement than the muscle strengthening exercise using elastic thera-band group or the aqua aerobic exercise group for the triglyceride and HDL-C.

The waist circumference shows significant difference in 3 groups, interaction according to the group and time and the combined exercise shows significant decrease compared to other groups. Most of the subjects show abdominal obesity based on the measurement of the waist circumference. In particular, increasing the abdominal obesity is known as an independent risk factor in the cardiovascular system [24,25]. Decreasing the waist circumference affect the decrease in the metabolic syndrome indicators and it is required to continuously implement the combined exercise with the most positive effect.

The result of the triglyceride, HDL-C and waist circumference in the study seems to reflect the advantage of the combined exercise compared to other exercises based on the study [26] that the combined exercise with the aerobic exercise and resistance exercise cause the synergy and the study [27] with significant result in the metabolic syndrome indicators for the circulation exercise with the aerobic exercise.

In conclusion, the conditions before and after each exercise program are effective for the subjects with the metabolic syndrome but the positive effect of the combined exercise may be confirmed with significant difference in the blood lipid and waist circumference of the metabolic syndrome indicators in the combined exercise compared to other groups.

However, the limitations in the study are as follows. First, the study covers the elderly women with the metabolic syndrome in a single region and is limited to generalize the result to all elderly with metabolic syndrome. Second, the subjects are the senior with large individual difference compared to other age groups and that is why the study performs the homogeneity test but it may not be said that their physical fitness is not the same and it is difficult to conclude that the momentum for all the subject is the same. Therefore, repetitive studies on the comparison of the exercise types is required under control.

A lot of health promotion programs provided by healthcare centers only focus on single exercise program with walking, health gymnastics, yoga and muscular strength exercise or aquatic exercise. Therefore, the effective health promotion program would be developed to prevent from the contraction of a disease by forming the program with combined exercise (ground and aquatic exercise) rather than the single exercise program to avoid the sameness and boredom and increase the participation rate and satisfaction.

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