

Convergence Study on Effects of Underwater Rehabilitation Exercise on Physical Fitness and Blood Lipids in Middle Aged Women

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중년여성의 수중재활운동이 신체적성과 혈중지질에 미치는 융합연구

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Abstract The purpose of this study is to find out how underwater rehabilitation exercises affect physical fitness and blood lipids for 10 weeks and provide basic data to help prevent middle-aged women from cardiovascular diseases. The subjects of this study were middle-aged women living in Seoul, Korea. The underwater rehabilitation exercise was performed for 1 week and 3 times for 10 weeks, and the exercise time was 60 minutes for 1 time including the warm up, the main exercise and the cool down. The exercise intensity was set at 60-70% of the heart rate reserve calculated from the pre-exercise test. The measurement variables were physical fitness and blood lipid. In the data processing, descriptive statistics were presented for each measurement item and a 2-way RGRM ANOVA was conducted to examine the interaction effects between groups. The results have shown significant interaction effects in physical fitness(Flexibility, Cardiorespiratory Endurance, Muscular Endurance) and the blood lipids(TG, TC, HLD-C, LDL-C). This study found that the 10-week underwater rehabilitation exercise program of middle-aged women increased physical fitness level and decreased and increased blood lipid, which could be an effective and convergent program to prevent and reduce cardiovascular disease.

Key Words : Underwater rehabilitation exercise, Physical fitness, Blood lipids, Middle aged women, Convergence

요약 본 연구는 10주간의 수중재활운동이 중년여성의 신체적성과 혈중지질에 미치는 영향을 알아보고자 하였다. 연구 대상은 서울에 거주하는 중년 여성을 대상으로 하였다. 수중재활운동 프로그램은 10주간 주 3 회 실시하였고, 운동 시간은 준비운동, 정리운동, 본 운동을 포함하여 60분간 실시하였다. 운동 강도는 운동 전 검사를 통해 심박수를 기준으로 60-70 %로 설정하였다. 자료처리는 각 측정 항목에 대한 기술 통계를 제시하고 그룹 간에 상호 작용 효과를 조사하기 위해 2-way RGRM ANOVA를 수행하였다. 연구 결과 신체적성(유연성, 심폐지구력, 근지구력) 및 혈중지질(TG, TC, HLD-C, LDL-C)에서 의미 있는 상호작용효과를 나타냈다. 본 연구를 통해 중년 여성의 10주간의 수중재활운동 프로그램이 신체적 성 수준은 높이고 혈중지질은 감소 및 증가 시키는 것으로 나타내, 심혈관 질환 예방 및 위험을 낮추는 효과적이며 융합적인 프로그램이 될 수 있음을 확인하였다.

주제어 : 수중재활운동, 신체적성, 혈중지질, 중년여성, 융합

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1. Introduction

Obesity in Korea is a difficult problem to overcome, since it is regarded as structural phenomenon that coincides with current lifestyles and economic development. Plus, there is also a high possibility of an increase in obesity rates due to the spread of Western lifestyles[1]. The prevalence of obesity among adults (Body mass index, BMI 30 kg/m² and above) shows a continuous increase from 26.0% in 1998 to 34.8% in 2016, and the rate of obesity especially from middle age was high-indicating the importance of post-aged care[2]. Middle-aged age is a transition period, which brings decrease in reproductive power, and various menopause symptoms- such as facial flushing, memory loss, and changes in the urinary system, and increases the likelihood of chronic diseases such as cerebral cardiovascular disease, joint pain, osteoporosis, and female cancer. Women in this period, in particular, can experience situational crises such as isolation, shrinkage, changes in self-identity, stress and the onset of aging processes due to changes in their children's roles in the home due to their growth and independence[3]. Middle-aged women are apt to have various biological, psychological and social changes, and at that time menopause can cause myriads of physical and mental problems including depression, anxiety, osteoporosis and ischemic heart disease[4]. In order to prevent and improve obesity and cardiovascular diseases, physical strength and body composition should be maintained or improved to a normal level by increasing basic metabolic and calorie consumption through regular physical activity and exercise. As such, exercise has a beneficial effect on blood lipids, health-related fitness, and body composition for obese and menopause women[5]. Therefore, as women reach to their middle-age, regular exercise should be performed to prevent an increase in body fat and a decrease in muscle mass, and the active function of energy metabolism of muscles is the best way to prevent the decline of basic

metabolism[6]. There are advantages of regular aerobic exercise over a long period of time since it helps to prevent adult diseases and delay obesity which comes from lack of exercise[7], and particularly underwater exercise leads to injury prevention, balanced muscle development and high energy consumption of obese middle-aged women[8]. It mainly brings weight loss and prevent cardiovascular disease since it is a systemic exercise with repetitive movements mainly using large muscles[9]. Underwater exercise is safe and effective for middle-aged and elderly people who have little physical activity and have been reduced in physical strength due to aging. Many previous studies have shown the general benefits of underwater exercise, including increased metabolic volume, psychological improvement, cardiovascular benefits and many other physiological benefits[10-14]. Underwater exercise provides similar effects to various types of track exercises such as aerobic exercise, resistance movement and stretching activities. Water resistance and buoyancy help to relieve pain and improve balance, stability, strength and flexibility[15,16]. Underwater exercise always has a special and specific effect because of the nature and characteristics of water. Water not only has psychological and emotional properties that positively affect mankind, but also has integer and hydrodynamic properties, affecting various physical factors such as cardiovascular fitness, muscle strength, flexibility, balance and muscular endurance. In addition, underwater exercise can be used as a rehabilitation treatment that can have a positive effect on posture alignment and daily life and treat many musculoskeletal problems[17]. As such, underwater exercise helps people who have physical or athletic limitations to work-out, by applying buoyancy which brings more stability than ground exercises. It can improve joint mobility, muscle strength and endurance. It also has the advantage that the physical changes in water movement are not visible to others[18]. In addition, underwater exercise is

effective in preventing not only mental illness, but also physically diverse clinical disorders such as coronary artery disease, degenerative arthritis and musculoskeletal pain[19], and it also increases oxygen intake and heart rate[20]. Therefore, the purpose of this study is to find out how underwater rehabilitation exercises affect physical strength and blood lipids for 10 weeks and provide basic data to help prevent middle-aged women from cardiovascular diseases.

2. Research Methods

2.1 Subjects of study

The subjects of this study are middle aged women

Table 1. Physical Characteristic of Subjects

Group	Variables	Age(year)	Height(cm)	Weight(kg)	%Body Fat(%)
	URG(n=10)	53.67±3.39	160.80±2.07	65.84±3.67	23.26±2.51
	CG(n=10)	52.05±2.15	159.96±2.65	64.44±3.98	23.29±3.46

M±SD : Mean ± Standard Deviation
 URG : underwater rehabilitation group
 CG : control group

2.2 Underwater rehabilitation exercise program

The underwater rehabilitation exercise was performed for 1 week and 3 times for 10 weeks, and the exercise time was 60 minutes for 1 time including the warm up, the main exercise and the cool down. The exercise intensity was set at 60-70% of the heart rate reserve calculated from the pre-exercise test. A wireless heart rate monitor (Polar system, Finland) was used to maintain exercise intensity. Using the ratings of perceived exertion(RPE) of Borg, 1-5 weeks were maintained at RPE 10-11 and 6-10 weeks were maintained at 12-13, but this was applied considering the physical condition of the individual. Table 2 showed the specific underwater rehabilitation exercise program.

2.3 Measurement method and equipment

We measured the cardiopulmonary endurance, muscle endurance, power and flexibility by using a wireless heart rate (Polar system, Finland). To

living in Seoul, Korea. The subjects of this study were 20 persons who agreed to participation in the underwater rehabilitation exercise program and 10 persons in the underwater rehabilitation exercise group(URG) and 10 people in the control group(CG). The underwater rehabilitation exercise group was allowed to participate in the water rehabilitation exercise for three times a week for 10 weeks, 60 minutes, and the control group was able to maintain the daily life of the person while participating in this experiment. Table 1 showed the physical characteristics of the subject.

measure cardiovascular endurance, the number of repetitions of 20m round trip was measured and the number of sit - ups for one minute was measured for muscle endurance. A good record was selected by performing two long jumps(cm) in order to measure power. Flexibility measurements were performed in a sitting posture bending forward. TG, TC, HDL, and LDL were measured in blood lipids, and blood analysis was requested by N medical institutions.

2.4 Data analysis

The data of this study were analyzed using SPSS PC for windows 18.0 statistical program. The mean and standard deviation were presented for all measured variables, and 2-way RGRM(random group repeated measures) ANOVA was performed for 10 weeks before water rehabilitation exercise program. Interaction effect and main effect analysis were performed to analyze the difference between group and time. The significance level was set to a = .05.

Table 2. 10 Weeks underwater rehabilitation exercise program

Division	Exercise Program	Intensity	Time(min)
Warm Up	Joint Relaxation Stretching Slow Walking		10
Main Exercise	Step-Up Side-Stepping	1-5week RPE 10-11, 6-10week RPE 12-13	15
	Hopping Stretching Resistive Walking		15
	Fast Jogging kicking		10
Cool Down	Knee Joint Stretching Trunk Stretching Slow Walking		10

*RPE: Rating of Perceived Exertion

3. Results

3.1 Physical fitness

Physical fitness tests showed significant interaction effects on cardiorespiratory endurance($p=.015$),

muscular endurance($p=.005$) and flexibility($p=.030$) in 10 week underwater rehabilitation exercise group and control group. According to Table 3, there was a significant main effect in the power($p=.001$).

Table 3. The result of physical fitness

Factor	Group	Pre	Post	p
Cardiopulmonary Endurance (Repetition)	URG	23.80±6.40	26.5.65±5.65	Group*period:.015 Group:.487 Period:.030
	CG	21.70±6.25	22.80±6.04	
Muscle Endurance (Times)	URG	26.80±7.52	29.90±6.55	Group*period:.005 Group:.767 Period:.001
	CG	28.60±5.68	29.80±5.43	
Power (m)	URG	145.40±8.47	148.40±7.83	Group*period:.086 Group:.274 Period:.001
	CG	140.10±14.16	142.00±9.32	
Flexibility (m)	URG	8.84±5.52	11.91±5.47	Group*period:.030 Group:.626 Period:.020
	CG	9.62±6.75	9.17±5.39	

3.2 Blood lipids

According to Table 4, the blood lipid profiles of the 10 week underwater rehabilitation exercise group and the control group showed significant

interaction effects in TG($p=.046$), TC($p=.044$), HDL($p=.035$) and LDL($p=.009$).

Table 4. The result of Blood lipids

Factor	Group	Pre	Post	p
TG(mg/dl)	URG	166.30±62.90	144.70±55.90	Group*period:.046 Group:.848 Period:.049
	CG	148.60±78.98	148.30±74.99	
TC(mg/dl)	URG	183.10±37.49	167.10±29.82	Group*period:.044 Group:.823 Period:.045
	CG	173.90±36.83	173.60±31.54	
HDL(mg/dl)	URG	57.70±11.74	73.20±11.62	Group*period:.035 Group:.799 Period:.005
	CG	58.10±10.64	56.20±10.69	
LDL(mg/dl)	URG	98.40±49.65	82.70±43.56	Group*period:.009 Group:.803 Period:.020
	CG	86.60±51.86	99.60±41.22	

4. Discussion

The following discussion is based on the results of this study and prior study to present the basic data of an effective underwater rehabilitation program to prevent midlife health promotion, maintenance, and cardiovascular diseases by comparing differences between physical strength and blood lipid through the underwater rehabilitation exercise program for 10 weeks for middle-aged women.

'Physical strength' of middle-aged women refers to muscle strength, flexibility, agility, and balance, and these factors decrease as they get older[21]. Since middle-aged women are at their transition period, they show rapid debilitation in their late 40s, including obesity, hypertension, heart disease, diabetes, hyperlipidemia, and so on[22]. In addition, the prevalence rate of metabolic syndrome is more than 50% in women over 50 the age of[23] recorded 50%, and the blood lipid also changes to the condition which are susceptible to arteriosclerosis[24].

According to the preceding studies on the change of physical strength through underwater exercise for middle-aged women, Poyhonen et al[25] reported the improvement of static and dynamic torque of femoral head and hamstring in healthy adults, increased femoral activity, and increased fat levels of femur and hamstring muscles as a result of the 10 weeks of gradual underwater resistance training program. Park & Chung[26] reported significant improvement in lower limb strength after conducting six-weeks-underwater training for stroke patients. It had bigger effect than over-ground gait training. Kim[27] reported that 8-weeks-regular underwater exercise program for middle-aged women brought a significant increase in flexibility but didn't bring significant difference in muscle endurance and net power. Kim[28] reported that after 12 weeks of Aquarobic and Underwater Walking exercises for middle-aged women, both groups increased in all physical variants of

cardiopulmonary, muscular, flexible and muscular endurance, but Aquarobic had bigger effect.

Park & Lee[29] reported that eight weeks of underwater exercise training for middle-aged women had significant effects on lower limb strength and oxygen intake, but didn't had significant effect on muscle strength, flexibility and improvisation. In this study, a 10-week underwater rehabilitation program was conducted, and it showed significant increase in cardiopulmonary endurance, muscle strength, and flexibility among physical factors, and a slight increase in net power. These results were consistent with the results of a preceding study[30] which proved that underwater exercise has the effect of improving muscle strength, muscle endurance, flexibility, and cardiopulmonary endurance due to its characteristic buoyancy[31], and another preceding study which proved that it can increase muscle endurance, peak oxygen intake, and flexibility due to increased range of joints. In addition, the underwater regeneration exercise conducted in this study puts less load on joints, bones, tendons, ligaments and muscles compared to ground exercises[32], and it strengthens muscles, by making the whole muscle in the body to feel the resistance of the water. It can further help the joints to be protected, since people can feel less pressure and pain to the joints since the body becomes lighter due to the buoyancy of water[33].

In addition, when delving into the preceding studies which dealt with changes in blood lipids through underwater exercise for middle-aged women, Park et al[34] reported that the eight-week underwater exercise and swimming resulted in significant differences of blood lipids of middle aged women, while Kwon[35] reported that the 12 weeks of underwater exercise for middle aged women who suffers from high blood pressure showed statistically significant change in LDL-C, and less change in TC and HDL-C. Choi[36]

conducted 16 weeks of underwater exercise for middle-aged obese people, and reported that it didn't show a significant difference in high-density lipoprotein cholesterol (HDL-C), triglyceride (TG), and low-density lipoprotein cholesterol (LDL-C) and showed significant difference only in total cholesterol (TC). Lee[37] conducted a 12-week composite exercise and underwater exercise program for overweight women and found significant differences in high-density lipoprotein cholesterol (HDL-C), neutral fat (TG), low-density lipoprotein cholesterol (LDL-C) and total cholesterol (TC), but in underwater exercise, it didn't show a significant change in all of them.

In this study, a 10-week underwater rehabilitation program was conducted to the female participants who were in their middle ages, and the program showed significant differences in high-density lipoprotein cholesterol (HDL-C), triglyceride (TG), low-density lipoprotein cholesterol (LDL-C) and total cholesterol (TC) among blood lipids. These results confirmed that it could also be an effective exercise program which can reduce the risk of cardiovascular disease occurrence, and it also showed a positive effect on underwater rehabilitation. In addition, it is thought that the regular underwater rehabilitation program is the result of two elements-reduced LDL-C synthesis due to oxidation and reduction of TG, and the difference in density between water and air resulting in greater energy consumption. It is considered that it may ultimately contribute to prevent diseases such as coronary artery disease or arteriosclerosis.

5. Conclusion & Suggestion

This study showed significant improvement in the cardiopulmonary endurance, muscle endurance, power and flexibility as a result of underwater rehabilitation exercise for 10 weeks in middle aged women. This suggests that water resistance was

used effectively in the exercise program and long term exercise period affected the fitness. In addition, serum lipid profiles of TG, TC, HDL, and LDL were significantly improved. The results of this study suggest that regular water rehabilitation exercise program has a positive impact on the blood lipid level by increasing the resistance of muscles to water by the difference of density of water and air. It is thought that the occurrence of diseases can be effectively prevented.

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