ORIGINAL ARTICLE

Effects of aquarobic on health-related physical fitness, cardiovascular factor and frailty-index in pre-frailty elderly women with hypertension

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
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Abstract

Background and Study Aim: The treatment of hypertension in the elderly is reported to decrease the occurrence and mortality of cardiovascular disease and as frailty is reported to be higher in elderly people and in women than in men systematic management of the elderly women is necessary. Therefore, this study aim is the effects of aquarobics on health-related fitness, cardiovascular factor and frailty index to pre-frailty elderly women with hypertension.

Material and Methods: Thirty-six subjects with pre-frailty elderly women with hypertension in this study and were randomly divided into one of two groups: aquarobics group (n = 18) and control group (n = 18). The aquarobics program was conducted in program for 60 minutes, three times a week for 12 weeks. Outcomes, including health-related physical fitness, cardiovascular factor and frailty index, were measured before and after the training.

Results: Weight (p = .000), lean body mass (p = .000), fat mass (p = .000), % body fat (p = .000), left grip strength (p = .001), time up and go (p = .001), 2-minute walking (p = .023) showed a valid difference in the interaction between the group and time. In addition, systolic blood pressure (p = .016), diastolic blood pressure (p = .034), total cholesterol (p = .002), triglyceride (p = .043), low density lipoprotein-cholesterol (p = .007), insulin (p = .000), HOMA-IR (p = .000), tumor necrosis factor –a (p = .000), high-sensitivity C-reactive protein (p = .000), frailty scale (p = .021) showed a valid difference in the interaction between the group and time.

Conclusions: Aquarobics enhances the body composition and fitness of pre-frail elderly women with hypertension, alleviates cardiovascular factor and improves frailty index. Therefore, it is considered to be an effective method to prevent health-related fitness and frailty of pre-frail elderly women with hypertension.

Keywords: blood pressure • coordination • flexibility • physical activity • strength

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Aquarobics – *noun* aerobic exercises done to music in a swimming pool [46].

Cardiovascular – *adjective* relating to the heart and the blood circulation system [46].

Hypertension – *noun* arterial blood pressure that is higher than the usual range for gender and age. Also called **high blood pressure**, **hyperpiesia**. Compare **hypotension** [46].

Preventive – *adjective* used for describing an action taken to stop something happening, especially to stop a disease or infection from spreading [46].

Sensitivity *noun* **1.** the fact of being able to detect and respond to an outside stimulus **2.** the rate of positive responses in a test from persons with a specific disease. A high rate of sensitivity means a low rate of people being incorrectly classed as negative. Compare **specificity** [46].

Specificity – *noun* the rate of negative responses in a test from persons free from a disease, with a high specificity indicating a low rate of false positives. Compare **sensitivity** [46].

Exercise – *noun* **1.** physical or mental activity, especially the active use of the muscles as a way of keeping fit, correcting a deformity or strengthening a part **2**. a particular movement or action designed to use and strengthen the muscles ■ *verb* **1**. to undertake physical exercise in order to keep fit and healthy **2**. to subject the body, or part of it, to repetitive physical exertion or energetic movement in order to strengthen it or improve its condition [46].

Fitness – *noun* the fact of being strong and healthy [46].

Flexibility *noun* **1.** the amount or extent to which something can be bent **2.** the extent to which something can change or respond to a variety of conditions or situations [46].

Strength – *noun* the fact of being strong [46].

Agility – *noun* a combination of physical speed, suppleness and sill [46].

INTRODUCTION

According to the statistics of the Organization for Economic Cooperation and Development (OECD), South Korea is known to be one of the OECD countries that undergoes the fastest population aging [1]. Recently, the United States of America and Europe as well as the Korean society of hypertension have announced the third amendment of hypertension guidelines in 2018. As a shared trait of the amended hypertension guidelines, the regulatory goal of hypertension in patients has been changed from below 140/90 mmHg, the formal goal, to below 130/80 mmHg, which strengthened the regulatory goal of blood pressure [2]. The particular views of elderly hypertension are the increase in systolic blood pressure (SBP) and pulse pressure (PP) due to the increase in the stiffness of central aortic, and renovascular hypertension induced from natherosclerosis; and the dipper of blood pressure lowers and fluctuates largely in a day [3]. The treatment of hypertension in the elderly is reported to decrease the occurrence and mortality of cardiovascular disease [4-5].

Due to aging exercise capacity, reduction of lung capacity and strength, flexibility and reduction of bone mass, the elderly faces many restrictions [6]. Of aging impaired physical function and dysfunction impedes an independent daily life of the elderly, and it can lead to increased costs for dependents and society; thus, management efforts for anti-aging is in need, and one of them is frailty prevention [7].

Frailty can be defined as a state of a decreased ability to perform and social activity ability in daily life [8]. As the causes of frailty are multiple organ function lowered from aging, it cannot be solved with a single treatment method [9, 10]. Therefore, precautionary approaches should be taken in the phase of pre-frailty stage, the early stage before the frailty fully develops, and as frailty is reported to be higher in elderly people and in women than in men systematic management of the elderly women is necessary [11].

An inflammatory reaction regarding sarcopenia in the frail elderly is also reported to be important [12, 13]. The reason is that inflammatory cytokine IL-6 (interleukin-6), TNF-α (turmor necrosisfactor-α and hs-CRP (high sensitivity C-reactive protein) – an index of inflammatory response – which are produced and secreted in reduced skeletal muscle and accumulation of abdominal fat cells induced by sarcopenia increase the risks of cardiovascular disease occurrence risk [14, 15]. In addition, higher levels of IL-6, TNF-α and hs-CRP in the elderly has been reported to be directly related with muscular functional degradation [16-18].

The increase in exercise and physical activity definitely has a positive effect to the elderly. However, it is hard for the elderly to conduct free-weight and muscular-resistance exercise on their own, and for beginners, it shall be a risk of injury [19]. On the other hand, aquatic exercise conducted underwater with buoyancy resistance can be done with a little movement while it consumes high energy [20, 21], and the reduced weight bearing exerted on the joints of frail elderly enables conducting safe exercise thanks to decreased risks of fall and reduced [22]. Among them, aquarobics in the water like walking or aerobics easy-to-follow exercise has an advantage of reducing the risk of injury [23]. Like myalgia, the primary factor of hindering continuing exercise, the possibility of occurring pain is lower [24]; thus for the elderly, it may be recommended as an exercise that can prevent various diseases induced by the frailty [25].

However, for the pre-frail elderly women more than 65 years old, there are only a few studies observing the changes in physical activity, health-related fitness, inflammatory factor and frailty index applied with the aforementioned merits of aquarobics. Therefore, this study aim is the effects of aquarobics on health-related fitness, cardiovascular factor and frailty index to pre-frailty elderly women with hypertension.

MATERIAL AND METHODS

Subjects

This study was conducted to the 36 elderly women aged over 65 who visited a sport training centre run by D university in district S, and the subjects were pre-frail elderly women, applying the 'Korean Frailty Index' developed by Hwang et al. [26]. The study received the written consent from the subjects and was approved by the ethic committee of D university. The selected subjects were randomly grouped into aquarobics group and control group by randomized control trial – each group has 18 subjects – and were recommended to maintain normal daily life (Figure 1). The characteristics of the subjects are shown in Table 1.

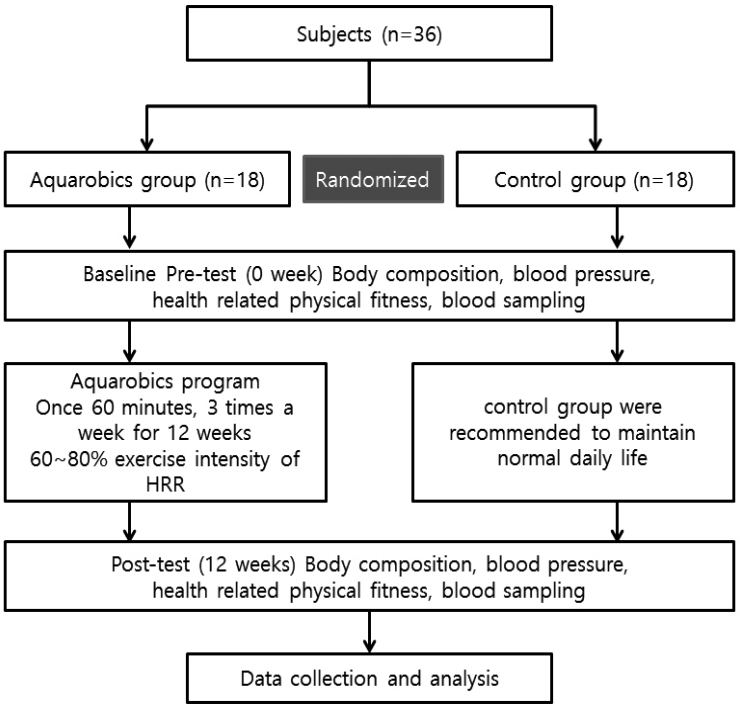

Figure 1. Flow diagram of subjects.

Balance – *noun* **1**. the act of staying upright and in a controlled position, not stumbling or falling **2.** a state of emotional and mental stability in which somebody is calm and able to make rational decisions and judgments **3.** the proportions of substances in a mixture, e.g. in the diet [46] – in this paper see point **1**.

Coordination *noun* the ability to use two or more parts of the body at the same time to carry out a movement or task [46].

Fat-free mass – *noun* all body tissues not containing fat, including bone, muscle, organs, hair, blood and retained water [46] in this paper **fat mass**.

Lean body mass – *noun* same as **fat-free mass** [46].

Physical activity – *noun* exercise and general movement that a person carries out as part of their day [46].

Procedure

Body composition and blood pressure

Before and after the aquarobics program, the study measured the subjects' body composition at the same time while they are fastened for 8 hours and attired comfortably. A body composition analyzer (InBody 470, Body Composition Biospace, Seoul, Korea) was used to measure height, body weight, lean body mass (LBM), body fat percentage, and body mass index (BMI) was calculated by the body weight/height(kg/m^2) formula. For blood pressure, the study measured systolic and diastolic blood pressure twice in resting and took the average value by using the mercury-free blood pressure monitor (KENKO, CK-E301, TAIWAN)

Health related physical strength measurement

The research corrected and supplemented the measurement standards used for the elderly in "National Fitness 100" of Korea Sports Promotion Foundation [27]. Strength was measured by using dynamometer (Takei Kiki Kogyo Co., LTD., Tokyo Japan, Grip Dynamometer), twice for the right and left each, and the study recorded the average. Relative grip strength was calculated by the following formula: grip strength/body weight×100. For chair sit and up, after having the chair (height 42cm×width 26cm) fixed to the wall, the subjects had their arm crossed at their wrist on the chest; with the start sign, they were made to repeat standing straight up and sitting back to the original position within 30 seconds, and the conducted numbers were counted.

For cardiopulmonary endurance, 2-minute walking was conducted with a stopwatch. After measuring the length from knee to sacrum and marking the middle point with a tape, it suspended a rubber band on the same level of marking point on each pillar to regulate the height, and counted the number of a complete walk using both feet in 2 minutes.

Flexibility used a sit and reach measurement tool (NH-3000 G, 0811054) with a posture of 90 degrees at the waist and the knees bent forward without reaching the bend. The distance (cm) at which the fingertip was pushed out was measured. The higher of the two values was recorded; 2.44m time up & go test (TUG) was conducted to measure dynamic balance and agility. Having the subjects sit comfortably on a fixed chair (height 42cm×width 26cm), the study measured the time of the subject turning around a cone and coming back to sit on a chair, and the average time of the two trials was recorded.

Table 1. The characteristics of study subjects – values are mean & SD (±); *p*-value was calculated by independent t-test.

Variable	Aquarobics (n=18)	Control (n=18)	p-value
Age (years)	72.67 ±4.02	71.72 ±4.56	.541
Body height (cm)	156.32 ±7.33	157.27 ±5.80	.669
Body weight (kg)	60.81 ±7.11	59.69 ±5.80	.599
Lean body mass (%)	65.78 ±4.82	65.97 ±3.46	.892
Systolic blood pressure (mmHg)	135.78 ±13.14	138.17 ±7.51	.509
Diastolic blood pressure (mmHg)	78.11 ±9.68	81.56 ±6.13	.211
Frailty scale (score)	3.11 ±1.61	3.61 ±1.24	.303

For coordination, walking in a figure-of-eight tract was measured. Marking a line of a rectangle sized a length 3.6m×breadth 1.6m, fixing a cone on the both sides corners, and fixing a chair (height 42cm×width 26cm) 2.4m apart from it, subjects are directed to revolve the cone at the right-rear with a start sign, sit back to the chair, revolve the cone at the left-rear and sit back to the chair again; the study recorded the time of the repeated two terms.

Frailty index measurement

For frailty index measurement, the study utilized the Korean type frailty – the frailty index developed by Fried et al. [11] that can be applied and proven to be used to Korean elderly people [26]. The Korean type frailty index is composed of 8 questions, and judged the over 4.5 points as frailty, over 2.5 points as pre-frailty and below 2.5 points as health elderly.

Blood analysis

Blood samples were taken before and after exercise intervention, 15 ml each taken from vena cardinal veins at the same time after 12 hours of an empty stomach and in a stabilized state. Total cholesterol (TC), triglyceride (TG), low density lipoprotein cholesterol (LDL-C) and high density lipoprotein cholesterol (HDL-C) were analyzed with enzymatic method while insulin was analyzed with radioimmunoassay (RIA); glucose was observed with YSI 2300 Glucose Analyzer (Yellow Spring, Ohio). HOMA-IR was calculated with [fasting insulin(μU/ml) × fasting plasma glucose(mg/dl) / 405. For glycated hemoglobin (HbA1c) measurement, Variant II HbA1c T Kit MEIA(Micropaticle Enzyme Immunoassay) was used. Enzyme-Linked Immnosorbent Assay (ELISA) was utilized to analyze Interleukin-1β (IL-1β), Interleukin-6 (IL-6), Tumor necrosis factor-α (TNF-α), and High-sensitivity C-reactive protein (hs-CRP).

Aquarobics program

Referring the aquarobics program of Kim [28], warm-up 10 min, main exercise 40 min, cool-down 10 min for once 60 minutes, 3 times a week for 12 weeks aquarobics were conducted. For measuring heart rate during exercise, underwater wireless heart rate monitor (For Polar H7 Heart Rate Sensor, Polar Electro Co., Finland) was used, and the average heart rate of the main exercise indicated around 60~80% exercise intensity of HRR maintaining the rating of perceived exertion (RPE) around 13~15. The environment for swimming pool was length 50m, breadth 25m, and aquarobics was conducted under the circumstances in which the depth of water was about 1.1m, having the indoor temperature 26~29℃, water temperature 28~29℃ and 50~70% of wetness.

Statistical analysis

The study used SPSS-PC statistics program (version 22.0), and conducted an inter-group difference verification with an independent t-test. In addition, the measured results of all variables were calculated by mean (M) and standard deviation (SD), and a two-way repeated ANOVA for respective variables was calculated to determine group differences. If there were similarities between times, it conducted a paired t-test, and Pearson's correlation coefficients (r) was used to observe correlations between respective variables. The statistical significance was set at $p<.05$.

RESULTS

Body composition and health-related physical fitness

In the Aquarobics group, weight (p<.001), fat mass (p<.001), % body fat (p<.01), SBP (p<.01), DBP (p<.01) and TUG (p<.01) showed a valid reduction and Left grip strength (p<.01), 2-minute walking (p<.05) represented a valid increase. On the other hand, lean body mass (p<.05) of the control group showed a valid decline while fat mass (p<.01), % body fat (p<.05), TUG (p<.01) increased validly. In addition, weight (p = .000), lean body mass (p = .000), fat mass (p = .000), % body fat (p = .000), left grip strength (p = .001), TUG (p = .001), 2-minute walking (p = .023) showed a valid difference in the interaction between the group and time. The details of the participants are shown in Table 2.

Cardiovascular indicators and frailty index

In the Aquarobics group, SBP (p<.01), DBP (p<.01), TC (p<.01), TG (p<.05), LDL-C (p<.01), Glucose (p<.001), Insulin (p<.001), HOMA-IR (p<.001), IL-6 (p<.001), TNF-a (p<.001), hs-CRP (p<.001) and frailty scale (p<.01) turned out to be decreased validly while HDL-C (p<.01) seen a valid increase. Meanwhile, the contrast group showed a valid reduction in HDL-C (p<.01). Moreover, SBP (p = .016), DBP (p = .034), TC (p = .002), TG (p = .043), LDL-C (p = .007), insulin (p = .000), HOMA-IR (p = .000), TNF-a (p = .000), hs-CRP (p = .000), frailty scale (p = .021) showed a valid difference in the interaction between the group and time. The details of the participants are shown in (Table 3).

Correlations

Frailty scale and weight (r = .519, p<.01), fat mass (r = −.502, p<.01), and HOMA-IR (r = .348, p<.05) presented a valid static correlation. Frailty scale and HDL-C (r = .519, p<.01) represented a negative correlation (Figure 2).

Table 2. The changes of body composition and health-related physical fitness variable between the groups at baseline and after 12 weeks – values are means & SD (±).

Variable	Group	Baseline	12 weeks	% diff	p-value
Body weight (kg)	Aquarobics	60.81 ±7.11	60.09 ±6.88	−1.18***	.000
	Control	59.69 ±5.48	60.11 ±5.50	0.70**	
Lean body mass (%)	Aquarobics	65.78 ±4.82	66.44 ±4.86	1.00***	.000
	Control	65.97 ±3.35	65.85 ±3.35	-0.18*	
Fat mass (kg)	Aquarobics	20.77 ±3.50	20.14 ±3.53	−3.03***	.000
	Control	20.24 ±2.13	20.45 ±2.04	1.04**	
% body fat	Aquarobics	34.23 ±4.82	33.56 ±4.86	−1.96***	.000
	Control	34.03 ±3.46	34.15 ±3.35	0.35*	
Left grip strength (%)	Aquarobics	33.33 ±6.56	33.87 ±6.56	1.68**	.001
	Control	31.93 ±9.01	31.41 ±8.45	−1.63	
Right grip strength (%)	Aquarobics	34.64 ±5.56	34.95 ±5.58	0.89	.127
	Control	34.62 ±8.38	34.39 ±7.85	−0.66	
Sit and reach (cm)	Aquarobics	10.44 ±11.66	10.60 ±11.06	1.53	.375
	Control	15.00 ±6.96	14.87 ±7.27	−0.87	
Chair sit and up (times/30sec)	Aquarobics	16.33 ±2.28	16.44 ±2.18	0.67	.410
	Control	16.94 ±4.14	16.72 ±4.04	−1.30	
Time up and go (s)	Aquarobics	6.61 ±1.31	6.45 ±1.09	−2.27*	.001
	Control	6.75 ±0.83	6.88 ±0.74	1.93**	
Figure of 8 tract (s)	Aquarobics	26.77 ±5.22	26.92 ±4.95	0.56	.141
	Control	28.81 ±3.69	28.73 ±3.59	−0.28	
2 minute walking (times/120 sec)	Aquarobics	112.28 ±20.81	114.44 ±18.32	1.92*	.023
	Control	108.33 ±16.02	108.11 ±15.69	−0.20	

*p<.05, **p<.01, ***p<.001

Table 3. The changes of cardio-cerebrovascular factors and frailty scale between the groups at baseline and after 12 weeks – values are means & SD (±).

Variable	Group	Baseline	12weeks	% diff	p-value
SBP (mmHg)	Aquarobics	135.78 ±13.14	132.83 ±10.28	−2.17**	.016
	Control	138.17 ±7.51	138.00 ±6.26	−0.12	
DBP (mmHg)	Aquarobics	78.11 ±9.68	76.89 ±8.76	−1.56*	.034
	Control	81.56 ±6.13	81.61 ±5.68	0.06	
TC (mg/dL)	Aquarobics	179.72 ±11.91	175.44 ±10.14	−2.38**	.002
	Control	181.61 ±11.49	182.28 ±9.61	0.37	
TG (mg/dL)	Aquarobics	114.89 ±11.01	112.28 ±9.80	−2.27*	.043
	Control	114.06 ±10.62	114.33 ±10.91	0.24	
LDL-C (mg/dL)	Aquarobics	115.28 ±17.92	111.61 ±15.00	−3.18**	.007
	Control	113.61 ±13.32	114.44 ±10.80	0.73	
HDL-C (mg/dL)	Aquarobics	44.19 ±7.88	47.33 ±7.73	7.11**	.000
	Control	42.48 ±4.81	41.72 ±4.37	−1.79**	
Glucose (mg/dL)	Aquarobics	99.89 ±8.70	95.00 ±7.42	−4.90***	.247
	Control	104.39 ±10.42	103.89 ±11.23	−0.48	
Insulin (U/dl)	Aquarobics	13.16 ±4.00	9.30 ±3.03	−29.33***	.000
	Control	9.81 ±3.51	10.06 ±3.01	2.55	
HOMA-IR	Aquarobics	3.26 ±1.04	2.17 ±0.66	−33.44***	.000
	Control	2.49 ±0.80	2.61 ±0.95	4.82	
HbA1c (%)	Aquarobics	6.33 ±1.08	6.05 ±1.00	−4.42	.467
	Control	6.28 ±1.07	6.28 ±1.13	0.00	
IL-1β (pg/ml)	Aquarobics	3.57 ±0.56	3.49 ±0.41	−2.24	.329
	Control	4.36 ±1.08	4.63 ±1.45	6.19	
IL-6 (pg/ml)	Aquarobics	3.92 ±0.43	3.77 ±0.40	−3.83***	.091
	Control	3.58 ±0.78	3.61 ±0.93	0.84	
TNF-α (pg/ml)	Aquarobics	4.01 ±0.45	3.37 ±0.34	−15.96***	.000
	Control	3.41 ±0.74	3.51 ±0.61	2.93	
hs-CRP (mg/L)	Aquarobics	0.78 ±0.14	0.64 ±0.12	−17.95***	.000
	Control	0.68 ±0.16	0.71 ±0.18	4.41	
Frailty scale (score)	Aquarobics	3.11 ±1.61	1.28 ±1.49	−58.84**	.021
	Control	3.61 ±1.24	3.28 ±1.71	−9.14	

$p<.05$, $^{**}p<.01$, $^{***}p<.001$

SBP systolic blood pressure; **DBP;** diastolic blood pressure; **TC** total cholesterol; **TG** triglyceride; **HDL-C** high-density lipoprotein cholesterol; **LDL-C** low-density lipoprotein cholesterol; **HOMA-IR** homeostatic model assessment for insulin resistance; **IL-1β** interleukin-1β; **IL-6** interleukin-6; **TNF-α** tumor necrosis factor-alpha; **hs-CRP** high-sensitivity c-reactive protein.

DISCUSSION

Song et al. [29] stated that conducting aquarobics with resistance of water is helpful for improving muscle functions of elderly person; although gravity is less than being outside of water, it is reported that muscle resistance and aerobic exercise can be exerted as the resistance of water imposes resistance on body movements [30]. As a result of this study, 12 weeks of aquarobics program presented a valid difference between the groups and time and changes in body composition, weight, LBM, fat mass, % body fat of the pre-frail elderly women. Related to the characteristics of pre-frail elderly women, this result can improve the quality of life of the subjects suffering from a decline in physical activity or pains due to reductions in muscle mass since aquarobics can increase muscle mass and lean body mass. In case of the elderly, health-related fitness is very important for them to maintain their lives without

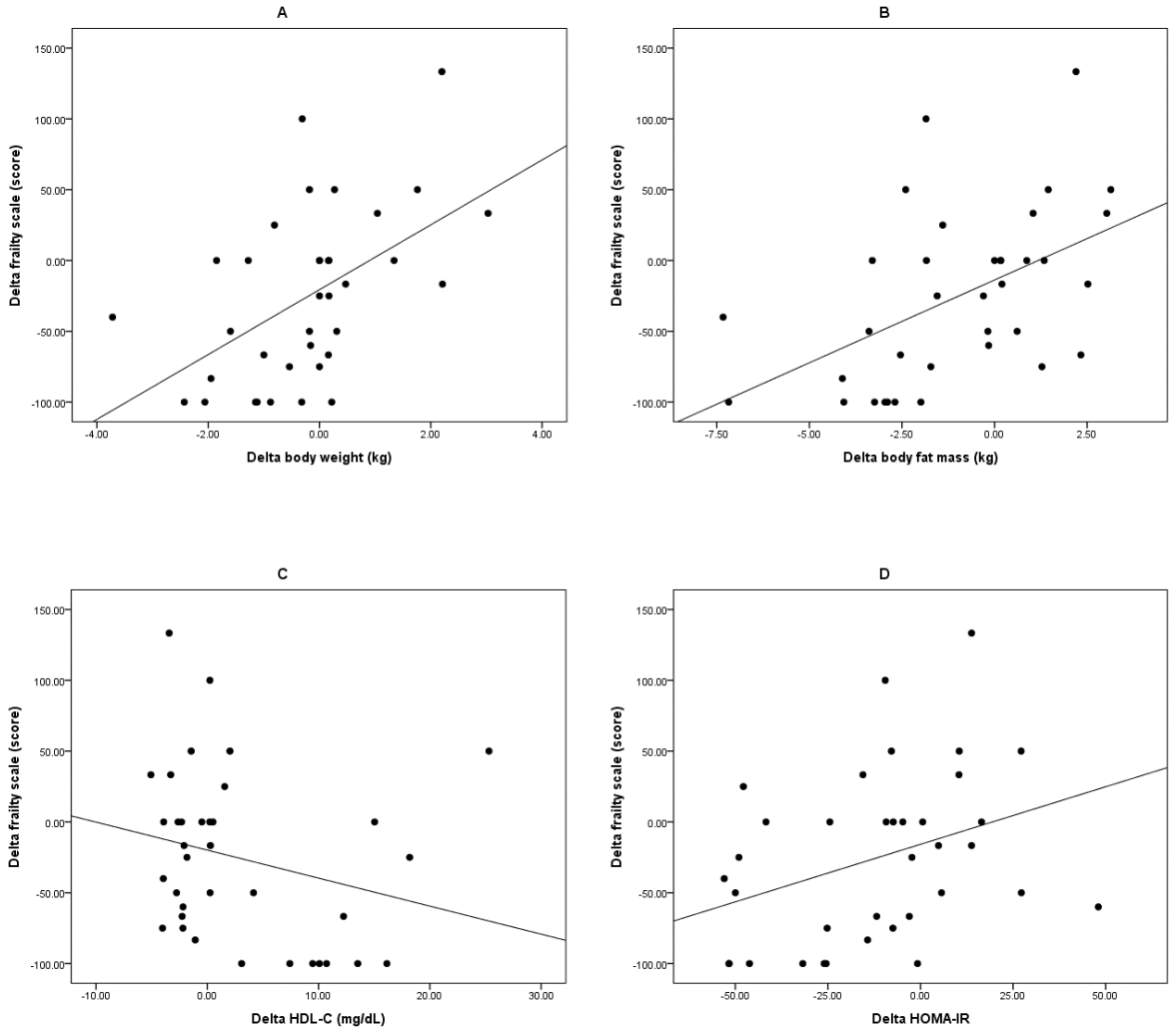

Figure 2. Correlations coefficients between frailty scale, body weight, body fat mass, HDL-C (high-density lipoprotein cholesterol) and HOMA-IR (homeostatic model for insulin resistance) in pre-frailty elderly women (A: r = .519, p = .001; B: r = .502, p = .002; C: r = –.250, p = .141; D: r = .348, p = .038).

having to have a help from others. In particular, dynamic equilibrium and walking ability are critical to sustain their daily life by their own such as getting off a bus or going to a toilet [31-33]. Chang et al. [34] also defined the fitness levels of the frail elderly on their level of frailty, and the more one gets frailty, the worse fitness level is determined; and stamina is considered to be important to daily live and frailty index.

This study showed an interaction between the groups and time among health-related fitness factors, left grip strength, TUG, and 2-minute walking. Relative grip strength is considered to have been increased thanks to the stimuli from this program such as grasping a fist and hitting the surface with a hand. In addition, the positive improvement of fitness factor, which is an index of dynamic equilibrium and agility, cardiopulmonary endurance is concerned to be a highly meaningful result; In particular, relative grip strength and muscle function of lower limbs are one of the most basic fitness factors of the elderly person to maintain their lives; thus aquarobics is worth being recommended as an exercise to various fitness levels of the pre-frailty elderly women that can improve myofunctions, without giving them much pressure.

Béland et al. [35] reported that the aerobic exercise is effective in improving cardiovascular function, and physical activities under water can alleviate hypertension to those who are suffering from it. This study showed a valid improvement of SBP and DBP, and this result is similar to that of Castro et al. [36] which reported that

conducting exercise in and out of the water to 18 hypertension patients had an effective impact on lowering blood pressure. Thus, this aquarobics program is also considered as an effective program for lowering blood pressure of pre-frailty elderly women.

IL-6, TNF-α and hs-CRP, which are inflammatory cytokine, are the materials produced and secreted at adipocyte. These materials should be importantly managed as they can raise the risks of heart disease [37, 38]. In a recent cross-sectional study on the elderly, Soysal et al. [39] reported that frailty and pre-frailty elderly showed validly higher variables of inflammatory factors (i.e. IL-6 and CRP) than normal elderly; in order to prevent and improve the increase of inflammatory factors, kinematic intervention is known to be effective [40, 41]. Like the precedent research, this study showed a valid difference between the groups and time among TC, TG, LDL-C, HDL-C, Insulin, HOMA-IR, TNF-α and hs-CRP when conduced the aerobics. As Magkos et al. [42] claimed that weight loss is highly related to inflammatory factors, the aquarobics' effects of the combined exercise (aerobic and muscle resistance exercise) in this study brought about loss of body weight, then reduced inflammatory factors and improved the reduction in blood lipid. Accordingly, the 12 weeks of aquarobics not only improves health to the pre-frail elderly women with a high risk of frailty, but also prevents diseases that may occur in the future. Thus, improving the inflammatory cytokine is highly critical as it can prevent the transference to the secondary diseases.

Frailty is related to high risks of disease outbreaks such as ab aggravation of health, sanatorium admission, an increase of death rate and a fall [43]. Recently, geriatric disease specialists define it as a biological syndrome induced by vulnerability due to reduction of stress-resistance function and of physiological system activity [44]. Park et al. [45] reported that a pre-frailty elderly person has higher obesity-inducing factors such as % body fat and BMI than an elderly person at a health stage, and has lower amount of physical activities; these sets a condition of limiting physical activities such as reduction in muscle mass or pain occurrence, in which this vicious cycle repeats itself. Thus, it is concerned that kinematic intervention at the level of pre-frailty is needed in order to prevent frailty

This study showed a meaningful result in frailty scale after conducting aquarobics intervention. Moreover, the study presented the high correlation body weight, fat mass, HOMA-IR and frailty scale, and it is considered that the improvement in factors related to body composition and blood lipids had a positive impact on improving frailty scale. Especially considering the standards suggested by Hwang et al. [26], the aquarobics group has seen an enhancement to the health stage from the pre-frailty stage while the control group maintained the pre-frailty. The result indicates that it not only improves pre-frail elderly women to be at the health stage and effectively prevents frailty, but also raises quality of life by sustaining their daily life.

CONCLUSIONS

Aquarobics enhances the body composition and fitness of hypertension pre-frail elderly women, alleviates cardiovascular factor and improves frailty index. Therefore, it is considered to be an effective method to prevent health-related fitness and frailty of pre-frail elderly women with hypertension.

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