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Effects of aquarobic exercise and burdock intake on serum blood lipids and vascular elasticity in Korean elderly women☆

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ABSTRACT

Background: The elderly's health issues are often complex and tend to lead to chronic diseases; such issues can be due to a fitness decline resulting from a lack of physical activities. The burdock root is a blood purifier, lymphatic system strengthener, and natural diuretic. The purpose of this study was to analyze the effects of aquarobic exercise and burdock intake on serum blood lipids and vascular elasticity in elderly women by implementing a 12-week program with these interventions.

Methods: Forty elderly female volunteer subjects aged 70 to 80 years comprised the control group ($n = 8$), aquarobic exercise group ($n = 11$), aquarobic exercise and burdock intake combination group ($n = 11$), and burdock intake group ($n = 10$). The variables of serum blood lipids, and vascular elasticity were measured in all participants before and after the 12-week study.

Results: Total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) levels significantly decreased in the aquarobic exercise group and aquarobic exercise and burdock intake combination group ($p < 0.05$, $p < 0.01$, $p < 0.001$). No statistically significant changes in pulse wave velocity were also found within or between the groups before and after participation in the 12-week program.

Conclusions: Our findings indicate that aquarobic exercise and burdock intake improved the serum blood lipid levels and vascular elasticity of Korean elderly women. Additionally, burdock extract intake may be useful in vascular health by playing a secondary role in disease prevention and health promotion.

1. Introduction

As people get older, physiological functions of the body gradually decline. Functional flexibility, such as physiological regulation, metabolic ability, overall fitness, and motor skills, decreases, reaction time and nerve conduction worsen, and bones weaken. These declines make it difficult to maintain even the basic activities of daily living (Gu, 2006; Jee et al., 2003). The elderly's health issues are often complex and tend to lead to chronic diseases (Kim and Shin, 2012); such issues can be due to a fitness decline resulting from a lack of physical activities.

Regular exercise based on participation in physical activities is the most effective way to improve elderly health problems associated with lack of exercise (Hwang et al., 2011). Moreover, regular exercise improves physical fitness, functional fitness necessary for daily living, and self-reliance in performing physical fitness activities (Han and Lee, 2008).

On the other hand, as age increases, circulatory system functioning and physical fitness decline (Wei, 1992); the decline of the former is closely associated with vascular elasticity (Chambers et al., 1999; Nichols and O'Rourke, 1998).

In particular, in elderly women, the decreased estrogen stimulation and the activity of low-density lipoprotein (LDL) receptors associated with the decline in ovary functioning due to follicle-stimulating hormone deficiency after menopause elevate the LDL cholesterol (LDL-C) level and decrease the high-density lipoprotein cholesterol (HDL-C) level, which rapidly increases the blood lipid level and consequently, the risk of coronary artery diseases (Aubertin-Leheudre et al., 2017; Bijelic et al., 2016; Grundy, 1990).

The arterial pulse wave velocity (PWV) and aortic augmentation index (AI_X) are based on a pulse wave analysis, which has demonstrated their utility as the risk index for arteriosclerosis and cerebrovascular and cardiovascular diseases caused by vascular problems; these show more negative results when the blood vessels are stiffer and the lumen

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Table 1
Proximate composition of burdock roots (Guo, 2016) (g/100 g and mg/100 g).

Protein (g)	Fiber (g)	Ca (mg)	P (mg)	Fe (mg)	Carotene (mg)	Vitamin B1 (mg)	Vitamin B2 (mg)	Vitamin C (mg)
4.7	2.4	242	61.0	7.6	390.0	0.02	2.29	25.0

narrower and thicker. Such results suggest a high level of arteriosclerosis and low level of vascular elasticity, indicating arteriosclerosis in the aorta and increased risks in the coronary artery (Laurent et al., 2001; Zureik et al., 2003). In addition, such results are closely associated with a decrease in muscle mass and weakening muscular strength (Abbatecola et al., 2012; Fahs et al., 2010).

Aquarobic exercise is an aerobic exercise that does not tax the joints because it takes advantage of buoyance and water resistance, which can be used for the prevention and rehabilitation of joint damages and is recommended as an exercise regimen for the elderly (Lee and An, 1991).

The fresh sprouts and roots of burdock are used for food, roots of burdock contain abundant nutrients such as synanthrin, cellulose, protein, calcium, phosphorus and iron in Table 1 (Chen and Chen, 2010; Guo, 2016).

Burdock contains a large amount of biologically active substances saponins, arctin, flavone, and synanthrin and serves various functions, including intestinal regulation and physiological functions, such as blood lipids and insulin response regulation and can positive effects of prevent certain diseases (Chen and Chen, 2010; Park et al., 2006). They also increased immunity, alleviates visceral pain (Lee, 2007; Seo, 2010), and it has a positive effect on cardiovascular health and cardiovascular diseases such as arteriosclerosis by inhibiting blood glucose, hypoglycemia, total cholesterol, LDL-cholesterol, and increasing HDL-cholesterol and vasodilation (Lin and Harnly, 2008; Shin, 1995; Qi, 2010; Zhao et al., 2009).

Therefore, the present study aimed to determine the effects of aquarobic exercise and burdock intake on serum blood lipids and vascular elasticity in elderly women. In addition, the study aimed to provide basic information on effective exercise strategies and nutritional intake for elderly women, determine the effect of burdock as a folk remedy, and provide scientific evidence on vascular health for the population.

2. Methods

2.1. Participants

Forty healthy elderly female volunteers aged 75 ± 4.32 years with > 32% body fat (%BF) who were recruited from the city of Busan, Korea. All elderly female were sedentary, did not regularly participate in physical activity, and had no history of drug or alcohol abuse or cardiovascular disease. The health of the participants was determined by a health questionnaire, physical examination, and laboratory tests. All participants gave a written informed consent approved by the Institutional Human Research Committee. Prior to their participation, they were informed about the possible risks and discomforts of the study.

2.2. Study design

The purpose, goal, and experimental procedures were thoroughly outlined verbally to each participant. The participants were tested in the morning at the same time each day to avoid diurnal variations of temperature. Participants were asked to refrain from exercising 24-h before testing and from caffeine or alcohol ingestion the day before or the morning of each test, to otherwise follow their normal diet, and to eat a light meal 2-h before coming to the laboratory. Upon arrival, a 12-h fasting blood sample and data on the standardized health questionnaire, anthropometry and body composition were obtained. After their baseline measurements, participants were randomized into the control group (n = 8), aquarobic exercise group (n = 11), aquarobic exercise and burdock intake combination group (n = 11), and burdock intake group (n = 10).

The study participants in the aquarobic exercise and burdock intake combination group and the burdock intake group were instructed not to take health supplements other than the burdock extracts that were part of the experimental regimen during the 12-week experimental period.

2.3. Anthropometric assessments

Height was measured to the nearest 0.1 cm with the participants barefooted. Weight was measured to the nearest 0.1 kg with light clothes. From these measurements, body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters (kg/m^2). Overall body fat mass was analyzed at the beginning and end of each phase using the bioelectrical impedance analysis method (Inbody 720; Biospace, Seoul, Korea), following the procedures recommended by the American College of Sports Medicine (American College of Sports Medicine, 2006).

2.4. Blood sampling

The venous blood samples were collected between 8 and 10 a.m. after a 12-h overnight fasting, and the serum was separated and stored at − 70 °C. Total cholesterol (TC), triglycerides (TG), HDL-C, and LDL-C levels were measured using an ADVIA-1650 analyzer (Georgia, USA).

2.5. PWV and AI_X

For the measurement of PWV, we measured the pulse wave at both sides of the artery when the pulse wave propagated from the carotid artery into the brachial artery and recorded the distance between the two measurement sites. PWV was calculated by dividing the distance (D) by the time difference between the pulse waves recorded at the two sites (Δt) (Laurent et al., 2006). Regarding the AI_X, when the pressure wave that propagated to the peripheral tissues was superimposed with the reflection signatures, the area with the refraction (augmentation point) was observed in the measured pulse waves, and the AI_X was calculated by dividing the pressure difference between the augmentation point and the maximum point of the aortic pressure by the pulse pressure (Kelly et al., 1989).

2.6. Aquarobic exercise program

The aquarobic exercise program was designed by modifying and improving the exercise guideline provided by the Korea Aquatic Exercise Association (Korea Aquatic Exercise Association, 2011), and the average water temperature in the swimming pool was maintained at 26–28 °C. Considering that the study participants were elderly women aged 65–80 years, the program was implemented three times a week for 12 weeks after a 1–2-week adjustment period. Each session lasted for 50 min, consisting of a 5-min warm-up, a 40-min main exercise period, and a 5-min wrap-up. Exercise intensity was measured using the rating of perceived exertion (RPE): RPE 9–10 for Weeks 1–4, RPE 11–12 for Weeks 4–8, and RPE 13–14 for Weeks 9–12 (Borg, 1988). Changes in