International Journal of Humanities and Social Science Invention (IJHSSI)
ISSN (Online): 2319 – 7722, ISSN (Print): 2319 – 7714
www.ijhssi.org ||Volume 11 Issue 7 Ser. I || July. 2022 || PP. 97-103

Effect of Auatic Walking Exercise on Functional Fitness, Bone Quality Index and Immune Factors Related to Healthy Lifespan of the Elderly

Sun Ho, Kim[1]
[1] *Department of General Education, Nambu University, Gwang, South Korea*

ABSTRACT: *With the development of science and medical technology, the average lifespan of people is getting longer and the aging process is rapidly progressing. The aging of the population is not an individual or family problem, but a social task that future generations must bear. This study attempted to investigate how participation in underwater exercise programs such as walking forward and backward in water affects functional fitness, bone mass index, and immune-related factors of elderly women. Walking forward and backward in water was conducted for 22 elderly women who participated in the underwater exercise program. Functional fitness (muscle strength, muscular endurance, flexibility, balance, coordination, and mobility tests), bone mass index, and immune-related factors (active oxygen, antioxidants) were measured and analyzed according to 12 weeks of the underwater exercise. Functional fitness factors after participating in underwater exercise (muscular strength, muscular endurance, flexibility, balance, coordination, movement ability), bone quality index, and immune factors (active oxygen, antioxidant capacity) showed significantly positive changes, respectively. As discussed above, it was found that regular participation in underwater exercise had a positive effect on the functional physical strength, bone mass index, and immunity of elderly women. Therefore, we expect that water walking exercise will be included in the health promotion exercise program of the elderly who have brought about physical decline.*

KEYWORDS: *Aquatic exercise, functional fitenss,immunity factor, actice oxygen, antioxidant capacity*.

Date of Submission: 10-07-2022 Date of Acceptance: 26-07-2022

I. INTRODUCTION

Although life expectancy is getting longer due to the development of medical science and technology, health life expectancy is getting shorter due to various factors such as lifestyle. According to the 2020 Social Indicators-Life Table of Korea by Statistics Korea (KOSIS, 2021), the healthy life expectancy (excluding the illness period) is more than 15 years apart from the life expectancy, acting as a factor that increases the economic burden on individuals, families and the nation.

Healthy life expectancy is the average life expectancy minus the period of illness or injury. It is a health indicator that indicates how long you have lived in good health rather than simply how long you have lived. In the age of aging, healthy life expectancy rather than life expectancy plays an important role in determining the quality of life. Unlike the increased life expectancy, the degeneration of the body's musculoskeletal system and physiological changes with aging negatively affect the activity and independence of life in old age. Therefore, the question and interest in how to suppress the changes in old age to the maximum is increasing. In particular, it is reported that physical function is considered the most important factor for health in old age and is closely related to regular exercise habits (Mosallanezhad et al., 2014; Aboarrage et al., 2018; Tung et al., 2020).

Physical function is important to lead an independent and active life as we age. However, as we age, we inevitably undergo various physiological changes. In the physical aspect, the decrease in exercise capacity is accelerated due to the overall decrease in muscle mass, the overall physique is reduced, and the decrease in bone mass and lack of flexibility limits normal movement and makes bones prone to fracture. In addition, physiological function deterioration such as a decrease in body temperature control and excretion function, a decrease in sleep time and quality, an increase in the number of excretions at night, and an increase in blood pressure due to temperature changes appear. It is accompanied by a decrease in sensory function, and the reaction time to hot and cold things is prolonged, and the functions of sight, hearing, smell and touch are deteriorated. For this reason, the elderly suffer from chronic diseases and pain as not only the incidence of diseases is higher than when they are young, but also the recovery period takes longer (Shigmatsu et al., 2008; Liu & Latham, 2010; Kim, 2012).

Exercise, nutrition, and rest are important factors for a healthy lifespan. In particular, it is a well-known

fact that exercise plays an important role in the health of the elderly. It is reported that the aging phenomenon cannot be artificially changed, but various functional declines due to reduced physical activity can be prevented by regular exercise participation. A regular lifestyle can reduce chronic disease-related mortality by 47% and increase life expectancy by 9.3 years worldwide (WHO, 2009). Recently, it has been reported to have a positive effect on brain function (Erickson et al., 2011; Suwabe et al., 2018; Gujral et al 2017; Xu et al,. 2019). However, the proportion of the elderly participating in exercise is about 45%, and even if they participate in exercise, it is reported that they participate for only 15 minutes, and improvement measures are urgently needed (KOSIS, 2021).

Despite the many advantages of exercise, in the case of the elderly, if physical activity is wrong due to degenerative changes, it can have an excessive influence on the weakened joints. And because of these factors, the elderly's exercise can be further restricted. Considering the specificity of the elderly, it is desirable to consider the physical factors of the elderly, and to select an exercise that is not restricted by facilities, space, and economics. The cost or equipment required for exercise should be minimized, and programs that can be easily followed anywhere are most desirable, and at the same time, it can be a good exercise program only if there are no restrictions on where multiple people can exercise (Jessup *et al.*, 2003). In this context, one of the sports that many people are participating in recently is the aquatic exercise. Various forms of aquatic exercise, including underwater walking, have been reported to improve weight loss and joint mobility, movement, muscle strength, and endurance in the elderly with poor physical function, while reducing gravity using water buoyancy. In particular, it is recommended that elderly people with poor physical function actively participate in aquatic exercises that can have various effects such as strengthening body balance and preventing chronic diseases without causing strain on their spine and joints (Pérez & Cruz, 2017 ; Waller et al., 2017 ; Narasaki-Jara et al., 2020 ; Fantozzi et al., 2020; Fuentes-Lopez et al., 2021).

Therefore, the purpose of this study was to investigate the effect of water walking exercise on functional fitness, bone mass index, and immune factors related to healthy lifespan for the elderly with reduced physical function due to the increase in age.

II. METHODOLOGY

1. Subject

The subjects of this study were 30 who voluntarily participated in a health class conducted at N University among 65-80 year-olds in G city. Among them, 25 people who did not have any specific medical findings and who wished to participate actively by explaining the purpose and method of the study were selected. In order to enable all subjects to understand and practice the behavior patterns which can impact on the result during this study period, we educated them and received test agreements from them. Finally, among them, 3 subjects who did not faithfully implement the exercise program were excluded from this experiment, and the final number of participants was 22 (69.83±5.02 yrs, 156.23±3.59cm, 57.96±7.26 kg).

2. Experimental procedure & Design

In order to adapt the subjects to the experiment and treatment, the main exercise for 12 weeks was conducted after 1 week of preliminary exercise. The underwater exercise program was reorganized to treat injuries with water exercise recommended by Roberts et al.(1996). At the frequency of five times a week (Monday, Tuesday, Wednesday, Thursday, and Friday), it was conducted as a warm-up, main exercise, and cooling down for 50 minutes each time. The time for each underwater exercise was kept constant, and the intensity of the exercise was configured to be 13~15 (a little difficult~difficult) of the rating of perceived exertion (Kisner & Colby, 1996). This exercise program consisted of eight movements: riding a bicycle in water, twisting the body with the hands on the sides, twisting the torso with the arms open, spreading arms, crossing the arms, lifting the knees, hanging the legs on the wall, and walking forward-backward in the water. At a depth of 120cm, the upper body was kept upright within a range where pain was not felt. In other words, in the movement of walking forward underwater, the center was moved in order from the foot jump to the front while watching the front in a straight posture. In the movement of walking backward underwater, the center was moved from the heel to the heel, contrary to the movement of walking forward. In the backward walking motion, at first, it was moved while holding the rope so that the center of gravity was not lost. In the movement of walking forward and backward in water, the arm movement was maintained naturally.

3. Evaluation items & method

Functional fitness closely related to health life was measured for muscle strength, muscular endurance, flexibility, balance, coordination, and mobility tests according to the guidelines of the elderly fitness test developed by Riklia & Jones(2001). Muscle strength(grip), muscular endurance(cahir & stand), flexibility(sit & reach test), balance(one leg stance), coordination(up & go test), and mobility tests(10m walking speed) were measured at 10 a.m. twice before and after underwater walking exercise. The measurement of the line-up in the

chair was made to sit on the chair for 30 seconds according to the signal with the arms crossed on the chest in an X-shaped shape and the standing-up was repeated as much as possible. Standing up and walking (up & go test) from the chair measured the time it took to get up from the position of sitting on a chair without an armrest and return 3m away and sit again. The 10m walking test measured the time required for both feet to pass through the end line by drawing a 10m red line on the ground and making a start line and an end line on both sides so that they could walk as quickly as possible with the start.

The bone mass index was measured for the right longitudinal region using equipment SONOST 2000(Oseteosis, Kor.) using a quantitative ultrasonic dry method, which Sosa et al.(2002) reported that longitudinal measurement was a safe and reliable method for evaluating skeletal condition. The measurement procedure is first, perform a daily inspection of the device condition, apply ultrasonic gel to the longitudinal bone (ankle), adjust the foot support, and insert it vertically. Bone mass index was measured twice as a diagnostic index of bone density, and the average value was calculated for each.

Immunity measurement was performed by measuring free radicals and antioxidant capacity (antioxidants), which are reported to be closely related to aging, bone mass index, and healthy lifespan. The active oxygen items d-ROMs(derivatives of reactive oxygen metabolites) and antioxidant capacity BAP(biological antioxidant potential) were measured using the FRAS4 system (free radical analysis system, fras4 H & D Ltd, ITALY).

4. Statistical analysis

The measured values obtained in this experiment were calculated using the SPSS Package Ver.21.0 statistical processing program to calculate the mean and standard deviation for each measurement item. All data were subjected to error verification to maintain the accuracy of data analysis. Comparison of related variables before and after aquatic exercise was verified by paired t-test. All statistical significance levels were set to .05.

III. FINDINGS

The purpose of this study is to investigate the effects of 12 weeks of water exercise on functional fitness, bone quality index, and immunity related factors in elderly women aged 65-80 years, and the results are shown in <Table 1>.

표 5. Change of related variables after aquatic exercise **M ± S.D**

Division	Functional fitness factor						Osteoporosis factor	Immunity factor	
	Muscle sttength	Muscle endurance	Coordination	Balance	Flexibility	Mobility	BQI	Free radical	Antioxidant
	Grip (kg)	Chair & Stand(num)	Up & go (sec)	One leg stance(sec)	Sit & reach(cm)	10m walking(sec)	BQI (score)	d-ROMs (carr, u)	BAP (μmol)
BEX	20.69±3.91	11.25±1.57	15.36±4.19	11.63±2.08	2.69±0.52	7.15±1.55	53. 78 ± 14.72	436. 82 ± 60.57	1537.68 ± 119.85
AEX	25.53±4.36	15.09±3.26	11.16±3.08	16.21±3.03	5.19±1.02	5.29±106	60.94 ± 13.69	398. 61 ± 46.58	1906.37 ± 125. 81
t-value	3.9425**	3.5683**	3.3986**	4.9301**	2.2465*	2.1731*	2.1383*	3.1395**	4.0453**

1 CARR.U ; 0.08mgH2O2, Values are means ± SEM. *,**Significant different among group(p<0.05, p<0.01), AEX; after exercise, BEX; beforre exercise, Chair & Stand; sitting and standing on a chair, Up & go; stand up from a chair and walking, One leg; standing on one foot with eyes open; Sit & reach;sitting and bending forward, 10m walking; 10m walking speed, BQI;bone quality index index, d-ROMs;derivatives of reactive oxygen metabolites,, BAP; biological antioxidant potential.

As shown in Table1, among the factors related to functional fitness after participating in underwater exercise, muscle strength(*p<.01*), muscular endurance(*p<.01*), coordination(*p<.01*), balance(*p<.01*), flexibility (*p<.05*) , and mobility (*p<.05*) showed significant changes, respectively. In addition, after participating in water exercise, bone mass index (*p<.05*) among factors related to bone density, active oxygen index(d-ROMs; *p<.01*) and antioxidant ability index(BNP, *p<.01*) among immune-related factors, respectively, showed significant changes.

IV. DISCUSSION

With the development of medical science, the lifespan of human beings is increasing day by day, and we have to spend 1/3 of our lives as the elderly. But increasingly, people are not satisfied with just living their life expectancy. People crave to live as healthy as possible. So what should I do? It totally depends on the practice of lifestyle including exercise.

All parts of the body have their own functions, and if used and moved properly, they become healthy, their body functions develop well, and they age slowly and healthy. However, if not used, it is prone to disease, and if not developed, it quickly ages. Depending on the degree of the various activities you engage in during this life, you can age quickly or grow old slowly. In other words, aging is a natural phenomenon that comes to all people, so it is important to know how to delay the aging process and practice it in life.

In the case of the elderly, various exercises are designed and recommended to prevent various degenerative changes because they often hesitate to participate in physical activities due to excessive effects on weakened joints (Fatouros et al., 2002; Jessup et al., 2003).

In this context, the elderly have recently participated in underwater exercises that can minimize accessibility, mobility, and psychological barriers when activities are limited due to chronic pain and health problems. Underwater exercise can stimulate all the important muscles in the body. Buoyancy by water has the advantage of being able to accept most of the shocks caused by exercise, eliminating the fear of falling, and effectively relieving daily stress (Huey & Knudson, 1982; Wilder & Brenan, 1993). In addition, it is more effective in improving overall physical strength than other exercises, and it is not only suitable for developing joint function and cardiopulmonary endurance, but also refreshing after exercise (Fantozzi et al., 2020). In water, the weight is only 10% compared to the ground, which puts less load on joints, bones, tendons, ligaments, and muscles. For this reason, exercise in water is effective for people with back problems, people with weak knees and hip joints, osteoporosis, and limited joint mobility.

In particular, underwater exercise is a well-known technique of physical activity, and ancient doctors report that water-based prescriptions have the property of healing wounds or pain, preventing the recurrence of tension or injury commonly occurring in other exercise programs, and at the same time resistance (Nagle et al., 2003). In other words, since underwater exercise has a low risk of injury due to excessive movement, it can be applied to joint-related diseases, back pain patients, and elderly people with limited joint range due to an increase in age through reconstruction of exercise intensity and program items.

Functional fitness refers to the ability to safely and independently perform daily life activities without fatigue. Functional fitness is multidimensional and includes strength, muscular endurance, flexibility, agility, and balance. Functional fitness is a concept similar to health-related fitness, which is defined as the ability to vitalize daily life or to prevent diseases related to lack of physical activity at an early stage, and is being used as an indicator of healthy aging (ACSM, 2019).

Many studies have reported that regular exercise participation is effective in reducing physical function(strength, muscular endurance, flexibility, balance, agility, and coordination) due to aging (Rikli & Jones, 2014; Eibich et al., 2016; Tung et al., 2020; Pullyblank et al., 2020). Akune et al.(2014) reported that people who regularly participate in exercise in middle age maintain high muscle strength and muscular endurance in old age. Siddiqui et al.(2010) reported that regular exercise participation improves all movements of the body, especially flexibility can improve the quality of life by improving muscles, joints, and ligaments. In addition, Edelberg(2001) reported that the decrease in equilibrium due to aging is caused by weakening of the overall lower body muscle, and it is necessary to improve balance and water-soluble sensory functions through regular physical activities. In particular, it is reported to be effective for health-related fitness and functional fitness after participating in underwater exercise, including walking in the water, targeting people with musculoskeletal disorders, low back pain, obese people, and the elderly (Pérez & Cruz, 2017 ; Waller et al., 2017 ; Narasaki-Jara et al., 2020 ; Fantozzi et al., 2020; Fuentes-Lopez et al., 2021).

In this study, there was a positive change in functional fitness after conducting underwater exercise (forward-backward walking) with exercise intensity of RPE (Rating of Perceived Exertion) in the elderly who complained of pain due to physical dysfunction, showing a difference in age and increase, but it tends to be consistent with previous studies.

Osteoporosis appears as bone mineral mass and bone density decrease due to aging, family history, amenorrhea, malnutrition, menopause, and reduced physical activity. Recently, active oxygen and antioxidant capacity, which play an important role in the aging process, have been highly correlated with osteoporosis (Cervellati et al., 2012). In particular, since it can significantly lower the quality of life as it leads to fractures, it is emerging as a serious problem not only in the present but also in the future society, so proper management and prevention are necessary (Kobayashi & Hwang, 2021; Pollycore & Simon, 2012).

A regular exercise habit is recommended as part of preventing osteoporosis (Simas et al., 2017). The rapid decrease in bone density with increasing age slows or increases the decrease in bone mineral density after regular exercise participation (Beck & Snow, 2003). Regular participation in postmenopausal women prevents

bone loss in the lumbar and femoral regions or increases by 1% per year, and weight-bearing exercise is essential to skeletal health and acts as the most important external factor for bone development and reconstruction (Blanshet et al., 2002; Beck & Snow, 2003).

This study showed a significant change in the bone mass index after participation in underwater walking exercise, consistent with previous studies that showed an increase in bone density after participation in high-intensity underwater exercise and an increase in bone strength while preventing bone loss (Blanshet et al., 2002; Beck & Snow, 2003; Lui et al., 2008; Aboarrage et al., 2018). This result is believed to be due to the delay in bone loss as the weight load walking activity in water acts as an increase in physical load.

When we consume food, a byproduct called active oxygen is generated in the process of converting it into an energy source. This active oxygen is a necessary substance, but it has deadly toxicity. Active oxygen adheres to genes and causes damage, and as a result, aging and disease progresses and causes diseases such as cancer. In addition, it is reported that active oxygen can be useful for the diagnosis of osteoporosis in menopause women because it plays an important role in bone-reabsorption and bone mass reduction while affecting the survival and production of osteoblasts, osteoblasts, and osteoblasts (Zhao et al., 2012).

Most of these active oxygen are neutralized by antioxidants. Since antioxidants in skeletal muscle and intracellular tissue mitochondria increase after regular exercise participation, it is recommended to actively participate in regular exercise as you age. The antioxidant capacity is the first reaction to protect tissue from the influence of active oxygen and serves to prevent the formation of new active oxygen, and the degree of activation of the antioxidant capacity may vary (Michaelides et al., 2011; Suntraluck et al., 2017; Ceci et al., 2020). Regular exercise participation has been reported to improve muscle function while improving the ability to protect cells exposed to active oxygen, thereby inhibiting the increase in new active oxygen (Aoi & Sakuma, 2011; Parolini et al., 2018).

In this study, there were also positive changes in active oxygen and antioxidants after participating in weight load underwater exercise (forward and backward walking). This study tended to be consistent with previous studies reporting an increase in antioxidants after participating in 12-week exercise in elderly women (Rosado-Perez et al., 2012), a decrease in free radicals after 8 weeks of walking exercise in elderly people aged 60 to 85 (Cetin et al., 2010), and an increase in antioxidants after participating in underwater exercise in hypertension patients (Da Silva et al., 2018). This result is believed to be due to the improvement of the body's antioxidant defense system and suppression of new active oxygen as underwater exercise (forward and backward walking) improves skeletal muscle mass and physical function by exercising all upper body muscles such as arms, shoulders, chest, and back muscles while walking (Berzosa et al., 2011).

V. CONCLUSION

As such, exercise in water (forward and backward walking) had a positive effect on functional fitness, bone quality index, and immunity (active oxygen, antioxidant capacity), which are closely related to healthy aging and healthy lifespan. Therefore, it was confirmed that water walking exercise can be recommended as an exercise method to prevent deterioration of physical function due to aging.

REFERENCES

[1]. Aoi W, & Sakuma K.(2011). Oxidative stress and skeletal muscle dysfunction with aging. Curr Aging Sci. 4(2):101-9. doi: 10.2174/1874609811104020101.

[2]. Aboarrage Junior AM, Teixeira CVS, Dos Santos RN, Machado AF, Evangelista AL, Rica RL, Alonso AC, Barroso JA, Serra AJ, Baker JS, & Bocalini DS(.2018). A High-Intensity Jump-Based Aquatic Exercise Program Improves Bone Mineral Density and Functional Fitness in Postmenopausal Women. Rejuvenation Res. 21(6):535-540. doi: 10.1089/rej.2018.2069.

[3]. Akune T, Muraki S, Oka H, Tanaka S, Kawaguchi H, Tokimura F, Yoshida H, Suzuki T, Nakamura K, & Yoshimura N.(2014) A ssociation of physical activities of daily living with the incidence of certified need of care in the long-term care insurance system of Japan: the ROAD study. J Orthop Sci. 19(3):489-96. doi: 10.1007/s00776-014-0537-z.

[4]. American College of Sports Medicine.(2019). Physical fitness testing. ACSM guidelines for exercise testing and prescription. 10th edition, Lippincott Williams and Wilkins; Media, PA.

[5]. Beck BR, & Snow CM.(2003). Bone health across the lifespan—exercising our options. Exerc Sport Sci Rev. 31(3):117-22. doi: 10.1097/00003677-200307000-00003.

[6]. Berzosa C, Cebrián I, Fuentes-Broto L, Gómez-Trullén E, Piedrafita E, Martínez-Ballarín E, López-Pingarrón L, Reiter RJ, & García JJ.(2011). Acute exercise increases plasma total antioxidant status and antioxidant enzyme activities in untrained men. J Biomed Biotechnol. 2011;2011:540458. doi: 10.1155/2011/540458.

[7]. Blanchet C, Giguère Y, Prud'homme D, Dumont M, Rousseau F, & Dodin S.(2002). Association of physical activity and bone: influence of vitamin D receptor genotype. Med Sci Sports Exerc. 34(1):24-31. doi: 10.1097/00005768-200201000-00005.

[8]. Ceci R, Duranti G, Di Filippo ES, Bondi D, Verratti V, Doria C, Caporossi D, Sabatini S, Dimauro I, & Pietrangelo T(2020). Endurance training improves plasma superoxide dismutase activity in healthy elderly. Mech Ageing Dev. 185:111190. doi: 10.1016/j.mad.2019.111190.

[9]. Cervellati C, Montin K, Squerzanti M, Mischiati C, Ferrari C, Spinozzi F, Mariani P, Amenitsch H, Bergamini CM, & Lanzara V.(2012). Effects of the regulatory ligands calcium and GTP on the thermal stability of tissue transglutaminase. Amino Acids. 42(6):2233-42. doi: 10.1007/s00726-011-0963-6.

[10]. Cetin E, Muzembo J, Pardessus V, Puisieux F, & Thevenon A.(2010). Impact of different types of walking aids on the physiological energy cost during gait for elderly individuals with several pathologies and dependent on a technical aid for walking. Ann Phys Rehabil Med. 53(6-7):399-405. doi: 10.1016/j.rehab.2010.06.003.

[11]. Da Silva LA, Menguer L, Motta J, Dieke B, Mariano S, Tasca G, Zacaron RP, Silveira PCL, & Aurino PR.(2018). Effect of aquatic exercise on mental health, functional autonomy, and oxidative dysfunction in hypertensive adults. Clin Exp Hypertens. 40(6):547-553. doi: 10.1080/10641963.2017.1407331.

[12]. Edelberg HK.(2001). Falls and function. How to prevent falls and injuries in patients with impaired mobility. Geriatrics. 56(3):41-5; quiz 49.

[13]. Erickson KI, Voss MW, Prakash RS, Basak C, Szabo A, Chaddock L, Kim JS, Heo S, Alves H, White SM, Wojcicki TR, Mailey E, Vieira VJ, Martin SA, Pence BD, Woods JA, McAuley E, & Kramer AF.(2011). Exercise training increases size of hippocampus and improves memory. Proc Natl Acad Sci USA. 15;108(7):3017-22. doi: 10.1073/pnas.1015950108.

[14]. Fantozzi S, Cortesi M, Giovanardi A, Borra D, Di Michele R, & Gatta G.(2020). Effect of walking speed during gait in water of healthy elderly. Gait Posture. 82:6-13. doi: 10.1016/j.gaitpost.2020.08.112.

[15]. Fatouros, L. G., Taxildaris, K., Tokmakidis, S. P., & Kalapotharakos, V.(2002). The effects of strength training, cardiovascular training and their combination on flexibility of inactive older adults. Int. J. Sports Med., 23(2), 112-119.

[16]. Fuentes-Lopez J, Vidal-Espinoza R, Alvear-Vasquez F, Sanchez-Macedo L, Mamani Velasquez D, Rivera Pacco W, Cossio-Bolaños M, & Gomez Campos R.(2021). Systematic review of aquatic physical exercise programs on functional fitness in older adults. Eur J Transl Myol. 5;31(4):10006. doi: 10.4081/ejtm.2021.10006.

[17]. Gujral S, Aizenstein H, Reynolds CF 3rd, Butters MA, & Erickson KI.(2017). Exercise effects on depression: Possible neural mechanisms. Gen Hosp Psychiatry. 49:2-10. doi: 10.1016/j.genhosppsych.2017.04.012.

[18]. Huey L. & Knudson R.(1982). The waterpower workout, New American Libeary Pub.,

[19]. Jessup, J. V., Horne, C., Vishen, R. K., & Wheeler, D.(2003). Effects of exercise on bone density, balance, and self efficacy in older woman. Riol. Res. Nurs., 4(3), 171-180.

[20]. kim, SH.(2012). Effects of Elastic-band Exercise on Physical Fitness for Activities of Daily Living, Muscle Mass and Pain in Elderly Women. Journal of Coaching Development 14(1): 67-77.

[21]. Kisner C, & Colby LA.(1996). Therapeutic exercise foundations a techniques. 3rd ed. Philadelphia; Davis.

[22]. Kobayashi T, & Hwang I.(2021). Association Between Low Bone Mineral Density Risk Factors and Estrogen Receptor α Gene Polymorphisms in Japanese Female Athletes. Womens Health Rep (New Rochelle). 11;2(1):11-19. doi: 10.1089/whr.2020.0106.

[23]. KOSIS(2021). Funeral population estimates, community health surveys and health behaviors. 2012 National Statistics Portal, korea Statistical Information Service - Topical Statistics. https://kostat.go.kr/portal/korea/index.action.

[24]. Liu CJ, & Latham, NK.(2010). Porgressive resistance strength training for improving physical function in older adults. Cochrane Database Syst. Rev., 8(3), 2759-2768.

[25]. Lui PP, Qin L, & Chan KM.(2008). Tai Chi Chuan exercises in enhancing bone mineral density in active seniors. Clin Sports Med. Jan;27(1):75-86, viii. doi: 10.1016/j.csm.2007.09.002.

[26]. Michaelides AP, Soulis D, Antoniades C, Antonopoulos AS, Miliou A, Ioakeimidis N, Chatzistamatiou E, Bakogiannis C, Marinou K, Liakos C, & Stefanadis C.(2011). Exercise duration as a determinant of vascular function and antioxidant balance in patients with coronary artery disease. Heart. 97(10):832-7. doi: 10.1136/hrt.2010.209080.

[27]. Mosallanezhad Z, Salavati M, Sotoudeh GR, Nilsson Wikmar L, & Frändin K.(2014). Walking habits and health-related factors in 75-year-old Iranian women and men. Arch Gerontol Geriatr. 58(3):320-6. doi: 10.1016/j.archger.2013.11.008.

[28]. Nagle EA. Otto J, Jakicic, & Robertson R.(2003). Effect of aquatic plus walking exercise on weight loss and functional in sedentary obese females, Med. Sci. Sports Exerc., 35(5); S136-145.

[29]. Narasaki-Jara M, Wagatsuma M, Holt JL, Acuña SM, Vrongistinos K, & Jung T.(2020). Aquatic treadmill walking at three depths of water in people with traumatic brain injury. Physiother Res Int. 25(2):e1817. doi: 10.1002/pri.1817.

[30]. Parolini M, De Felice B, Ferrario C, Salgueiro-González N, Castiglioni S, Finizio A, & Tremolada P.(2018). Benzoylecgonine exposure induced oxidative stress and altered swimming behavior and reproduction in Daphnia magna. Environ Pollut. 232:236-244. doi: 10.1016/j.envpol.2017.09.038.

[31]. Pérez de la, Cruz S.(2017). Effectiveness of aquatic therapy for the control of pain and increased functionality in people with Parkinson's disease: a randomized clinical trial. Eur J Phys Rehabil Med. 53(6):825-832. doi: 10.23736/S1973-9087.17.04647-0.

[32]. Pollycove R, & Simon JA.(2012) Osteoporosis: screening and treatment in women. Clin Obstet Gynecol . 55(3):681-91. doi: 10.1097/GRF.0b013e31825caa50.

[33]. Pullyblank K, Strogatz D, Folta SC, Paul L, Nelson ME, Graham M, Marshall GA, Eldridge G, Parry SA, Mebust S, & Seguin RA.(2020). Effects of the Strong Hearts, Healthy Communities Intervention on Functional Fitness of Rural Women. J Rural Health. 36(1):104-110. doi: 10.1111/jrh.12361.

[34]. Rikli R, & Jones CJ.(2014). Senior fitness test manual. Champaign, IL: Human Kinetics.

[35]. Robert W, Bill B, & Loverock, P(1996). The water workout recovery program. Contemporary Books.

[36]. Rosado-Pérez J1, Santiago-Osorio, E, Ortiz, R, & Mendoza-Núñez, VM.(2012). Tai chi diminishes oxidative stress in Mexican older adults. J Nutr Health Aging. 16(7):642-6. doi: 10.1007/s12603-012-0029-9.

[37]. Shigematsu, R., Okura, T., Nakagaichi, M., Tanaka, K., Sakai, T., Kitazumi, S., & Rantanen, T.(2008). Square-stepping exercise and fall risk factors in older adults ; a single - blind, randomized controlled trial. J. Gerontol, A, Biol, Sci, Med, Sci., 63(1), 76-82.

[38]. Siddiqui NI, Nessa A, & Hossain MA.(2010). Regular physical exercise: way to healthy life. Mymensingh Med J. 19(1):154-8.

[39]. Simas V, Hing W, Pope R, & Climstein M.(2017). Effects of water-based exercise on bone health of middle-aged and older adults: a systematic review and meta-analysis. Open Access J Sports Med. 27;8:39-60. doi: 10.2147/OAJSM.S129182.

[40]. Sosa,M., Saavedra P. Mono-Torres, M, Alegre J, Gomez C., Quesada, M., & Salas E.(2002). Quantitative ultrasound calcaneus measurements; normative data and precision in th Spanish population. Osteoporosis, Int., 13(6, 487-492.

[41]. Suntraluck S, Tanaka H, & Suksom D.(2017). The Relative Efficacy of Land-Based and Water-Based Exercise Training on Macro- and Microvascular Functions in Older Patients With Type 2 Diabetes. J Aging Phys Act. 25(3):446-452. doi: 10.1123/japa.2016-0193.

[42]. Suwabe K, Byun K, Hyodo K, Reagh ZM, Roberts JM, Matsushita A, Saotome K, Ochi G, Fukuie T, Suzuki K, Sankai Y, Yassa MA, & Soya H.(2018). Rapid stimulation of human dentate gyrus function with acute mild exercise. Proc Natl Acad Sci USA. 9;115(41):10487-10492. doi: 10.1073/pnas.1805668115.

[43]. Tung HT, Lai CC, Chen KM, & Tsai HY.(2020). Meridian Cuffing Exercises Improved Functional Fitness and Cardiopulmonary Functioning of Community Older Adults. Clin Nurs Res. 29(1):37-47. doi: 10.1177/1054773818768021.

[44]. Waller B, Munukka M, Rantalainen T, Lammentausta E, Nieminen MT, Kiviranta I, Kautiainen H, Häkkinen A, Kujala UM, & Heinonen A.(2017). Effects of high intensity resistance aquatic training on body composition and walking speed in women with

mild knee osteoarthritis: a 4-month RCT with 12-month follow-up. Osteoarthritis Cartilage. 25(8):1238-1246. doi: 10.1016/j.joca.2017.02.800.

[45]. WHO(2009). Global recommendations on physical activity for health..

[46]. Wilder R. & Brennan D.(1993), Physiological response to deep water running in athletes, Sports Med., 16; 374-380,

[47]. Xu X, Fu Z, & Le W.(2019). Exercise and Parkinson's disease. Int Rev Neurobiol. 2019;147:45-74. doi: 10.1016/bs.irn.2019.06.003.

[48]. Zhao XH, Zhe RX, Qin Z, & Yun MY.(2012). Simvastatin protects human osteosarcoma cells from oxidative stress-induced apoptosis through mitochondrial-mediated signaling. Mol Med Rep. 5(2):483-8. doi: 10.3892/mmr.2011.641.

Sun Ho, Kim. " Effect of Auatic Walking Exercise on Functional Fitness, Bone Quality Index and Immune Factors Related to Healthy Lifespan of the Elderly." *International Journal of Humanities and Social Science Invention (IJHSSI)*, vol. 11(07), 2022, pp 97-103. Journal DOI-10.35629/7722