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Effects of Recreational Swimming on Blood Pressure and Lower Extremity Muscle Strength of Older Adults With Elevated Blood Pressure: A Sample of Altınova Beachgoers

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ABSTRACT

This study aimed to investigate the effects of recreational swimming (RS) on blood pressure (BP) and lower extremity muscle strength (LEMS) in older adults with elevated blood pressure (EBP). A total of 44 elderly people, 21 men ($\bar{x}$age=70.6 years, sd= 1.07; body mass index (BMI)=27.4 kg/m2, sd=0.67) and 23 women ($\bar{x}$age=70.2 years, sd=1.15; BMI=28.6 kg/m2, sd=0.92) participated in the study. Participants were reached by snowball sampling method. Data were collected using a semi-automated BP monitor and Chair Stand Test. Analyses were performed using mixed-design ANOVA with a significance level of p<.05. There was a significant difference between groups [F (2,84)=16.59, p<.001, η^2p=.028] and times [F (2,84)=3.55, p<.033, η^2p=.080] in systolic blood pressure (SBP). There was significant difference between groups [F (1,42)=24.48, p<.001, η^2p=.368] in diastolic blood pressure (DBP). There was a statistically significant difference between groups [F (1,42)=28.68, p<.001, η^2p=.041] in mean blood pressure (MBP). There was a statistically significant difference between groups and times [F (1,42)=4.2, p<.046, η^2p=.96; F (1,84)=87.1, p<.001, η^2p=.96, respectively] in LEMS. There was a significant difference between times [F (2,84)=26.6, p<.001, η^2p=.1] in BMI. There was a statistically significant difference between groups, time and group*time interaction [F (1,42)=18.53, p<.001, η^2p=.03; F (2,84) =29.35, p<.001, η^2p=.04; F (2,84)=4.59, p<.013, η^2p=.099, respectively] in rating of perceived exertion. RS in a blue ecological environment is thought to provide positive improvements in BP and LEMS values of older adults with EBP and to have a cumulative effect on metabolic safety and the quality of the aging process

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INTRODUCTION

In Turkey, the proportion of the elderly population in the total population is 10.2%; the rate of chronic diseases such as hypertension, diabetes, stroke, paralysis, musculoskeletal, asthma, etc. is 78.7%; the rate of those who do not exercise regularly is 81.7%; the rate of falls in the last year is 24.0%; the rate of those who have functional difficulties is 27.1%, and the rate of those who have difficulty in carrying and holding is 29.7% (Türkiye İstatistik Kurumu, 2023).

The World Health Organization (WHO) states that 68% of deaths each year occur as a result of non-communicable (chronic) diseases (WHO, 2014). Over 1.3 billion people worldwide are thought to suffer from hypertension and this condition is more common in elder people (Picon et al., 2013).

Studies have shown that the prevalence of hypertension is higher among men until the age of 50 and following this age. Women are more likely to have it, especially after menopause (Cunha et al., 2021). It is also reported that hypertension complicates the living conditions of more than half of people aged 60-69 years and about three-quarters of people aged 70 years and older (Huang et al., 2013). Hypertension (HT) is a systemic disease characterized by persistent high blood pressure and is an important health problem due to its widespread prevalence in the population (Bahar, 2024; Türkiye Endokrinoloji ve Metabolizma Derneği, 2022).

The 2017 American College of Cardiology/American Heart Association (ACC/AHA) classifies blood pressure into four levels: Normal BP, elevated BP, Stage 1 hypertension, and Stage 2 hypertension, respectively (SBP/DBP ranges by classification level are <120 and <80 , 120-129 and <80, 130-139 or 80-89, ≥140 or ≥ 90, respectively). In addition, the office recommends that SBP/DBP values ≥140/90 mm Hg be considered as the reference point for the definition of hypertension (ACC/AHA, 2018; Muntner et al., 2019).

The report of the Turkish Society of Endocrinology and Metabolism (2022) stated that ≥4 days a week, moderate intensity, 30-60 minutes of dynamic activities have a positive effect on weight control, stress management and cardiovascular system (Türkiye Endokrinoloji ve Metabolizma Derneği, 2022). Research has shown that a -10 mm Hg change in SBP can reduce the risk of progression to major cardiovascular disease by 20%, coronary heart disease by 17%, stroke by 27%, heart failure by 28% and overall mortality by 13% (Ettehad et al., 2016). Igarashi and Yoshie Nogami's (2018) 14 Meta-analysis study results showed that regular aqua exercises positively affected on blood pressure (SBP-8.4 mmHg; DBP-3.3 mmHg). In a similar direction Sarmento et al. (2020) reported that in a systematic meta-analysis of 44 articles on the Web of Science, SPORTDiscus, MEDLINE, and PubMed databases that recreational football reduces BP and resting heart rate, increases bone mineral density, and acts as a stimulus for osteogenesis. It has been reported that brisk walking can reduce the risk of acute cardiovascular events in elderly patients with essential hypertension (He et al., 2018). In a meta-analysis of 23 articles, Huang et al. (2013) reported that regular aerobic exercise provided significant reductions of 3.9% and 4.5% in both SBP (-5.39 ± 1.21 mmHg, p<.0001) and DBP (-3.68 ± 0.83 mmHg, p<.0001) in sedentary older adults, respectively.

Although the benefits of physical activity and recreational sports are known, significant restrictions such as movement difficulties caused by aging, a sense of withdrawal to safe areas in health, social prejudices or diseases that have formed in society toward old age may limit the participation of the elderly population in exercise programmes (Marques et al., 2019; Kendall et al., 2014) It is thought that one of the means of overcoming these limitations will be swimming activities in the natural marine environment, which can be expressed as recreational and green exercise.

Aquatic exercise has recently become an alternative exercise programme for fitness and rehabilitation purposes (Delavatti et al., 2015). The conditions of seawater not only reduce the effect of body weight on joints and the likelihood of injury or falls (Lord et al., 2006) but can also provide multifaceted benefits to the cardiovascular system and muscle strength by creating non-mechanical resistance to exercise in water.

The fact that the sea has a different ambiance than land exercise and the effect of its biophysical characteristics may provide some advantages (Assis et al., 2006). However, the advantages and disadvantages of the marine environment for the hemodynamic safety of the elderly should be known in detail. For example, the intensity of water exercises decreases with increasing water depth (Barbosa et al., 2009).

Lower limb muscle groups are exposed to more resistance than upper limb muscle groups in exercises performed in the vertical position (Kim et al., 2015) and blood pressure values are higher in the aquatic environment than on land. Shallow water decreases buoyancy

In post-menopausal women (~74 years), 24 weeks of swimming exercise had a positive effect on blood pressure (BP) and muscle strength in terms of group*time interaction, respectively (systolic BP=Δ-9 mm Hg; diastolic BP=Δ- 9 mm Hg; muscle strength= Δ3 kg, P<0.05; Wong et al., 2019). Cunha et al. (2021) investigated the effects of resistance, cycling, and water-based exercise on blood pressure in older adults with hypertension and reported a significant decrease in systolic blood pressure values only in the water-based exercise group (WE = Δ-4.6 mmHg; $p < .05$).

12 weeks of swimming exercise decreased systolic blood pressure from 131 ±3 mm Hg to 122 ±4 mm Hg in healthy adults (60 ±2) over 50 years of age with stage 1 hypertension and not taking medication (Nualnim et al., 2012). It was also reported that a 10-week swimming exercise program resulted in significant reductions in resting heart rate (81 ± 4 to 71 ± 3 beats/min; $P < 0.01$) and systolic blood pressure (150 ± 5 to 144 ± 4 mmHg; $P < 0.05$). An indicator of cardiovascular adaptation in adults [48 ± 2 years (mean ± SEM)] with stage 1 or 2 essential hypertension (Tanaka et al., 1997).

Interacting with the natural environment, such as green spaces (woodlands, urban parks) or blue spaces (aquatic environments such as rivers, lakes or the sea), has been shown to promote physical activity, improve mental health, reduce the propensity for illness and disease, and increase life expectancy. Living near blue areas, visiting blue areas, exercising in green and blue areas and incidental contact with blue areas (e.g. daily commuting from blue areas) are positively associated with health and well-being (Gascon et al., 2017; White et al., 2020).

Knowing about the functional living opportunities provided by seawater and at the same time generating scientific data by investigating the suitability of this exercise environment for the hemodynamic safety of the elderly will help the purposeful design of exercise programmes. Obtaining scientific norms for changes in blood pressure and LEMS values of the elderly belonging to different geographical clusters living in coastal areas and exercising in the marine environment is vital for research and application processes.

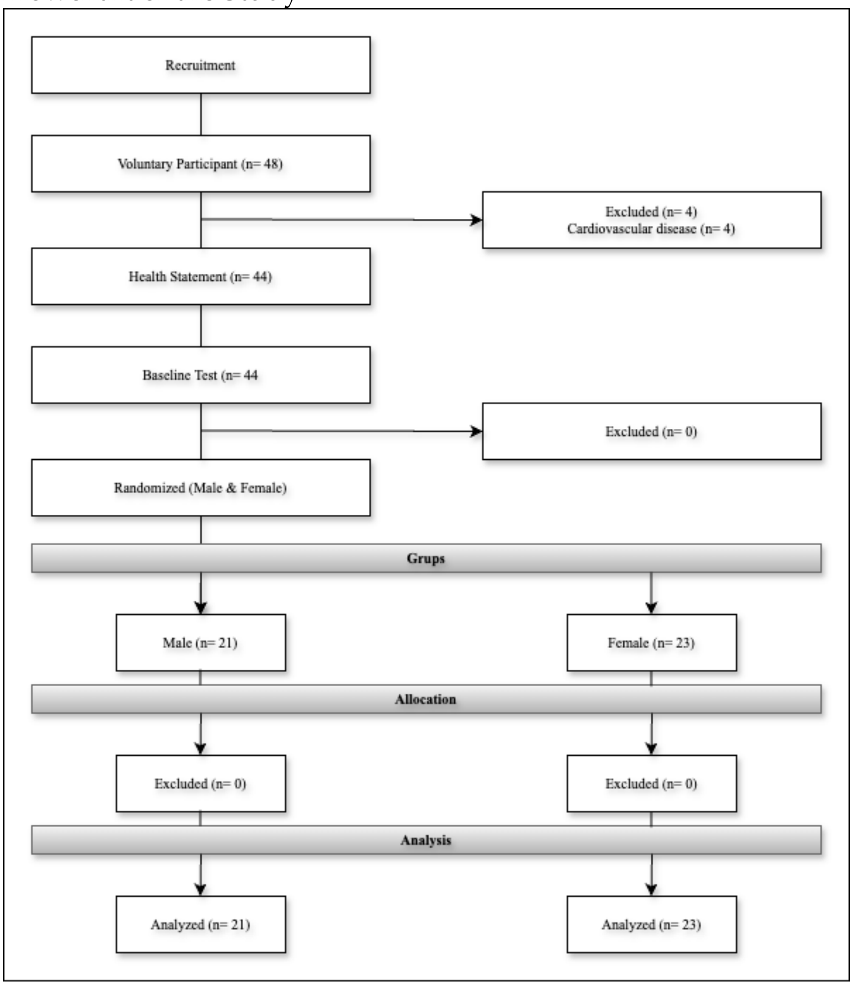
This study is thought to contribute to the creation of appropriate exercise protocols in terms of hemodynamic safety of elderly adults living in different geographies in terms of BP and lower extremity muscle strength values obtained due to swimming conditions and effects in the sea. It is assumed that there will be a significant effect on SBP, DBP, lower extremity muscle strength and body mass index values between groups, between times and depending on the group*time interaction. It is thought that there is a need for comparative practices and norm values specific to geriatric communities with different codes, including leisure time and psycho-social benefits. This study aimed to investigate the effect of a total four session of modified moderate intensity swimming exercise on blood pressure and lower extremity strength in elderly adults.

METHODS

Participants

This study was conducted in the summer of 2023 with older adults using Altinova Sand Island beach. The reasons for choosing this beach were that the residents living around it were mostly older adults, it was possible to walk to and from the beach and water safety (there was a wave breaker and the depth of a large area was at chest level), the average sea water temperature during the application period was 30-32 Co (651710 Thermometer Seawater). The water depth was 1.4-1.6 m in a large area and it was suitable for water recreation. To form the sample of the study, male and female visitors aged 65 years and older who visited the beach for five days were contacted through snowball sampling and 47 participants, 23 males and 24 females who met all the criteria below were invited to participate in the study. Three male participants (criteria 5 and 8) and one female participant (criterion 4) were excluded on the grounds of risk (Figure 1). For participation, the ability to swim freestyle and backstroke in rough form on the water surface was required.

Figure 1
Flowchart of the Study



Current studies on exercise in hypertension show that 18-20 participants per group provides and adequate sample size. For this study, the sample size and the ratio of groups to each other were calculated based on the literature (He et al., 2018; Sohn et al., 2007).

Participant criterias are; 1) 65 years and older, 2) not participating in an exercise program in the last six months, 3) elevated blood pressure (lower than mean 130/ 80 mmhg sbp/dbp), 4) body mass index (bmi) less than 34kg/m2, 5) non-smoker, 6) be independent living persons, 7) ability to move independently and perform daily activities, 8) no medical contraindications for testing and practice in terms of physical fitness, 9) having no problems with verbal communication and 10) the lack of cognitive constraints every participant received comprehensive information regarding every phase of the research was clearly stated that they could leave the study at any time. Participants were informed about the consent form declaring their voluntary participation and asked to sign it. The research was ethically approved by the ethics committee of Eskisehir Technical University, Science and Engineering Sciences Scientific Research and Publication Ethics Committee (2023/E-87.914.409-050.03.04-2.300.029.618/) and was conducted in accordance with the recommendations of the Declaration of Helsinki. Table 1 shows the groups, measurements and application protocol.

Table 1
Research Model

Groups	Pretest	Intervention-1	Midtest	Intervention-2	Posttest
Male (N=21)	SBP	Beachgoers' recreational	SBP	Beachgoers' recreational	SBP
	DBP	swimming	DBP	swimming,	DBP
	MBP				
	30secCST	21 sesions	30secCST	21 sessions	30secCST
	BMI		BMI		BMI
	RPE		RPE		RPE
Female (N=23)	SBP	Beachgoers' recreational	SBP	Beachgoers' recreational	SBP
	DBP	Swimming	DBP	Swimming,	DBP
	MBP				
	30secCST	21 sessions	30secCST	21 sessions	30secCST
	BMI		BMI		BMI
	RPE		RPE		RPE

Note. SBP: Systolic Blood Pressure (mmHg); DBP: Diastolic Blood Pressure; (mmHg); MBP: Mean Blood Pressure; 30secCST: 30-Second Chair Stand Test; BMI: Body Mass Index; RPE: Rating of Perceived Exertion

Procedures

Participants were divided into two groups male and female. The application was carried out for four sessions per week, for a total of 42 sessions. The exercises were performed in the sea environment with a water temperature of 31-32°C in a safe area determined as 6x20 m and at a depth where each participant was positioned at chest level. All practices were performed under the supervision of two swimming specialty students. Swimming sessions started at 07:30 in the morning. Ten minutes before the start of the practice, blood pressure measurements were taken and recorded by a nurse from the staff of Ayvalık Municipality according to the order in which all participants arrived at the beach. The sessions consisted of 10 min warm-up (5 min flexibility on land, 5 min warm-up in water); 30 min recreational swimming and resistance exercise [(swimming, 3x6 min + 2 min rest), 2 sets of resistance exercise/ 2 min rest between sets, 8x 30sec active/30sec passive, fixed point and forward east jump)] and 10 min active rest.

Data Collection Tools

Hemodynamic Measurements

Participants were instructed not to smoke, drink tea or coffee, take caffeine, preferably not to eat, and not to talk during the measurement (at least 30 min). SBP and DBP measurements were taken in the sitting position using a semi-automated blood pressure (BP) monitor (Omron 705CP; Matsusaka, Japan), which is internationally validated according to the Eighth Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Arterial Pressure (James et al., 2014). All BP measurements were performed between 07.00 and 07.30 in the morning. BP measurements were performed on the participant's bilateral arm for the first two sessions and when there was a difference between the measurements, subsequent measurements were performed on the arm with the higher value. After 10 minutes of rest, the participants' BP readings were recorded in a seated position in a chair with both feet on the floor, palm open, arm at heart level and at least two measurements were taken at a time and the mean values were recorded. All BP measurements were performed according to the American Heart Association guidelines. (Tanaka et al.,1997). Mean arterial blood pressure (MABP) was calculated using the following formula: MABP = SBP + (2 x DBP) /3 (Rmirez-Valez et al., 2020).

30-Second Chair Stand Test (30 sec. CST)

Evaluation of lower body strength. The examination subect is seated on a chair that is 43 cm high, the proper height. At the level of the chest, the arms are crossed. The goal is to complete as many right lifts (rpt) out of the chair in 30 seconds or less. (Rikli & Jones., 2013).

Body Mass Index

Height and weight measurements of the participants were performed using a SECA measuring device (model 764). Body Mass Index (BMI) values were calculated based on these data (underweight <18.5 kg/m2; normal 18.5-24.9 kg/m2; overweight 25-29.9 kg/m2; obesity> 30 kg/m2) (WHO, 2013).

Rating of Perceived Exertion

In this study, we applied the Rating of Perceived Exertion (RPE) scale developed by Borg (1998) and adapted by Foster et al. (2001), which is based on the idea of estimating the level of difficulty caused by the physical activity load with a specific rating method (Borg, 1998; Foster et al., 2001). Participants were briefed about the scale and encouraged to dry off immediately after exercise and rest sitting on the beach. Thirty minutes after each exercise session, they were asked to answer "How was your workout?". Two sessions of trials were conducted before the study. The participants' Rating of Perceived Exertion for the entire session was recorded numerically according to the same scale (Foster et al., 2001). The 42 sessions were divided into 3 blocks of 14 sessions and each block's RPE values were analyzed.

Data Analysis

The normality of the data was tested with the Kolmogorov-Smirnov test and the homogeneity of the variances was tested with skewness, kurtosis and Levene's test. After it was determined that the data were normally distributed, it was decided to perform parametric analyses. The assumption of sphericity was tested with Mauchly's W test and their conformity to normal distribution was checked with the Shapiro-Wilk test. For variables that do not meet the assumption of sphericity, the correction of the degrees of freedom was made depending on the Epsilon (ε) value and the Greenhouse-Geisser correction was applied (if $\varepsilon<0.75$). Hemodynamic measurements, 30 sec. CST, BMI and RPE data were analyzed by mixed design ANOVA for male and female groups, time differences and group-time interactions. P value <0.05 was considered statistically significant. Group and time comparisons of data were compared using the Bonferroni post hoc test. Partial eta squared (η^2p) was calculated to determine the effect size of repeated measures ANOVA (Cohen, 1988; Schober, et al., 2018). Cohen's d effect sizes of the measures were calculated to determine the magnitude of pairwise comparisons over time and between groups. The significance of the effect sizes was determined as Cohen's d insignificant (<0.2), small (≥0.2), medium (≥0.5), and large (≥0.8; Cohen, 1988; Schober et al., 2018). Statistical analyses were performed using R Studio (version 4.2.1) and IBM SPSS software (version 2022).

RESULTS

The mean age of male participants before the intervention (n = 21) was 70.6 years (sd = 1.07), mean height 172.9 (sd = 1.02), mean body weight 81.9 (sd = 2.45), and mean body mass index 27.4 (sd = 0.67). The mean age of female participants (n = 23) was 70.2 years (sd = 1.15), mean height 161.5 (sd = 1.28), mean body weight 73.1 (sd = 2.25) and mean body mass index 28.6 (sd = 0.92). Table 2 show the distribution of the male and female participants's tests results for SBP, DBP, MBP,30sec CST, BMI and RPE.

Table 2
Distribution of the Participants Pre-Mid-Posttests Statistical Results of SBP, DBP, MBP, 30sec CST, BMI and RPE

Variable	MG						FMG					
	Pre		Mid		Post		Pre		Mid		Post	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
SBP	131.8	9.1	128.8	8.9	127.7	4.5	120.7	11	118.3	11.7	119.4	8.2
DBP	77.7	7.6	76.9	5.5	76.6	4.7	67.6	7.3	67.2	8.2	67.4	7.1
MBP	95.7	6.2	94.1	5.4	93.5	4.3	85.1	7.3	84.3	7.9	84.7	6.6
30sec	12.3	2.4	14.2	2.9	14.5	3.2	10.6	2.3	12.5	2.5	12.9	2.9
BMI	27.4	3	27.1	3	26.5	2.7	28.1	4.4	27.8	4.2	27.5	4.1
RPE	4.6	0.6	4.1	0.34	4.2	0.5	5.3	0.6	5	0.63	4.6	0.56

Note. MG: Male Group; FMG: Female Group; SBP: Systolic Blood Pressure; DBP: Dyastolic Blood Pressure; MBP: Mean Blood Pressure; 30secCST: 30-Second Chair Stand Test; BMI: Body Mass Index; RPE: Rating of Percieved Exertion

Mixed Design ANOVA Results of SBP

Mauchly's W assumption was met regarding time and group*time interaction (Mauchly's W = 0.990, p>0.05). There was a significant difference between groups [F (2,84) = 16.59, p<.001, η^2p = .028] and a significant difference across the three time points [F (2,84) = 3.55, p<.033, η^2p = .080] in SBP. There was no statistically significant interaction between groups*time (p > .05; Table 3).

Mixed design ANOVA results of DBP

Mauchly's W assumption was not met regarding time and group*time interaction (Mauchly's W = .692, p<.001). Therefore, Greenhouse-Gaiser effect values were taken into consideration. In this context, when Table 8 was analyzed, there was a statistically significant difference between the groups in the two-way ANOVA performed for DBP values [F (1,42) = 24.48, p<.001, η^2p = .368]. There was not statistically significant difference between times* interaction between groups*time (p>.05; Table 3).

Mixed design ANOVA results of MBP

Mauchly's W assumption was not met regarding time and group*time interaction (Mauchly'sW = .808, p<.013). Therefore, Greenhouse-Gaiser effect values were taken into consideration. Table 11 ANOVA results of MBP values showed a statistically significant distinction existed between groups [F (1,42) = 28.68, p<.001, η^2p = .041], while no statistically significant interaction difference between times and group*time (p > .082; Table 3).

Mixed Design ANOVA Results of 30sec CST

Mauchly's W assumption was not met regarding time and group*time interaction (Mauchly's W = .607, p<.001). Therefore, Greenhouse-Gaiser effect values were taken into consideration. In this context, when Table 13 is examined, it is seen that in the two-way ANOVA conducted for 30 sec. CST values, between groups and time, respectively there was a statistically significant difference [F (1,42) = 4.2, p<.046, η^2p = .96; F (1,84) = 87.1, p<.001, η^2p = .96]. No statistically significant difference was found between groups*time interaction (p > .05; Table 3).

Table 3
Mixed Design ANOVA Results of SBP, DBP, MBP,30sec CST, BMI and RPE

Variables		Sum of Sq	df	MS	F	p	η^2_p	O. Power[a]
SBP	Group	3272.75	1	3272.75	16.591	**0.001*** **	0.28	0.978
	Time	209.819	2	104.909	3.553	**0.033***	0.08	0.646
	G*T	49.455	2	24.727	0.837	0.44	0.02	0.189
DBP	Group	3073.342	1	3073.34	24.48	**0.001*** **	0.368	0.998
	Time	10.493	2	5.247	0.538	0.586	0.013	0.136
	G*T	4.675	2	2.337	0.24	0.787	0.006	0.087
MBP	Group	3125.154	1	3125.15	28.68	**0.001*** **	0.41	0.999
	Time	44.986	1.7	26.81	2.7	0.082	0.06	0.525
	G*T	16.427	1.7	9.79	0.995	0.363	0.02	0.218

Table 3 (Continued)

Variables		Sum of Sq	df	MS	F	p	η^2_p	O. Power[a]
30sec	**Group**	90.04	1	90.04	4.2	**0.046***	0.96	0.518
	Time	132.87	1.4	92.56	87.1	**0.001*****	0.675	1
	G*T	0.03	1.4	0.021	0.02	0.949	0.001	0.053
BMI	**Group**	6.34	1	6.34	0.464	0.5	0.011	0.102
	Time	11.1	1.7	6.44	26.6	**0.001*****	0.388	1
	G*T	0.409	1.7	0.237	0.98	0.369	0.023	0.215
RPE	**Group**	13.21	1	13.21	18.53	**0.001*****	0.03	0.988
	Time	6.75	2	3.37	29.35	**0.001*****	0.04	1
	G*T	1.05	2	0.528	4.59	**0.013***	0.99	0.764

Notes. Sum of Sq: Sum of Squares; M.S: Mean Squares; O. Power[a]: Observed Power; G*P, Group*Time; *: p<0.05, ***: p<0.001

Mixed design ANOVA results of BMI

Mauchly's W assumption was not met regarding time and group*time interaction (Mauchly's W = .839, p < .027). Therefore, Greenhouse-Gaiser effect values were taken into consideration. In this context, there was a significant difference across the three time points [F (2,84) = 26.6, p<.001, η^2_p = .1] in BMI. There was not statistically significant between groups*interaction between groups * time (p > .05; Table 3).

Mixed design ANOVA results of RPE

Mauchly's W data are considered since the assumption of sphericity is met (Mauchly’s W = .993, P > .872). In this context, A statistically significant distinction existed between groups, time and group*time interaction respectively [F (1,42) = 18.53, p < .001, η^2_p = .03; F (2,84) = 29.35, p < .001, η^2_p = .04; F (2,84) = 4.59, p<.013, η^2_p = .099] in RPE (Table 3).

Table 4

Groups * Time Post Hoc Results of SBP and DBP

Variables			Mean Difference	SE	p_{bonf}
SBP	M1	FM1	11.1	2.8	**0.002***
		FM2	13.5	2.8	**0.001*****
		FM3	12.4	2.8	**0.001*****
	M2	FM1	8.1	2.8	0.064***
		FM2	9.7	2.8	**0.004***
		FM3	9.5	2.8	**0.016***
	M3	FM2	9.4	2.8	**0.015***
		FM3	9.3	2.8	0.054
	FM2	M1	-13.5	2.8	**0.001*****
		M2	-10.4	2.8	**0.004***
		M3	-9.4	2.8	**0.015***

Table 4 (Continued)

Variables			Mean Difference	SE	p_{bonf}
DBP	M1	FM1	10.1	2.1	**0.001*****
		FM2	10.4	2.1	**0.001*****
		FM3	10.2	2.1	**0.001*****
	M2	FM1	9.3	2.1	**0.001*****
		FM2	9.7	2.1	**0.001*****
		FM3	9.5	2.1	**0.001*****
	M3	FM1	9	2.1	**0.001*****
		FM2	9.3	2.1	**0.001*****
		FM3	9.2	2.1	**0.001*****

Note. M1: Male pretest; M2: Male midtest; M3: Male posttest; FM1: Female pretest; FM2: Female midtest: FM3, Female posttest, *: p<0.05, ***: p<0.001

*Groups * Time Post Hoc Results of SBP*

Table 4 showed a statistically notable distinction between the SBP pretest values of male participants and the pretest, midtest and posttest values of female participants ($p < .001$). There was a considerable distinction between the SBP midtest values of male participants and the midtest and posttest values of female participants, respectively (p. < .004, $p < .016$). There was a considerable distinction between the SBP posttest values of male participants and the midtest values of female participants, respectively ($p < .015$). There was a considerable distinction between the pre-test, mid-test and post-test values of female participants and male participants respectively, ($p < .001$, $p < .004$, $p < .015$). There was a statistically significant difference in SBP between men and women at all three measurements.

*Groups * Time Post Hoc Results of DBP*

ANOVA was applied to determine which groups the difference was a statistically significant difference was observed $F (5) = 12.78$; $p<.001$). In this context, the Bonferoni Post-hoc test was performed to determine between which groups the difference was between. Table 9 showed that a statistically significant difference was observed. In DBP between men and women at all three measurement points ($p < .001$; Table 4).

*Groups * Time Post Hoc Results of 30 sec CST*

Table 5 shows a statistically significant difference between male participants' 30 sec. CST midtest and female participants' 30 sec. CST pretest and between male participants' 30 sec. CST posttest and female participants' 30 sec. CST pretest ($p<.001$).

Table 5
Group and Time Post- Hoc Results of 30 sec. CST and RPE

Variables	Male	Female	Mean Difference	SE	p_{bonf}
30sec CST	M2	FM1	3.62	0.834	**0.001*****
	M3	FM1	3.91	0.834	**0.001*****
RPE	M1	FM1	-0.687	0.169	**0.001*****
	M2	FM1	-1.146	0.169	**0.001*****
		FM2	-0.82	0.169	**0.001*****
	M3	FM1	-1.075	0.169	**0.001*****
		FM2	-0.749	0.169	**0.001*****
	FM1	FM3	0.683	0.169	**0.001*****

Note. 30secCST: 30sec Chair Stand Test; BMI: Body Mass Index; RPE: Ratio of Percieved Exertion, ***: p<0.001

*Groups * Time Post Hoc Results of RPE*

Table 5 shows a statistically meaningful variation in the male participants' RPE pretest and female participants' RPE and female participants' RPE pretest; between male participants' RPE midtest and female participants' RPE pre- midtest; between male participants' RPE posttest and female participants' RPE pre- midtest. A statistically significant difference between female participants' RPE posttest ($p < .001$).

DISCUSSION

There is strong evidence that swimming positively effects on the BP of older adults. In this context research has shown that a -10 mmHg change in SBP can reduce the risk of progression to major cardiovascular disease by 20%, (Ettehad et al., 2016). Igarashi and Yoshie Nogami's (2018) 14 Meta-analysis study showed that regular aqua exercises positively affected BP. In a similar direction Sarmento et al. (2020) reported that in a systematic meta-analysis of 44 articles in Web of Science, SPORTDiscus, MEDLINE, and PubMed databases that recreational football reduces blood pressure.

It has been reported that brisk walking can reduce the risk of acute cardiovascular events in elderly patients with essential hypertension (He et al., 2018). In a meta-analysis of 23 articles, Huang et al. (2013) reported that regular aerobic exercise provided significant reductions in SBP and DBP ($p <. 0001$, $p <. 0001$) in sedentary older adults, respectively. In post-menopausal women (~74 years), 24 weeks of swimming (SWM) exercise had a positive effect on blood pressure (BP) and muscle strength in terms of group*time interaction ($P < 0.05$) (Wong et al., 2019).

Cunha et al. (2021) investigated the effects of resistance, cycling, and water-based exercise on blood pressure in older adults with hypertension and reported a significant decrease in SBP values only in the water-based exercise group ($p <. 05$). 12 weeks of swimming exercise decreased systolic blood pressure from 131 ±3 mm Hg to 122 ± 4 mm Hg in healthy adults (60 ± 2) over 50 years of age with stage 1 hypertension and not taking medication (Nualnim et al., 2012).

It was reported that 12 weeks of aquatic strength training significantly increased the maximal power of knee extensors by 20% in the right and left legs and knee flexors by 33% in both legs. In addition, 10 weeks of progressive resistance-type water training resulted in a 7% increase in the 60° s1 isokinetic torque of knee flexors and extensors in healthy women (Gusi et al.,2006) Meta-analyses show that there is a significant increase in hand grip strength, isometric peak torque (60°-s-1) of knee extension and flexion, and that exercises performed on land and in water provide similar muscle strength gains (Prado et al., 2022).

This study showed that recreational swimming in the sea, referred to as a blue exercise environment, contributes positively to blood pressure (BP) and lower limb muscle groups, which cumulatively affect the well-being of older adults. Decreased levels of noradrenaline and inhibition of sympathetic activity due to the effects of exercise; decreased circulating levels of angiotensin II, adenosine, endothelin and their receptors in the central nervous system may effect on blood pressure. Again, the improvement in exercise capacity increases baroreflex sensitivity and the stabilizing effect on the autonomic nervous system, the vasodilator effect of prostaglandins and nitric oxide released during exercise, positive changes in blood lipid levels, body fat and increase in metabolic rate with the effect of seawater temperature can be counted among the reasons. In addition, contribution to endothelium-related vasodilation by increasing the basal level of plasma nitrates, decrease in vascular tone and peripheral resistance in the sea, exercise-induced changes in blood volume and volume-regulating hormones may have a positive effect on blood pressure. Again, the fact that seawater is denser than air means that the resistance in the water increases the frequency of muscle stimulation depending on the speed of the movement. In addition, jumping movements with forward movement in the water cause neural and structural improvements in quadriceps and hamstring muscle strength suggesting that it provides positive development in lower extremity muscle groups. The partial resistance of the water movements (partial effect of the waves on the other participants), and the participants' initial 30-second sit-stand test values were quite low, suggesting that muscle strength.

CONCLUSION

The study's findings demonstrate that recreational semi-structured swimming exercise significantly reduces systolic, diastolic and mean blood pressure in older adults with stage-1 hypertension and is a potent modifier in preventing and controlling hypertension-related cardiovascular risks. In cases where lowering blood pressure is the main goal, aerobic swimming is considered one of the appropriate methods to achieve this goal. In this study, it is seen that the resistance created by seawater against calisthenic movements at the chest level provides significant increases in guadriceps and hamstring muscle strength. This situation can contribute to an increase in the activities of daily living of older adults.

As a result, it can be concluded that the incidence of injury is significantly lower in swimmers compared to endurance exercises such as running and cycling. It can be concluded that recreational swimming, which is purposefully organized by considering hemodynamic safety parameters, is a potentially useful alternative to land exercise for older adults. These findings also suggest that recreational swimming offers special conditions for obese patients, those with exercise-induced asthma or orthopedic injuries.

PRACTICAL IMPLICATIONS

The implementation process of the research provided an autotelic flow in a semi-structured manner that did not ignore the participants’ daily marine activity habits and expectations. The course of the participants' daily blood pressure measurements and their well-being on that day was monitored. The use of sea shoes to prevent the sea floor from damaging the feet during the activity and the use of pasta for balance were relaxing elements for safe exercise.

Adaptation to the activities applied in each part of the session improved progressively. The participants' ability to perform the skills increased with cognitive and neuromuscular adaptation. Particularly health and safety concerns about participation in the study decreased. Partial high blood pressure and leg muscle strength data in the interim test strengthened the continuity of participation. The study raised public awareness about the effectiveness of exercise in coping with health problems of older adults.

Considering that 78.7% of the elderly population in Turkey has chronic (chronic) diseases such as blood pressure, diabetes, asthma, etc., it is thought that the results of the research will contribute to establishing norm values, creating a basis for new exercise modules to laboratories or clinics and it is vital to make it more visible in public spaces with widespread practices.

The possible disadvantages of high-volume RT in institutionalized elderly patients need to be considered, particularly in light of the significant changes in hemodynamic parameters that occur during and right after the session. Numerous elements, such as hydrostatic pressure, diving, and the water's high heat conductivity, affect how the body reacts to swimming. While running and swimming have identical cardiac output levels, swimming results in a more significant mean arterial blood pressure. These variables should be considered when organizing interventions for special populations. In addition to body mass index, other variables related to body composition should be investigated concerning blood pressure. The oxygen saturation of the participants can be investigated as a variable. Increasing the number of participants in the study and conducting studies with control groups should be considered.

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Authors' Contribution

All processes of this research from the beginning to the end are single-authored.

Declaration of Conflict Interest

There is no conflict of interest in this research.

Ethics Statement

The research was ethically approved by the ethics committee of Eskisehir Technical University, Science and Engineering Sciences Scientific Research and Publication Ethics Committee (2023/E-87.914.409-050.03.04-2.300.029.618/) and was conducted in accordance with the recommendations of the Declaration of Helsinki.

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