Arch Health Sci Res. 2023;10(2):137-143
DOI: 10.5152/ArcHealthSciRes.2023.22111

Original Article

Investigation of Acute Effects of Slow Controlled Breathing on Fatigue and Vital Markers During Recovery Phase

Ecenur ATLI[1,2], Sezen UYANIK[1,3], Ali YILDIRIM[1,4], Nida YEKTEUŞAKLARI[1] Gizem Demir UZUN[1,5], Mehmet ACAR[1,6], Buket AKINCI[7]

[1]Program of Physiotherapy and Rehabilitation, Biruni University, Institute of Graduate Education, İstanbul, Turkey
[2]Department of Physical Medicine and Rehabilitation, Koç University Hospital,İstanbul, Turkey
[3]Program of Vocational School of Health Services, Health Care Services, Elderly Care, Çanakkale Onsekiz Mart University,Çanakkale, Turkey
[4]Department of Physiotherapy and Rehabilitation, İstanbul Aydın University, Faculty of Health Sciences, İstanbul, Turkey
[5]Department of Orthopedic Prosthesis and Orthotics, Fenerbahce University, İstanbul, Turkey
[6]Bilsev Rehabilitation Center, Kocaeli, Türkiye
[7]Department of Physiotherapy and Rehabilitation (English), Biruni University, Faculty of Health Sciences, İstanbul, Turkey

Cite this article as: Atlı E, Uyanık S, Yıldırım A, et al. Investigation of acute effects of slow controlled breathing on fatigue and vital markers during recovery phase. *Arch Health Sci Res.* 2023;10(2):137-143.

ABSTRACT

Objective: Our study aims to examine the acute effects of slow controlled breathing on fatigue, heart rate, blood pressure, and respiratory rate during the recovery period after moderate-intensity aerobic exercise in young adults.

Methods: Twenty-six volunteers between the ages of 18 and 30 were included in the study. Participants received the same aerobic exercise program. During the recovery period, the slow breathing group performed slow breathing with a respiratory frequency of 0.1 Hz (6 breath cycles/minute) combined with lower extremity static stretching exercises, while the control group only received a stretching exercise program. A modified Borg CR10 scale was used to evaluate perceived fatigue, a finger pulse oximeter was used for heart rate, and a digital sphygmomanometer was used for blood pressure. Participants were evaluated 5 times: at the beginning of the study, at the end of the aerobic exercise program (the 0th minute of recovery), 3rd minute of recovery, 6th minute of recovery, and 12th minute of recovery.

Results: At the end of the study, no significant differences were found between the groups for any parameter at each time point ($P > .050$). There were statistically significant time-dependent differences within groups in terms of respiratory rate (slow breathing group $P = .018$, control group $P > .001$), fatigue (slow breathing group $P \leq .001$, control group $P < .001$), and heart rate (slow breathing group $P = .001$, control group $P = .017$). There was no statistically significant time-dependent difference within groups for systolic or diastolic blood pressure ($P > .050$).

Conclusion: The results of this study showed that slow controlled breathing combined with stretching or stretching alone applied in the recovery phase had similar acute effects on respiratory rate, heart rate, and fatigue but not on systolic and diastolic blood pressure.

Keywords: Aerobic exercise, slow breathing, stretching exercise, heart rate, fatigue

Introduction

The exercise program includes a warm-up period followed by the main exercise program and a cool-down phase where the intensity is gradually reduced. The purpose of the cool-down period is to allow the gradual improvement of heart rate and blood pressure and the removal of metabolic end-products from the muscles. Stretching exercises are an essential component of the cool-down phase.[1] Stretching during the recovery process is effective in increasing blood circulation in tense muscles and preventing delayed muscle soreness.[2] There are various types of stretching in the literature, and static stretching is the most widely used stretching type.[3] There are also differences in the literature regarding the frequency and duration of stretching.[3,4] When breathing less than 10 times per minute with slow controlled breathing, baroreceptor sensitivity increases and sympathetic nerve activation decreases.[5,6] It is known that slow breathing exercises affect blood pressure and heart rate by increasing baroreflex and cardiac parasympathetic activity in the long term.[6-8] After the high-intensity stress test, significant changes were shown in deep-slow breathing and heart rate and electroencephalogram (EEG) values.[9] The use of deep-slow breathing during stretching exercises is effective on pain, muscle tension, and heart rate in patients with neck pain.[10,11] In recent years, it has been shown that stretching is not only related to the musculoskeletal system but also has an effect on the cardiovascular system. A limited number of studies have examined cardiovascular adaptations following stretching, and stretching has been reported as an acceptable form of exercise that can improve cardiovascular function.[12,13]

Corresponding Author: Ecenur ATLI, e-mail: fztecenur@gmail.com

Received: September 1, 2022
Accepted: April 18, 2023
Publication Date: June 26, 2023

After exercise, a low-intensity cool-down session should be performed to facilitate the gradual transition to the resting state, lasting approximately 5-10 minutes.[14] A cool-down protocol can effectively restore heart rate and blood pressure to pre-exercise resting levels, thus leading to an antiarrhythmic effect and protecting the individual from a cardiac event or hypotensive episode.[15,16] A cool-down protocol can facilitate venous return and prevent accumulation of venous blood during recovery.[14,15] Therefore, the intensity should be reduced gradually and stretching should be done after exercise.[17] Static stretching is often included in a cool-down period.[18-20] Skeletal muscle stretchings cause an important microcirculatory response that affects arterial blood flow and heart rate. Considering that stretching exercises can cause a response on the cardiovascular system such as slow controlled breathing, combining these exercises can have a positive effect on vital parameters, especially during the recovery phase after aerobic training.

This study aims to investigate the acute effects of performing stretching exercises combined with slow breathing on fatigue, heart rate, blood pressure, and respiratory rate during the recovery period after moderate-intensity aerobic exercise in young adults.

Materials and Methods

Participants

This is a randomized controlled study. The ethics approval was obtained from the Fenerbahce University Non-Invasive Clinical Studies Ethics Committee, with protocol number 204.01.07-7405. This study was carried out at Biruni University Faculty of Health Sciences between April 4, 2022, and May 6, 2022. The study was conducted according to the principles of the Declaration of Helsinki, and informed consent was obtained from the participants.

The inclusion criteria were male and female participants who are aged between 18 and 30 years and are being volunteers. The exclusion criteria were body mass index (BMI) >30, pregnant or lactating individuals, individuals who answered "YES" to at least 1 question of the Physical Activity Readiness Questionnaire,[21] previous lower extremity surgery, previous surgery within the last 6 months, and poor compliance to the intervention.

Randomization

The sample size of this study was calculated with "G*power 3.1.9.4" and was found to be 11 individuals for each group (effect size 1.11, $\alpha = 0.05$, power 90%, 2-tailed), taking into account the immediate change in heart rate (after physical exertion, before slow-paced breathing = 107.12 ± 14.10 beat/minute and after slow-paced breathing = 92.72 ± 11.18 beat/per minute) in the slow-paced breathing after physical exertion group in the study of Laborde et al.[22] Assuming the probability of the participants leaving the study, 20% of the participants were added to each group, and the sample size was determined as 26 individuals. A computer-based randomization program (random.org) was used to determine the assignment of individuals included in the study to the slow breathing group (SB group) (n = 13) and control group (n = 13). After the voluntary consent form was obtained from all participants included in the study, they were asked to choose 1 of the opaque sealed envelopes in which the numbers 1-26 were written. Participants were randomized into appropriate groups according to the selected number. Participants were not informed about which group they belonged to.

Outcome Measurements

Fingertip pulse oximeter (Sanosat-F Fingertip Pulse Oximeter) was used for heart rate, and a digital sphygmomanometer (Omron M2 Basic) was used for blood pressure. The respiratory rate was calculated by observing the participants' chest movements for 15 seconds. Then, 4 times this number was calculated, and the respiratory rate per minute was recorded.[23] Modified Borg CR10 scale was used to evaluate perceived fatigue. This scale is a scale created for the evaluation of subjective symptoms. The participants were asked to verbally rate their fatigue from 0 (absent) to 10 (most severe).[24,25]

Exercise Program

The same aerobic exercise program was performed with both groups. Aerobic exercise intensity was determined according to heart rate reserve (HRR) [target heart rate = ([maximum heart rate − resting heart rate] × % intensity) + resting heart rate]. Maximum heart rate was calculated using the formula "220 – age."[26]

A treadmill was used for aerobic exercise training. The warm-up phase lasted 5 minutes at 40%-45% of HR. After warming up, 30 minutes of aerobic exercise was performed at 50%-55% of the HRR (without incline). Then exercise training was completed with a 5-minute cool-down phase at 40%-45% of the HRR.[27] The groups continued their training programs throughout the recovery period.

Slow Breathing Group (n = 12)

After the aerobic exercise program, active static stretching exercises were performed bilaterally on the hamstring and the quadriceps muscles. Each stretching exercise was carried out 3 times as a self-applied active static stretching of 30 seconds with 30 seconds of rest for each lower extremity. The total time was planned as 12 minutes.[28] Before the intervention, full instructions were given on how the stretch should be performed, and they were asked to practice them actively under the supervision of a physiotherapist. The subject started with active static stretching of the quadriceps in a standing position with the knee resting on a chair covered with soft material. One hand gripped the ankle of the experimental leg and the other hand gripped the chair back. The subject was instructed to press the lower leg in the direction of the gluteal region and press the pelvis forward to obtain the hip extension. After the quadriceps stretching, the hamstrings were stretched in the standing position with the heel resting on a chair. The subject was instructed to lean the trunk forward with the spine upright and pelvis pressed backward to obtain a stretch over both the knee and the hip.[28]

During the stretching exercises, the participants were asked to breathe at a frequency of 0.1 Hz (6 breath cycles/minute). The first minute was an adaptation period. Breathing was paced by an acoustic signal and the words "inhale" and "exhale" were displayed on the screen. Inhalation lasted 4 seconds and exhalation 2 seconds,[29] a ratio that resembles the spontaneous ratio during breathing at 0.1 Hz when only the length of the entire breathing cycle is paced.[30]

Control Group (n = 12)

Participants were asked to actively perform the same stretching exercises program[28] described for the SB group under the supervision of a physiotherapist, without any breathing cycles.

All evaluations were repeated 5 times at the beginning of the study, at the end of the aerobic exercise program (0th minute of recovery) and at the 3rd, 6th, and 12th minutes of recovery. The time elapsed during the evaluation was added to the duration of the stretching program.

Statistical Analysis

IBM Statistical Package for the Social Sciences 21.0 program (IBM Corp., Armonk, NY, USA) was used for statistical analysis. Descriptive statistics were given as mean ± SD or n (%). Repeated measures of analysis of variance (ANOVA) were used to evaluate the time-dependent interaction of respiratory rate, heart rate, blood pressure, and fatigue levels in both groups and a 2-factor mixed pattern ANOVA was used to evaluate the time–group interaction between the groups. The sphericity assumption for iterative tests was checked with the Mauchly test, and when the sphericity assumption was met, the sphericity assumed test was applied. If the sphericity assumption was not met, the Huynh–Feldt test was used for cases where the epsilon value was greater than 0.75 and the Greenhouse–Geisser test was used where the epsilon value was less than 0.75. The effect sizes of the relevant differences were evaluated by calculating the partial eta-square (ηp^2). The significance level was determined as $P < .05$ in all tests.

Results

Thirty subjects were examined for eligibility. Twenty-six subjects were included in the study. Two subjects were excluded from each group during the intervention because of poor compliance to follow the instructions during the interventions. Twenty-four subjects completed the study (Figure 1). No adverse events occurred during the assessments and interventions. No adverse event was observed related to the interventions.

Age, gender, BMI, and baseline vital markers of the groups were all similar ($P > .050$) (Table 1). The respiratory rate, fatigue, heart rate, and systolic and diastolic blood pressure measurements of the groups, the relative time (the baseline, 0th, 3rd, 6th, and 12th minutes of recovery), and the group common effect are shown in Table 2. Accordingly, the effects of time and the effects of study groups on respiratory rate, fatigue, heart rate, and systolic and diastolic blood pressure were not statistically significant ($P > .050$).

Changes in respiratory rate were examined in the groups. There were significant differences between 0th and 3rd minute of recovery ($P = .022$, 95% CI 0.535/8.631), 0th and 6th minute of recovery ($P = .005$, 95% CI 1.860/11.307), and 0th and 12th minute of recovery ($P = .009$, 95% CI 1.967/15.367) in the SB group. Significant differences were found between the baseline and 0th minute of recovery ($P < .001$, 95% CI –11.743/–6.924), the baseline and 3rd minute of recovery ($P = .001$, 95% CI −9.291/−2.543), the baseline and 6th minute recovery ($P = .011$, 95% CI −7.346 /−0.821), 0th and 6th minute of recovery ($P = .004$, 95% CI 1.595/8.905), 0th and 12th minute of recovery ($P = .003$, 95% CI 2.397/12.103), 3rd and 12th minute of recovery ($P = .035$, 95% CI 0.211/7.456), and 6th and 12th minute of recovery ($P = .039$, 95% CI 0.075/3.925) in the control group.

The changing trend in Borg fatigue values over time showed significant differences between the baseline and 0th minute of recovery ($P < .001$, 95% CI –3.825/–2.008), 3rd minute of recovery ($P = .001$, 95% CI −3.139 /−0.861), and 6th minute of recovery ($P = .013$ 95% CI −3.186/−0.314) in the SB group. The changing trend in Borg fatigue values over time in the control group showed significant differences between the baseline and 0th minute of recovery ($P < .001$, 95% CI −5.984/−2.349), 3rd minute of recovery ($P = .002$, 95% CI −4.766/−1.068), 6th minute of recovery ($P = .002$, 95% CI −3.936/−0.897), and 12th minute of recovery ($P = .043$, 95% CI −3.296/−0.037).

The heart rate change was analyzed over time in the groups. There were significant differences between the baseline and 0th minute of recovery ($P < .001$, 95% CI −45.889/−13.611), 3rd minute of recovery ($P = .005$, 95% CI −22.827/−3.673), 6th minute of recovery ($P = .009$, 95% CI 4.934/38.399), and 12th minute of recovery ($P = .003$, 95% CI 8.019/40.814) in the SB group. Significant differences were found at the baseline and 0th minute of recovery ($P = .004$, 95% CI −43.771/−7.729), 3rd minute of recovery ($P = .013$, 95% CI −20.712/−2.121), and 6th minute of recovery ($P = .019$ 95% CI −16.150/−1.183) in the control group.

The effect of time and study groups was not statistically significant for systolic blood pressure values ($P = .539$). Systolic blood pressure did not differ according to the groups, at the baseline ($P = .495$), 0th minute of recovery ($P = .477$), 3rd minute of recovery ($P = .892$), 6th minute of recovery ($P = .467$), and 12th minute of recovery ($P = .475$). The SB group ($P = .861$) and control group ($P = .062$) did not differ in measurements of the baseline, 0th, 3rd, 6th, and 12th minute of recovery.

The effect of time and study groups was not statistically significant for diastolic blood pressure values ($P = .408$). Diastolic blood pressure did not differ according to the groups, at the baseline ($P = .495$), 0th minute of recovery ($P = .051$), 3rd minute of recovery ($P = .219$), 6th minute of recovery ($P = .771$), and 12th minute of recovery ($P = .728$).

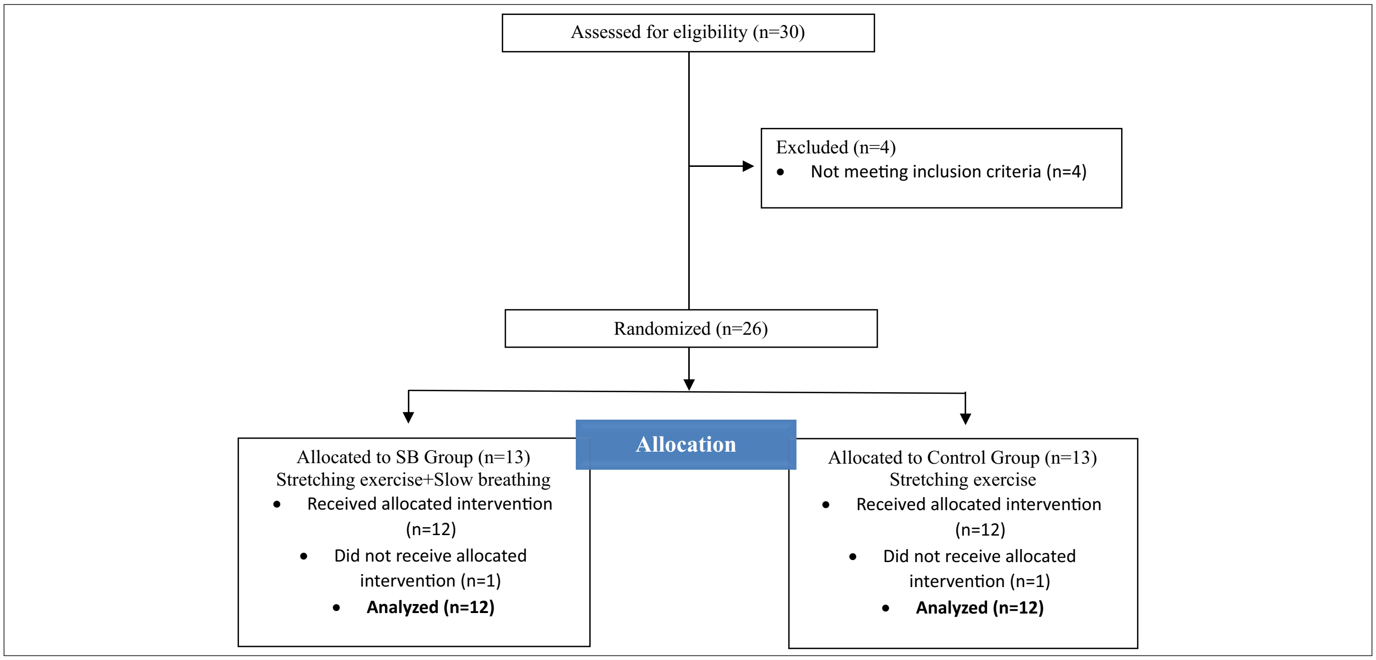

Figure 1. Flowchart indicating the flow of participants throughout the study.

Table 1. Evaluation of Demographic Information for the SB Group and Control Group (n = 24)

		SB Group (n = 12)	Control Group (n = 12)	TS	P
Gender	Female	5 (42%)	8 (67%)	1.510[δ]	.219
	Male	7 (58%)	4 (33%)		
Age		26.08 ± 3.554	24.83 ± 3.762	−0.759[β]	.478
BMI (kg/m^2)		22.91 ± 3.894	22.44 ± 4.675	0.266[α]	.793
Borg fatigue score (0-10)		1.83 ± 1.749	1.58 ± 1.782	−0.385[β]	.713
Respiratory rate (breaths/ minute)		20.92 ± 5.838	17.33 ± 5.694	−1.366[β]	.178
Systolic blood pressure (mmHg)		117.33 ± 12.22	113.67 ± 13.614	0.694[α]	.495
Diastolic blood pressure (mmHg)		79.17 ± 13.121	75.58 ± 12.845	0.676[α]	.506
Heart rate (bpm)		88.33 ± 11.625	82.83 ± 14.597	1.021[α]	.318

[α]Independent sample *t*-test; [β]Mann–Whitney *U*-test; [δ]Chi-square test.
BMI, body mass index; SB, slow breathing; TS, test statistic.

The SB group ($P = .283$) and control group ($P = .107$) did not differ in the baseline, 0th, 3rd, 6th, and 12th minute of recovery ($P > .050$).

Discussion

The results of this study showed that the acute effects of stretching exercises simultaneously with slow breathing on fatigue, heart rate, blood pressure, and respiratory rate were similar compared to stretching alone after moderate-intensity aerobic exercise.

The cardiovascular and respiratory systems are highly active during exercise to supply blood and oxygen to the muscles, and these systems do not return to resting levels immediately after exercise. Heart rate remains slightly above resting heart rate for a relatively long time after exercise, depending on the intensity and duration of the exercise.[15] Takahashi and Miyamoto found that heart rate was significantly reduced in people who underwent active cooling interventions 10 minutes after exercise. A later study confirmed these findings and showed that vagal and sympathetic tones were restored more rapidly with active cooling.[31] Slow breathing is one of several breathing techniques, usually to induce relaxation or voluntary hyperventilation or generally to achieve psychophysiological activation.[32,33] Slow-paced breath aims to reduce respiratory frequency below 10 cpm.[33,34] The physiological benefits of slow-paced breathing are based on its effects on respiratory sinus arrhythmia, baroreflex, pulmonary afferents, vagus nerve, and strengthening brain network dynamics.[35-38] The amplitude of the respiratory sinus arrhythmia increases and the baroreflex—represent ing the homeostatic system that regulates blood pressure—is stimulated with slow breathing.[35] Also, slow-paced breathing with prolonged exhalation increases cardiac vagal activity which creates a relaxing effect on the heart with a parasympathetic effect.[32,34,36,39,40] A frequency of about 6 breath cycles per minute is thought to trigger the largest increases in baroreflex stimulation, resonance effects, and cardiac vagal activity.[36,37,41]

Tharion et al[42] examined the effect of deep-slow breathing exercises on spontaneous breathing rate and heart rate variability in healthy individuals, and deep-slow breathing exercises were practiced for 30 minutes, 6 breath cycles/minute (4 seconds inhale and 6 seconds exhale) every day for a month and the control group received no intervention. As a result of the study, a significant decrease in the spontaneous resting respiratory rate was obtained. Likewise, in our study, deep-slow breathing was used at 6 breath cycles/minute (4 seconds inhale and 6 seconds exhale). There was a statistically significant change in the respiratory rate as an acute effect in the SB group and control group. We think that slow controlled breathing combined with stretching applied periodically following the aerobic training may provide more effective regulation of respiratory rate by stimulating parasympathetic activity in the long term.

Previous studies suggest deep-slow breathing exercises for relaxation and lowering arterial blood pressure in patients with hypertension.[6,43] The reason why there was no significant difference in a blood pressure change in our study may be because the individuals in our study population were between the ages of 18 and 30 without any health problems. Wongwilairat et al[10] examined different relaxation patterns with deep-slow breathing to reduce muscle tension and provide relaxation in 32 participants with neck muscle tension. It has been found that a slow and synchronized model applied repeatedly at least 4 times between deep-slow breathing, stretching, and eye-closed period is effective in reducing neck tension and pain as well as promoting relaxation in a short time. However, heart rate changes were not found to be significant which may arise from the short duration of the intervention (roughly 150 seconds) or the negative emotions of the subjects while performing an unfamiliar intervention. Similar to this study, there was no significant difference in heart rate change between the SB group and control group in our study.

Laborde et al[22] investigated the effect of slow-paced breathing on inhibition performance before and after physical exertion. It showed that slow-paced breathing before or after physical exertion had positive effects on the recovery of heart rate and respiratory frequency. Findings from high-performance sports show that the degree of perceived effort will generally increase linearly to the finish, providing an even pacing strategy is used under standard conditions.[44] Joosen et al[45] found a significant and clinical reduction in fatigue complaints after 6 weeks of the physical endurance training and breathing exercise program. In our study, we observed that the perceived fatigue level after aerobic exercise performed on the treadmill increased compared to the pre-exercise period and also observed a reduction in fatigue during the recovery period in both groups.

Thongtipmak et al[11] found the instantaneous effect of deep-slow breathing during stretching exercises in individuals with neck pain, and a significant improvement was shown in pain and joint range of motion. In our study, a similar breathing method was used, and its applicability with stretching exercises was demonstrated. Chethan et al[46] investigated the acute effect of deep breathing exercises on heart rate in healthy adult investigation that has been carried on Cheathan et al has common perspective with our studies. However, it was studied with a larger sample group than ours, and no statistically significant difference was found. It is thought that this may be caused by examining acute effects. Cheema et al[47] demonstrated in his study that a 10-week (50 minutes per session) hatha yoga program applied 3 sessions a week with 37 office workers did not improve heart rate parameters. Contrary to this study, statistically significant results were found in heart rate in our study. It is thought that this may be due to the hatha yoga technique or because long-term effects were not shown in our study. Sharma et al[48] examined the effects of fast and slow pranayama, which is yogic practice, on cardiovascular parameters in healthy young adults, and a significant decrease was shown in heart rate and diastolic blood pressure, especially in the group that underwent slow pranayama. Pramanik et al[49] examined 39 healthy individuals between the ages of 25 and 40 who performed the Bhastrika Pranayama breathing method, which is slow yoga breathing, 6 breaths/minute for 5 minutes, and evaluated the instant results, and a decrease in systolic and diastolic blood pressure and a slowdown in heart rate were shown. In our study, a slow breathing technique of 6 breaths/minute was used, and a statistically significant difference

Table 2. Comparison of Respiratory Rate, Borg Fatigue Score, Heart Rate, Systolic Blood Pressure, and Diastolic Blood Pressure Measurements

		All Groups		Time × Group for Each Time Point			Time × Group		
		SB Group (n = 12)	Control Group (n = 12)	*F*	*P*	η^2	*F*	*P*	η^2
Respiratory rate (breaths/ minute)	Baseline	20.92 ± 5.83	17.33 ± 5.69	2.31	.142	0.095	2.23	.095	0.383
	Zeroth minute of recovery	25.58 ± 8.26	26.67 ± 4.77	0.15	.698	0.007			
	Third minute of recovery	21.00 ± 8.10	23.25 ± 4.47	0.70	.409	0.031			
	Sixth minute of recovery	19.00 ± 6.62	21.42 ± 4.96	1.02	.323	0.044			
	Twelfth minute of recovery	16.92 ± 5.24	19.42 ± 6.02	1.17	.290	0.051			
Within-group change	*F**	**5.65**	**40.56**						
	P	**.018***	**.000***						
	η^2	0.73	0.95						
Borg fatigue score (0-10)	Baseline	1.83 ± 1.74	1.58 ± 1.78	0.12	.732	0.005	1.34	.292	0.271
	Zeroth minute of recovery	4.75 ± 1.60	5.75 ± 1.28	2.83	.106	0.114			
	Third minute of recovery	3.83 ± 1.94	4.50 ± 1.67	0.80	.379	0.035			
	Sixth minute of recovery	3.58 ± 1.92	4.00 ± 1.65	0.32	.575	0.014			
	Twelfth minute of recovery	2.83 ± 1.94	3.25 ± 2.00	0.26	.611	0.012			
Within-group change	*F**	**42.51**	**17.80**						
	P	**.000***	**.000***						
	η^2	0.95	0.89						
Heart rate (bpm)	Baseline	88.33 ± 11.62	82.83 ± 14.59	1.04	.318	0.045	0.94	.474	0.209
	Zeroth minute of recovery	118.08 ± 21.03	108.58 ± 23.71	1.07	.310	0.047			
	Third minute of recovery	101.58 ± 17.41	94.25 ± 15.25	1.20	.284	0.052			
	Sixth minute of recovery	96.42 ± 18.11	91.50 ± 17.51	0.45	.506	0.020			
	Twelfth minute of recovery	93.67 ± 16.17	89.92 ± 16.93	0.30	.585	0.014			
Within-group change	*F**	**13.70**	**5.82**						
	P	**.001***	**.017***						
	η^2	0.87	0.74						
Systolic blood pressure (mmHg)	Baseline	117.33 ± 12.22	113.67 ± 13.61	0.48	.495	0.021	0.84	.539	0.189
	Zeroth minute of recovery	120.17 ± 12.72	124.42 ± 15.87	0.52	.477	0.023			
	Third minute of recovery	119.75 ± 19.13	118.67 ± 19.58	0.01	.892	0.001			
	Sixth minute of recovery	119.92 ± 17.73	115.00 ± 14.64	0.54	.467	0.024			
	Twelfth minute of recovery	117.08 ± 17.07	112.50 ± 13.58	0.52	.475	0.023			
Within-group change	*F**	0.30	3.50						
	P	.861	.062						
	η^2	0.13	0.63						
Diastolic blood pressure (mmHg)	Baseline	79.17 ± 13.12	75.58 ± 12.84	0.45	.506	0.020	1.07	.408	0.230
	Zeroth minute of recovery	81.67 ± 8.71	80.83 ± 9.38	0.05	.824	0.002			
	Third minute of recovery	77.83 ± 6.95	75.83 ± 13.06	0.21	.644	0.010			
	Sixth minute of recovery	81.50 ± 18.09	76.17 ± 10.72	0.77	.389	0.034			
	Twelfth minute of recovery	81.08 ± 10.51	72.92 ± 7.65	0.72	.041	0.177			
Within-group change	*F**	1.52	2.71						
	P	.283	.107						
	η^2	0.43	0.576						

Data are presented as mean ± Standard Deviation.
F: analysis of variance, *p<050; F*: Analysis of variance in repeated measurements; η^2, partial eta square.

was found in heart rate, but no significant difference was observed in blood pressure. We think that the reason is due to the examination performed after aerobic exercise.

This study has some limitations. We investigated the acute effects of slow breathing, and long-term intervention may lead to different results. The absence of a control group in which no treatment was applied may be considered a limitation. The respiratory rate is recorded by direct observation because of a lack of equipment. The difference between our study from previous studies is the application of deep-slow breathing exercises together with stretching exercises in the recovery phase after aerobic exercise and the examination of its acute effect.

Conclusion

As a result of our study, it was found that the acute effects of slow controlled breathing combined with stretching on fatigue, heart rate, and respiratory rate were similar compared to stretching alone after moderate-intensity aerobic exercise. Both methods have no impact on the recovery of blood pressure. Clinicians may consider combining slow controlled breathing with stretching in the cool-down and recovery phases based on the choices of the patients/clients. Future studies should examine the long-term effects of slow controlled breathing combined with stretching in different populations.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Fenerbahçe University (Date: MArch 24, 2022, Number: 204.01.07-7405).

Informed Consent: Written informed consent was obtained from volunteer individuals who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – E.A., S.U., A.Y., N.Y., G.D.U., M.A., B.A.; Design – E.A., N.Y., B.A.; Supervision – B.A.; Resources – E.A., S.U., A.Y., N.Y., G.D.U., M.A.; Materials – E.A., S.U., A.Y., N.Y., G.D.U., M.A.; Data Collection and/or Processing – E.A.,S.U.,A.Y.; Analysis and/or Interpretation – E.A., A.Y., B.A.; Literature Search – E.A., S.U., A.Y., N.Y., G.D.U., M.A.; Writing Manuscript – E.A., S.U., A.Y., N.Y., G.D.U., M.A.; Critical Review – B.A.

Declaration of Interests: The authors declare that they have no competing interest.

Funding: The authors declared that this study has received no financial support.

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